REG. No. 24918 / 64
ISSN: 0022 - 1155
CODEN: JFSTAB

JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

ASSOCIATION OF FOOD SCIENTISTS & TECHNOLOGISTS (INDIA)

Vol.34, No.6 November-December 1997

ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS (INDIA) MYSORE - 570 013

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- Advancement of all the aspects of Science and Technology relating to production, processing and distribution of food, with the ultimate objective to serve humanity through better food.
- Promotion of research, development and training in the science, Technology and Engineering of Food.
- To provide a forum for exchange, discussion and dissemination of knowledge and current developments, especially among Food Scientists and Technologists as well as the Public and Society at large.

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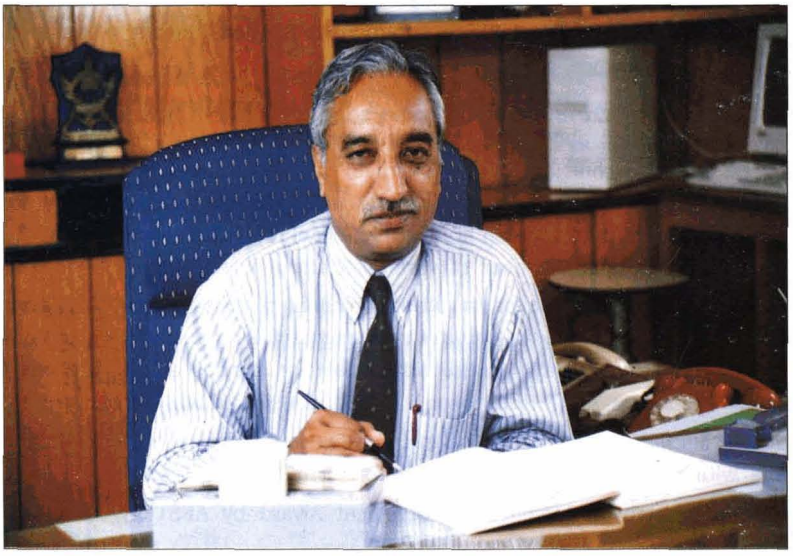
Dr. S.S. ARYA
PRESIDENT
ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS
(INDIA) FOR THE YEAR 1997-98



Helms of AFST (I) in the Strong Hands of a Dynamic and Distinguished Food Scientist of International Repute

Dr. Sada Singh Arya, born on April 5, 1939 at Mahendargarh in Haryana State and presently holding the post of Director of the Defence Food Research Laboratory (DFRL), Mysore, one of the constituent institutions of Defence Research and Development Organisation under the Ministry of defence, New Delhi, has taken over charge as President of AFST (I) for the period 1997-98 at a glittering ceremony in Mumbai on September 26, 1997.

It is my honour and privilege to introduce Dr. Arya to the subscribers and the readers of the *Journal of Food Science and Technology*, as well as the members of the AFST (I).

Dr. Arya took his Master's degree in chemistry in 1965 from Birla Institute of Technology and Science, Pilani, securing second position in the Order of Merit. After a short stay at the Kurukshetra University, Kurukshetra, he joined DFRL, Mysore, in 1966 as Senior Scientific Officer. While in service, he obtained his Ph.D. degree from the University of Mysore in 1978.

During his long research career spread over three decades, Dr. Arya has made valuable original contributions in the fields of fats and oils, food additives, food colourants, food flavours, cereal processing and convenience foods. His work on preservation of *chapatis* in the ready-to-eat form, formation and degradation of flavouring compounds in *chapatis*, role of lipids in flavour generation in foods and interactions of sorbic acid in foods is well recognised and being widely cited. Dr. Arya's work on carotenoids and anthocyanins in foods, the role of water activity, metal ions, lipids and other food constituents, led to better understanding of the mechanism of their degradation, thereby enabling the process development for their stabilisation and food quality enhancement.

Dr. Arya has always believed that the food industry can not grow without indigenisation and also without attending to the food needs of vast middle class consumers in India. To achieve this objective,

he has persistently investigated various methods for developing ready-to-cook and ready-to-eat foods of Indian cuisine. He has successfully developed more than 20 processes for instant cooking foods of Indian cuisine. These products require mere mixing with hot water for cooking and are comparable to instant products developed anywhere in the world. Dr. Arya has made valuable contributions in the designing of Operational Pack Rations for Indian Armed Forces, the major among these are the rations for Indo-Soviet Space Mission, Antarctica Expeditions, Compo Pack Rations and Survival Rations for Army, Navy and Air Force. In addition, he has made notable contributions to the development of standards and analytical methodologies for quality assurance programmes.

More than 15 process technologies developed by Dr. Arya are commercially utilized by food processing Industry. Dr. Arya has published about 225 research papers in peer-reviewed, reputed journals in both India and abroad. He has also contributed 4 chapters in books. Dr. Arya is a member of editorial and advisory boards of many journals and a recognised research guide in the faculty of food science and technology and chemistry. More than a dozen students have obtained their M.Sc. and Ph.D. degrees under his guidance. He is also Chairman/Member of various National Committees.

Dr. Arya has been solely responsible for establishing technology transfer extension services and training facilities at DFRL, He has been mainly instrumental in successfully transferring the know-how of about 40 technologies to the industry. Dr. Arya is also responsible for starting a P.G. Diploma Course in Food Analysis and Quality Assurance at DFRL, Mysore, which has been highly acclaimed by the industry.

In recognition of his outstanding contributions, various research associations and peer groups have honoured Dr. Arya with many prestigious awards. Prominent among these are:

(1) Prof. V. Subrahmanyan Industrial Achievement Award by AFST (I), 1992.

(2) AFST (I) Gardner's Best Publication Award, 1971.

(3) K.U. Patel Award by All India Food Preservers' Association.

(4) N.A. Pandit Award by All India Food Preservers' Association.

(5) Twentieth Century 500 Best Personality Award by American Biographical Research Association.

Dr. Arya is also fellow of the AFST (I) and member of New York Academy of Sciences.

Mrs. Shanti, the better-half of Dr. Arya, supports him in all his scientific, social and cultural endeavours. The culinary dishes churned out by Mrs. Shanti are so delicious that one yearns for a chance to devour these traditional preparations. Dr. Arya is blessed with two unmarried sons and two married daughters. Ms. Anita, the elder daughter, did her M.A. in Hindi, while Ms. Saroj, the younger daughter, did her M.Sc. in Foods and Nutrition. Mr. Sanjay, the elder son, did B.E. in Mechanical Engineering and is presently undergoing training in Marine Engineering. The younger son, Mr. Vijay, did B.E. in Computer Science and is presently working in Bangalore.

On behalf of the Central Executive Committee, Advisers, Editors, Associate Editors and Editorial Board Members of *Journal of Food Science and Technology*, and also on my own behalf, I warmly congratulate Dr. S.S. Arya on his assumption of the office of the President, AFST (I) and wish him all success in his endeavours to lift the Association to still greater heights.

B.K. LONSANE
Editor-in-Chief
Journal of Food Science and Technology

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JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

Volume 34 Number 6 November/December 1997

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Journal of Food Science and Technology, devoted to original R & D contributions in all branches of Science, Technology and Engineering of Foods and Food Products, is a bimonthly publication of the Association of Food Scientists and Technologists (India), Mysore. Review papers are also published to a limited extent.

Manuscripts for publication, books for reviewing and matter concerned with advertisements in the Journal should be addressed to the Editor, Journal of Food Science and Technology, AFST (I), CFTRI Campus, Mysore-570 013, India.

The Instructions to Authors are published in the January-February issue of the journal. These are required to be followed *in toto*. No deviation is accepted.

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Processing of Potatoes: Current Status, Need, Future Potential and Suitability of Indian Varieties - A Critical Appraisal

R.S. MARWAHA

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Potato processing, which is of ancient origin, started in India on a commercial scale in 1911. It is mainly confined to the developed countries and is in its infancy in most of the developing countries. However, it is expected that there is a vast scope for fast growth in India due to increased preferences for easy-to-prepare and fast foods. Fried products such as chips and French fries are likely to become more popular. The quality of processed products based on tubers is mainly influenced by morphological characters, dry matter and reducing sugar content. Evaluation of Indian potato varieties revealed that many of the present day varieties are suitable for various forms of processing. There is an immediate need to breed varieties exclusively for processing. Processing operations generally reduced the levels of reducing sugars, amino acids, vitamins and minerals in the finished products. An attempt has been made in this review, to critically appraise the current status and future potential of Indian varieties of potatoes *vis-a-vis* their processing.

Keywords : Potato, Processing, Chips, French fries, Starch, Potato flour, Flakes, Canning, Dry matter, Sugar, Discoloration, Varieties, Vitamins, Minerals, Free amino acids.

Potato processing is a very old method and has been practised in the highland areas of Peru and Bolivia for at least 2000 years. The dried products known as *chuno* and *papa seca* are a vital part of the diet in these areas and are produced by the methods unchanged over these years (Woolfe 1987). For many centuries, potatoes served as the primary food source of the Indians of Peru. Apparently, sufficient potatoes were dehydrated for supply during periods of shortages, when these were not available between crops. During the eighteenth and nineteenth centuries, when the potato became the major source of food in a large part of Europe, its two principal disadvantages- bulk and comparatively short storage life as compared with grains- became apparent. In Europe, experiments with various types of dried potatoes were made in the later half of the eighteenth century partly to increase the usefulness of the tubers as ships' provisions. A sample of potato flour or meal prepared in 1786, kept well for a long time (Fraser 1794).

Little work was accomplished along this line either in Europe or the United States until World War I, when a number of dehydrated potato products were required to be manufactured for military use. This war industry ceased to function soon after hostilities were over, although considerable quantities of potato flour, both for stock feeding and human consumption continued to be produced in Europe and to a lesser extent in the United States and England. Potato starch, which uses substantial quantities of potatoes, has been produced both in the United States and in England for over 100 years.

The first starch plant was established in the USA in 1831 and within a few years, over 100 plants were producing potato starch (Talburt 1987a). The manufacture of frozen French fries on an industrial scale started in the USA in 1945 and is the fastest growing category among processed products in the USA. Potato chips were first made in the USA in the middle of the nineteenth century and for a number of years they were prepared at a small scale, but their commercial production started only after 1944, when industrial techniques of potato peeling and frying were introduced (Lisinska 1989).

In India, the first attempt to process potatoes on a commercial scale was made by Col. Rennick, who established a factory at Narkanda in Himachal Pradesh to produce potato meal (Rennick 1911). He utilized hand-operated machines for peeling and slicing and cauldrons and furnaces for boiling and drying. The yield of the dried product was between 16-20%. The meal contained 84.1% carbohydrates, 9.5% proteins, 6% salts, including 2.5% potash and 0.4% fat and possessed anti-scorbutic properties.

Present position

Processing is a fast growing sector within the world potato economy. Currently, for instance, about half of the annual crop in the USA is processed. Processing has also expanded in Western Europe and has been the focus of numerous initiatives in Eastern Europe and the countries of

Commonwealth of Independent States (CIS). Processing has shown fast growth in many developing countries, especially in Argentina, Columbia, China and Egypt. The use of potato as stockfeed has declined in Eastern Europe and in the CIS (FAO and IPC 1995).

In the Netherlands and the USA, processing absorbs about 55 and 60%, respectively of the annual potato crop (FAO and IPC 1995). It is interesting to note that in the USA, only 4% of the harvest was processed into French fries in 1959-60, as against 32% in 1989-90. In the Netherlands, processors produced just 6000 tonnes of French fries in 1960 as against 1.47 million tonnes in 1990. Industrial manufacturing of processed potatoes seems to be only in its infancy in most of the developing countries with the exception of China (12%), Korea DPR (6%) and Mexico (8%).

In India, about 1000 tonnes of dehydrated potato products were produced for armed forces and the same quantity was canned in 1984-85 (Kankan 1986). Many processing plants with an annual capacity of 25,000 tonnes have been installed (Kankan 1986) and now, it may have increased to about 50,000 tonnes per annum. Naik Kurade (1986) reported that 6 plants for producing chips and 2 for French fries have been set up. The installed capacity of potato chips in organized sector was 6000 tonnes (Goenka 1990) and several brands of chips are available in the market. In India, processing of potatoes constitutes less than 0.5% of the total annual production. Thus, there is a considerable scope for expansion of processing in India.

Need and future scope for potato processing

On an industrial scale, processing is confined mainly to developed countries. Some developing countries in South America process potatoes into snack foods or instant mashed potato, but the market for these products is currently negligible, compared to that for fresh potatoes, due to economic restrictions. It is possible that future demand for such products and potatoes in the form of other convenience foods may increase. In some countries, for example India, processing of potatoes is desirable to avoid gluts and the consequent difficulty of storing large quantities of potatoes during period of extremely high temperature. Dehydration using solar energy has been suggested (Singh and Verma 1979), as a means of coping with the problem, particularly as a cottage industry in rural areas (Nankar and Nankar 1979; Sikka 1988). Processing in India is also desirable in places like Nilgiri hills in Tamil Nadu, where cyst forming nematodes present a problem and in Darjeeling district in West Bengal, where wart disease is prevalent. Processing in these areas will check the inflow of infected potatoes to other parts of India (Sukumaran and Verma 1993).

The change from fresh to processed potatoes in developed countries is partly due to enhanced efficiency in processing, which reduced the relatively high cost of canned, dried and frozen forms and partly due to factors such as increased demand for convenience foods, fast foods and picnic snacks. However, the situation is quite different in India. Potatoes, as a raw material, are not cheap except for a few weeks just after harvest. The costs of frying medium, processing, packaging and transportation add further to the cost of the finished product and it is beyond the reach of a common man. Potato chips in 50 g packets are priced at Rs. 240/kg and packaging accounts for over 10-15% of the total cost. Although, the demand for fried potato products like chips and French fries is likely to increase in India due to increased urbanization, preference of new generation for fast foods, rising per capita income, increase in the number of working women preferring ready-cooked food and expanding tourist trade, its consumption will be limited only upto the rich urban class. These products are not likely to come within the reach of an ordinary man. In order to make processed products available to the common man, it would be desirable to develop appropriate technology for the production of dehydrated products such as potato dices, granules and flour. Dehydrated dices can be cooked along with other vegetables in households. Potato granules and flour can be used for preparing *tikkis* in the fast food outlets and extruded products like *papads* as a cottage industry. Potato flour can also be used in the preparation of *idli*, *alu bhujiya* etc.

Further, there is a vast scope for installing chip processing and granule and starch production plants in certain areas in Uttar Pradesh, West Bengal, Gujarat and Punjab, where potatoes are grown extensively and the production is very high. The sub-standard potatoes unsuitable for the tablestock market, which are either cull, damaged, green, under-sized or over-sized along with the surplus potatoes, arising due to occasional gluts in these areas, will find their beneficial utilization in making granules or in the production of starch. Potato starch can be used to develop custard

powder, which has a superior taste over corn custard. It is reported that pre-gelatinised potato starch is used in making instant puddings in the USA and is preferred over cereal starches (Treadway 1987).

Forms of potato processing

Potato products may be classified as follows:- 1. Fried products, which include potato chips, frozen French fries and other frozen products, 2. Dehydrated products, such as dehydrated dices, potato flakes, potato granules, potato flour and potato starch, 3. Canned potatoes, 4. Pre-peeled potatoes and 5. Miscellaneous products such as alcohol, lactic acid and certain food products.

Potato chip, a fried snack food, was the most important form of processed potato product in the UK till 1979 and constituted about 38% of all potatoes destined for processing, although French fries superseded the chips afterwards. Chips should be fried, until 2% moisture is achieved. Potatoes are fried to produce chips and French fries in cooking oil at about 180-200°C for about 2 (chips) to 4 min (French fries). In case of chips, frying is considered complete, when bubbling stops, indicating the removal of the great bulk of water, while in French fries, when a sample breaks cleanly to show fully cooked tissue, the water content usually is in the order of about 60% (Burton 1989). At these respective stages, the colour of the chips or French fries should be according to the local preference, which may be from light yellow to brown. Chips should have a light yellow colour and possess pleasing and desirable flavour with a crispy texture. In order to get a finished product of good quality, it is necessary that potatoes destined for chipping should be fully mature, healthy, without any mechanical injury, uniform size (40-60 mm), round to oval, firm with shallow eyes and free from any internal or external defects.

Frozen French fries and other frozen products constitute about 60% of the processed potato products in the USA (Holm et al. 1994). Frozen French fries are the most important form of the frozen potato products, which are potato strips of 1 x 1 cm^2 in cross-section and 6-7 cm in length. They may be either par-fried or finish-fried by the processor. In the former case, they are later finish-fried in deep-fat, and in the latter, oven-heated before consumption. Other frozen products are potato patties, puffs and rounds, hash-browns and mashed potato. In general, high solids tubers of mealy texture are preferred for manufacture of frozen French fries. The high solids potatoes contain less water and provide better finished- product texture. The final yield of finished French fries from fresh potatoes is in the range of 30-45%.

Dehydration is one of the major means of preserving potatoes, giving products such as potato flour, granules, flakes and dice. The dehydration industry is particularly important in France, using 61% of all potatoes destined for processing in 1977-78 (Young 1981). Potato granules and flakes are convenience foods both for domestic and large scale use. The processes for granules and flakes preparation can use rejected potatoes, as they have less stringent raw material requirements (Hughes 1983). Dehydrated potato dice is an ingredient in processed foods such as canned meats, meat stews, frozen meat pies and potato salad. Potato flour is used by the baking industry and is incorporated in the baking of bread to retain its freshness. It also imparts a distinctive, pleasing flavour and improves toasting qualities. The generally accepted level of potato flour in the bread is 6% (Willard and Hix 1987). It is also used as a combined thickener-flavouring agent in products such as dehydrated soups, gravies, sauces and baby foods.

Potato starch is used in paper manufacture for beater sizing, tub sizing, calendar sizing and surface coating. It is also used in the textile industry in the sizing of cotton, worsted and spun rayon warps. Much of the potato starch utilized in the food industry is used in bakers' speciality items like Swedish and German style breads, crackers and matzoth. It is also used as a thickener in soups and gravies. Potato starch has been successfully used to make puddings. Pre-gelatinised potato starch is used in considerable quantities in instant puddings, in which its properties are preferable to those of cereal starches. Starch is used in confectionery industry as a medium for molding cast candies such as jelly beans and gum drops, as a thickening agent in synthetic jellies and as a dusting agent mixed with powdered sugar, for candy gums, chewing gums etc. It is also used in producing adhesives and dextrins, as a fermentation raw material, binder for tablets and binder and extender for sausages (Treadway 1987). The highest annual potato starch production is in the Netherlands, while France, Germany, Poland and Russia are important producers of starch. Sub-standard potatoes like too small, too large, misshapen, damaged, cull and surplus potatoes not fed to livestock can be used in starch manufacture.

Canned food is convenient, but it is bulkier and expensive to transport. Potatoes are canned in all the major growing areas of the USA. Small and whole potatoes are preferred for canning, but some may be diced, sliced or cut into strips. Whole potatoes, usually smaller than 1 1/2 inch in diameter, make up the greatest part of the potatoes, that are canned. The potatoes used for canning are not specifically grown for this purpose, but are primarily smaller potatoes not suitable for fresh market. Generally, after the harvest, small potatoes are separated from the larger ones and sent to the canneries for canning. Under such conditions, the processing season does not exceed 60 days. The only exception to this exists in Maine in the USA, where potatoes are canned for about 10 months in a year (Talburt 1987b). Potatoes for canning should be carefully inspected for insect or physical injury, bacterial diseases, sprouting, necrosis, excessive immaturity and greening. The green discoloration is not readily removed by normal peeling and may contribute a bitter taste to the canned product. Freshly harvested potatoes yield a better quality canned product and are easier to peel and require less labour for inspection and trimming.

Production of pre-peeled potatoes is a growing industry in developed countries. Peeled potatoes are available in both canned and frozen forms, but the term refers to peeled potatoes, preserved from discoloration by some chemical treatment and stored at a temperature of about 7°C. They are perishable and have a relatively short shelf-life, but are supplied to restaurants, canteens and retail establishments, where they do not need to invest in their own peeling machines. Potatoes may be whole, or cut into strips for French fries.

Potatoes have served as a raw material in many different industrial as well as food products. Potatoes are rich in starch, which can readily be converted into the fermentable sugars like maltose and dextrose for production of alcohol and other chemicals. Potatoes may be ground to a slurry in a hammer mill, then cooked and treated with malt or other preparations containing starch- splitting enzymes. Procedures for yeast fermentation and recovery of alcohol are generally similar to those with other starchy raw materials. Utilization of potatoes by fermentation has never achieved any degree of commercial importance in the USA (Feustel 1987). Butyl alcohol, used in the formulation of lacquers and in synthesis of organic chemicals, was also produced from potatoes. Except for special applications, potatoes are not considered as an economical raw material for use in fermentation. Since potatoes consist of about 80% water, they are bulky and costly to transport and handle.

Potato broth, the liquid obtained from boiled potatoes, has long been used by microbiologists as an ingredient of culture media for stimulating the growth of various bacteria, yeasts and molds. The amino acid composition and minerals together with carbohydrates in potatoes furnish an excellent medium for the growth of microorganisms. The potato broth or infusion to be used in a culture medium may be prepared from fresh potatoes.

Production of lactic acid as a fermentation product of potatoes was investigated by Cordon et al (1950). Either malt or sulphuric acid was used for conversion of the starch to sugar in preparation for fermentation. Fungal amylases were also used to convert the starch into sugars and several strains of lactobacillus were evaluated for their ability to produce lactic acid.

Certain food products, which can be produced from potatoes, include canned potato salad, canned corned beef hash and beef stew, potato soup, canned French fries or shoestring potatoes, potato pancakes, pancake mixes, potato chip bars, potato nuts and potato puffs. These products are prepared on a commercial scale in the USA.

Factors influencing processing

Processed potato products have been categorized mainly into 3 forms. (1) Fried products such as chips and French fries (2) Dehydrated products such as granules, flakes, dices, flour etc. and (3) Canned potatoes. The raw material requirements for different forms of processed products are not the same. Based on published information, the raw material requirement for some important forms of processed products as compiled by Sukumaran and Verma (1993) is given in Table 1.

Some of the characteristics required for processing are discussed below.

Dry matter content and specific gravity of potatoes : Besides the shape and size of the tuber, the dry matter content or specific gravity of potatoes is the most important factor in determining their suitability for processing. The specific gravity or dry matter content affects the yield of the processed products and the economics of processing. It also influences the uptake of oil during frying. In selecting potatoes for processing into chips or French fries, it is important that tubers of high

TABLE 1. QUALITY REQUIREMENTS FOR DIFFERENT FORMS OF POTATO PROCESSING

Characteristics	Dehydrated	French fries	Chips	Canned
Tuber shape		Long oval	Round to oval	
Tuber size, mm	30	50	40-60	35
Eyes	Shallow	Shallow	Shallow	Shallow
Specific gravity	1.080	1.080	1.085	1.075
Dry matter, %	22-25	20-24	22-25	18-20
Starch, %	15-19	14-16	15-18	12-14
RS* after 8 °C	2.5	2.5	1.25	2.5
ACD	Slight	Slight	-	Nil
ED	Slight	-	-	-
Texture	Fairly firm to mealy	Fairly firm	Fairly firm to mealy	Waxy

* on dry weight basis, RS; Reducing sugar, ACD: After cooking discoloration, ED: Enzymic discoloration

Sukumaran and Verma (1993)

specific gravity or dry matter content be chosen so as to obtain high yield of the product. Grewal and Uppal (1989) reported that potatoes with high specific gravity or high dry matter content resulted in high yield of dehydrated products and lower uptake of oil (Table 2). The specific gravity or dry matter content of potatoes varies considerably among varieties and is influenced by the environmental and cultural practices. Burton (1966) observed a large variation in the dry matter content of variety 'Record' (the preferred processing variety in UK), when grown at 4 different locations in UK and its dry matter ranged from 20.2 to 25.2%. Likewise, the dry matter content of variety 'Bintje' (the most preferred processing variety in the Netherlands) varied between 19.6 and 21.3%, when grown at different locations (Beukama and Vander Zaag 1979). A wide variation in the dry matter content of Indian varieties is also reported (CPRI Annual Scientific Report 1994-95). Generally, high dry matter containing potatoes are preferred for fried and dehydrated products, while those with low dry matter are best suited for canning. The dry matter of potatoes can be determined directly by oven-drying, but this is a time-consuming and destructive method. It can be determined from specific gravity measurement and the method is rapid and non-destructive. Specific gravity is positively correlated with dry matter content and can be measured by any of the usual procedures (Murphy and Goven 1959). From specific gravity, the dry matter can be estimated by using the equation derived by Von Scheele et al (1937). However, the relationship between specific gravity and dry matter content is not universal. Therefore, many regression equations are in use in different countries. Verma et al (1972) gave individual regression equations for different agro-climatic regions of India. However, a more accurate empirical regression equations with a high correlation coefficient was reported by Marwaha and Kumar (1987) for north western plains of India.

TABLE 2. YIELD AND OIL CONTENT OF CHIPS IN RELATION TO SPECIFIC GRAVITY OF POTATOES

Specific gravity	Yield, %	Oil content, %
< 1.0599	30.1	54.4
1.0599 - 1.0633	31.7	50.4
1.0633 - 1.0707	32.3	47.0
1.0707 - 1.0782	34.6	42.2
> 1.0782	35.7	38.2

Grewal and Uppal (1989)

Sugar content of potatoes: Sugar content of potatoes plays a very important role in determining the colour of the fried products such as chips and French fries. Out of all the sugars, glucose and fructose (reducing sugars) are the most important ones, as they react with amino acids to produce non-enzymic discoloration in chips and French fries during frying at high processing temperatures. Potatoes containing low amounts of reducing sugars produce light colour in chips and French fries. Wright and Whiteman (1951) reported that chips and French fries of most suitable colour were produced from potatoes with an average reducing sugar content of 0.18%. Smith (1956) found that chips of a satisfactory colour and texture were obtained, if the content of reducing sugars did not exceed 0.2% of the fresh weight. The ideal reducing sugar content for processing into chips is generally accepted to be 0.1% of tuber fresh weight with 0.33% as the upper limit, while for French fries the upper limit may be as high as 0.5% (Burton and Wilson 1978). A prediction equation for predicting the chip colour, based on the content of reducing sugar has been developed for the north western plains of India, based on 3 year data. According to the equation, in order to obtain an acceptable chip colour, the reducing sugar content of potatoes should not exceed 296 mg/100 g fresh weight (CPRI Annual Scientific Report 1993-94). Mature freshly harvested potatoes generally contain acceptable levels of reducing sugars and are thus most suitable for the manufacture of chips and French fries. However, accumulation of reducing sugars during low-temperature storage, particularly below 4.4°C, results in an undesirably dark-coloured product upon frying. The cold stored

TABLE 3. REDUCING SUGAR CONTENT (G/100G FRESH WT) IN STORED POTATOES

Storage condition	Variety	Period of storage, weeks				
		0	2	6	10	14
Room temperature storage	'Kufri Chandramukhi'	0.18	0.31	0.32	0.33	0.34
	'Kufri Jyoti'	0.42	0.40	0.43	0.47	0.52
	'Kufri Badshah'	0.40	0.65	0.53	0.55	0.44
Evaporatively cooled storage	'Kufri Chandramukhi'		0.54	0.49	0.69	0.65
	'Kufri Jyoti'		044	0.51	0.65	0.64
	'Kufri Badshah'		0.71	0.75	0.66	0.66
Refrigerated storage	'Kufri Chandramukhi'		0.58	0.69	0.90	1.11
	'Kufri Jyoti'		0.60	0.75	1.09	0.97
	'Kufri Badshah'		0.95	1.42	1.80	1.81

Mehta and Kaul (1988)

Indian potato varieties become unfit for processing into chips within two weeks of storage (Marwaha et al. 1990; Marwaha and Kang 1994b). This problem can be overcome to some extent by storing the potatoes at high temperatures either in an ordinary farm store or in an evaporatively cooled potato store (Mehta and Kaul 1988; Marwaha and Kang 1993; Marwaha 1994) (Table 3). However, in these stores, the potatoes can be stored only for a limited period after which there are high weight losses and they become unfit for processing (Mehta and Kaul 1988; Marwaha 1996a). The other method to overcome the problem of excess sugar accumulation during cold storage is to recondition the potatoes at 20°C for 2-3 weeks before processing.

TABLE 4. COMPARISON BETWEEN CHANGES (%) IN REDUCING SUGARS (RS) AND SUCROSE (S) CONTENT DURING COLD STORAGE AND RECONDITIONING OF POTATOES

	Marwaha et al[1] (1990)			Samotus et al[2] (1974)		Iritani and Weller[3] (1978)	
Treatment	RS	S	CCS	RS	S	RS	S
Cold storage of potatoes at 3-4 °C for 3 weeks	+224 (774)	+209 (581)	8.8	+260 (1800)	+380 (1200)	- (1280)	- (560)
Reconditioning of cold stored tuber at 20 °C for 3 weeks	-39 (474)	-66 (197)	7.4	-50 (900)	-67 (400)	-51 (628)	-74 (144)

Values in parentheses denote actual quantities, mg/100 g fresh wt

[1] Average of 5 Indian varieties, CCS (chip colour score) before cold storage was 3.6, CCS more than 5 was unacceptable

[2] Cold storage at 1°C, reconditioning at 20 °C for 2 weeks, average of 9 Polish varieties

[3] Cold storage at 5.5 °C for 4 weeks, reconditioning at 15.5 °C for 3 weeks, variety "Russet Burbank"

However, reconditioning, although reduces the content of reducing sugar, may not be a reliable remedy for high sugar content and for all the varieties due to the differences in their response towards reconditioning (Samotus et al. 1974; Iritani and Weller 1978). Reconditioning reduced the content of reducing sugars in Indian varieties, but was not very effective in improving the chip colour to the desired levels (Marwaha et al. 1990) (Table 4). Attempts have been made to identify varieties or selections, which accumulate less sugars during low temperature storage, such as "ND 860-2" and "Somerset" in USA (Johansen 1985; Reeves et al. 1990), "Brodick" in UK (Cotterell et al. 1990), "Kufri" "Sherpa" and "FL 1625" in India (Uppal and Verma 1990; Marwaha and Kang 1994b).

Some of the sugars and other reactants may be removed from tubers by soaking the potato slices in hot water before frying to improve the colour of the chips. A continuous flow method of hot water treatment in which potatoes are leached for 2.5-8 min at 65-70°C was developed by Janis and Bremforder (1956), but it had the disadvantage that there was a marked increase in the absorption of fat. This problem of high absorption of oil can be avoided, if slices are agitated in 7.5% sodium chloride solution for 2 min at 85°C before frying (Stutz and Burriss 1948). Other dips, which have been recommended, include 1 min in 0.25% sodium bisulphite at 80-95°C or 1 min at 80-95°C in a solution containing 0.8% sodium citrate, 0.15% sodium bisulphite and 0.16% phosphoric acid (Smith 1957).

A different method for avoiding undesirable browning in chips produced from potatoes with too high sugar content is being widely used. The major part of the brown colour develops in conventional frying, when the moisture content of the chips falls below 6%. If the chips are removed from the fryer before this stage, the final browning can be avoided. The chips can be dried down to 2% moisture by other suitable methods like tunnel drying, vacuum drying or microwave drying, which do not lead to appreciable browning. The most preferred method is microwave drying (Smith 1975).

Different types of discolorations: Generally, three types of discolorations are observed in the potato products, i.e., (a) enzymatic discoloration, (b) after-cooking darkening and (c) discoloration or browning of fried products.

Enzymatic discoloration takes place before potatoes are cooked. It develops in peeled or cut

potatoes, when they are exposed to air for a short time. It is generally accepted to be the result of tyrosine-tyrosinase reaction with the ultimate formation of a black pigment, melanin. Schaller and Amberger (1974) have shown that enzymatic discoloration of potatoes depends not only on tyrosine and polyphenol oxidase, but also on total phenol content, amino acids, dry matter content, chlorogenic acid and flavonols. Similar reaction is responsible for blue spot of potatoes in countries, where mechanical cultivation is common and occurs specially at low temperatures. Enzymatic discoloration is of great significance in pre-peeled potatoes or in sun- dried potatoes. To prevent this, peeled or cut potatoes should be dipped in 0.1-0.2% sodium bisulphite for 5 min or in 0.5% sodium metabisulphite solution for 10 min. Gaur et al (1980) observed that enzymic discoloration was affected by environmental conditions and varieties like 'Kufri Lauvkar' and 'Kufri Jyoti' showed higher enzymic browning under diversified environmental conditions. Uppal et al (1978) observed different levels of enzymic discolorations in varieties containing identical amounts of phenolic compounds. However, Joshi et al (1978) found a positive, but non- significant correlation between polyphenolase activity and enzymic discoloration. It is also reported that there is a decrease in the enzymic discoloration and phenolic compounds of potatoes with increased levels of potash application and the reduction was more, when muriate of potash was applied (Joshi et al. 1982).

Discoloration after cooking is one of the most widespread undesirable qualities of potatoes. It develops in the cooked potatoes and products after exposure to air, specially in boiled and steamed potatoes, but can also develop in canned, oil-blanched French fries and reconstituted dehydrated products. It is caused by the reaction of ferric iron with orthodihydroxy phenols, specially chlorogenic acid and gives a grey colour. Normally, potatoes contain iron in the ferrous form. Cooking, however, changes some ferrous to ferric iron and exposure of hot potatoes to air increases this conversion (Shaw and Booth 1983). It is, thus, considered advisable to cool cooked potatoes in a water spray, whenever possible. The amount of after-cooking darkening depends largely on variety. Different varieties contain different levels of iron and chlorogenic acid. In cases, where this type of discoloration causes loss of quality in the final product, it can be controlled by dipping the peeled potatoes in 0.4% citric acid or in 1% sodium acid pyrophosphate or in 1% tetrasodium salt of EDTA for 1 min. Generally, none of the varieties grown in India shows this discoloration, though, it has been observed occasionally in 'Kufri Jyoti'. Thomas and Joshi (1977) observed after-cooking discoloration in gamma-irradiated potatoes of variety 'Kufri Chandramukhi', stored at 15°C. Later, Thomas (1981) reported that irradiated tubers of 'Kufri Alankar' showed maximum after-cooking darkening followed by 'Kufri Chandramukhi', 'Kufri Lauvkar', 'Kufri Sheetman' and 'Kufri Sindhuri', while 'Kufri Chamatkar' showed least after-cooking darkening. Thomas and Joshi (1977) and Thomas (1981) were able to reduce after-cooking darkening of gamma-irradiated tubers by peeling them before boiling. This was ascribed to higher phenolic content of peels of potato and increased leaching of polyphenols from the flesh into cooking water.

Discoloration of fried products is due to a typical Maillard reaction between reducing sugars and amino acids at high frying temperatures. In practice, the quantities of amino-N are rarely limiting and the extent of browning is better correlated with the concentration of the principal reducing sugars, glucose and fructose (Gray and Hughes 1978). Of these two, the content of glucose is most closely correlated with browning (Heilinger 1964). Besides, citrate and phosphate, present in the tuber, may influence colour development and ascorbic acid may give a brown colour at frying temperatures, either alone or more particularly, in the presence of amino acids (Smith et al. 1954). But, neither the amino acids nor ascorbic acid is present in the potato in so high concentration as to cause unacceptably dark colour in the absence of sugars. Some other factors such as tuber pH and organic acid content may also be important for colour production (Fuller and Hughes 1984). Perfect correlation of the extent of browning with the content of sugar, or any particular sugar, is thus not to be expected (Wunsch and Schaller 1972). Normally, the potatoes with high levels of reducing sugars will always produce unacceptable dark chips and in general, the lower the reducing sugar content, the lighter the colour of chips. There may be exceptions to this general statement because of the variation in other participants in the reaction (Wunsch and Schaller 1972). Even so, in practice, the content of reducing sugars, or glucose alone, is the soundest simple guide to the suitability of potatoes for chip manufacture (Miller 1972). During cold storage, potatoes accumulate large quantities of reducing sugars and thus produce dark coloured

chips or French fries, which are unacceptable. There are some reports of removing considerable amounts of reducing sugars by several washings of slices with water before frying. The loss of reducing sugars during washing was much more in the slices made from fresh potatoes than from the cold stored ones. Manan et al (1987) reported an improvement in the colour of deep- fried chips made from the cold-stored tubers by fermenting the excess quantity of sugars to lactic acid by using *Lactobacillus plantarum*.

Performance and suitability of Indian potato varieties for different forms of processing

Twenty four Indian potato varieties released by the Central Potato Research Institute, Shimla were evaluated at the Central Potato Research Station, Jalandhar for 4 years from 1987-1991 and it was reported that 13 out of 24 varieties produced chips of acceptable colour at the harvest time. 'Kufri Lauvkar' and 'Kufri Sherpa' were found to be the best for chip processing, while chips prepared from 'Kufri Badshah', 'Kufri Sindhuri' and 'Kufri Bahar' were dark in colour and unacceptable (CPRI Annual Scientific Report 1990-91). Important processing characteristics of some commonly cultivated Indian varieties grown at Jalandhar are shown in Table 5. Besides, 5 exotic cultivars, namely, 'Atlantic', 'FL 1291', '1533', '1584' and '1625' grown at Jalandhar under short day conditions proved very good for chip processing at the time of harvest and upto mid May after storage at ambient temperature (Marwaha and Kang 1994a; Marwaha 1996b).

Chips prepared from the tubers of all the 5 exotic cultivars stored in evaporatively cooled storage (ECS) for 75 days were superior in colour and texture than the ones stored at ambient temperature (ATS). Mean peeling losses were less in ECS (15.7%) than in ATS (18.8%). Oil consumption of the fresh slices was also low in ECS (16.3 ml/100 g fresh wt) than in ATS (17.8 ml/100 g fresh wt). Mean recovery of fried chips was 31.5% in ECS and 26.6% in ATS (Marwaha 1996a). A comparison of Indian and exotic cultivars grown at Jalandhar showed the chipping superiority, high dry matter content and low reducing sugars in exotic cultivars over Indian varieties (Marwaha and Kang 1994a) (Table 6).

TABLE 5. IMPORTANT PROCESSING QUALITIES OF SOME FRESHLY HARVESTED INDIAN POTATO VARIETIES

Variety	Dry matter, %	Reducing sugars, mg/100g fresh wt	Chip colour score*
'Kufri Badshah'	16.9	288	6
'Kufri Bahar'	16.7	240	6
'Kufri Chandramukhi'	20.7	184	5
'Kufri Jawahar'	19.3	176	4
'Kufri Jyoti'	17.8	164	5
'Kufri Lauvkar'	19.2	128	3
'Kufri Sherpa'	20.4	92	2
'Kufri Sindhuri'	18.8	228	6

* on a 1-10 scale of increasing dark colour, chip colour score upto 5 was acceptable

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TABLE 6. DRY MATTER CONTENT, CHIP COLOUR SCORE AND REDUCING SUGAR CONTENT OF SOME INDIAN AND EXOTIC CULTIVARS

Cultivar	Dry matter, %	Chip colour score°	Reducing sugars mg/100g fresh wt
Indian cultivars			
'Kufri Chandramukhi'	20.5	5	285
'Kufri Jyoti'	18.0	5	203
'Kufri Lauvkar'	19.2	3	128
Exotic cultivars			
'Atlantic'	20.8	1	98
'FL 1291'	21.4	1	78
'FL 1533'	23.2	1	80
'FL 1584'	20.1	1	69
'FL 1625'	20.2	2	89

° On a 1-10 scale of increasing dark colour, chip colour score upto 5 was acceptable

Marwaha and Kang (1994)

Recently, the Central Potato Research Station, Shimla in 1996 has identified a number of promising cultivars with very good chipping quality, high dry matter content and low reducing sugars (Table 7). Particular mention is being made of 'MP/90-83', which performed well during large scale chipping trial at the uncle chips factory, Noida, Gaziabad in Uttar Pradesh. Rai and Verma (1989) reported that 'Kufri Chandramukhi', was the most suitable variety for chip making after conducting investigations over a number of years on several varieties grown at Patna in Bihar. The same observation was also confirmed by the Farm Frites Co., Netherlands in 1996 after testing 6 Indian cultivars sent to them by the Institute. Rai and Verma (1989) identified a number of hybrids, which did not accumulate large amounts of sugars during storage or could be reconditioned to produce chips of good quality. However, Marwaha et al (1990) reported that reconditioning the cold-stored potatoes, although, lowered the content of reducing sugars in 5 Indian varieties, did not sufficiently improve the colour of chips.

TABLE 7. PROMISING POTATO CULTIVARS SHOWING PROCESSING QUALITIES AT THE TIME OF HARVEST AND DURING HIGH TEMPERATURE STORAGE

Cultivar	Storage period, days: 0 — Dry matter, %	0 — Chip colour score°	0 — Reducing sugars, mg/100g fresh wt	75 — Chip colour score°	75 — Reducing sugars, mg/100g fresh wt
'MP/90-83'	21.0	2	88	3	208
'MP/90-94'	22.6	1	84	2	116
'MP/91-1'	21.1	2	84	2	108
'MP/91-69'	23.3	1	84	2	124
'MP/91-76'	22.4	2	76	1	144
'MP/91-G'	23.1	1	92	2	180

° Chip colour score upto 5 was acceptable

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There is not much research work on French fries and other frozen products in India, as these are not preferred potato products. Nine potato varieties grown at Jalandhar in the plains of Punjab were evaluated for French fries immediately after harvest. Peeling losses varied from 10.4 to 16.5% and the total losses including nubbins and slivers ranged from 12.6 to 21.2%. The yield of French fries ranged from 44.8% ('Kufri Sindhuri') to 52.5% ('Kufri Jyoti') of the raw unpeeled potatoes. Good quality French fries were made from 'Kufri Dewa', 'Kufri Jyoti', 'Kufri Lauvkar' and 'Kufri Sindhuri' (Marwaha 1996c) (Table 8). Two advanced cultivars, "MP/90-83" and "MP/91-G", which yielded 59.3% and 58.3% French fries, respectively were identified by the Institute. It was reported by the Farm Frites Co., Netherlands in 1996 after evaluation of 14 potato cultivars at Modipuram in Uttar Pradesh that 'MS-717', 'Kufri Sutlej' and 'Kufri Chandramukhi' were suitable for the manufacture of French fries.

Work on potato processing in India

In India, work on dehydration of potatoes started in the early years of this century. The first dehydration factory was put up at Narkanda in HP by Col. Rennick in 1911. He prepared potato meal by utilizing hand-operated machines for peeling and slicing and for boiling and drying. He used three cauldrons and furnaces. The capacity of each furnace was 4 tonnes per day. Singh and Lal (1941) fabricated a home dryer for fruits and vegetables, in which temperature could be maintained between 60.0-62.7°C and potato slices could be dried within 9-11 h. Abundant solar energy is available in the plains of India after the harvest of potatoes, which can be utilized by the housewives to dehydrate potato slices and make potato *papads*, but the product is generally not of a very high quality.

Srivastava et al (1973) described a procedure, which insured a product of good acceptability. The procedure consisted of cutting 2-3 mm thick slices with a hand slicer in cold water, followed by blanching in hot water for 1 to 5 min and then spreading in the sun to dry at the end of the day. The dried product could be stored in air-tight containers or sealed polythene bags for 6 months. A cabinet for solar drying of 20 kg of blanched potato slices was made at the Central Potato Research Station, Jalandhar during 1975. This was found to be quite efficient and produced better quality solar-dried products than made in the open sun (Singh and Verma 1975).

TABLE 8. PROCESSING CHARACTERISTICS OF SOME COMMONLY CULTIVATED INDIAN POTATO VARIETIES DURING PREPARATION OF FRENCH FRIES

Cultivar	Dry matter, %	Peeling loss, %	Loss as nubbins, %	Total losses during French fries processing, %	Colour	Texture	Oil consumption per 100g raw fries, ml	Recovery of French fries from fresh potatoes, %
'K. Badshah'	16.9	10.8	1.8	12.6	MB	Soggy	13.3	49.5
'K. Bahar'	16.7	13.4	2.6	16.0	LB	Soggy	8.6	46.6
'K. Chandramukhi'	20.7	12.2	2.3	14.4	MB	Typical	12.2	46.6
'K. Dewa'	19.8	14.7	4.2	18.9	L	Mealy	9.4	47.6
'K. Jawahar'	19.3	13.0	3.8	16.8	GY	Soggy	13.9	47.8
'K. Jyoti'	17.8	10.4	3.4	13.8	L	Mealy	9.3	52.5
'K. Lalima'	20.6	14.4	2.9	17.3	MB	Mealy	6.0	48.4
'K. Lauvkar'	19.2	12.6	2.3	14.9	L	Mealy	7.1	50.7
'K. Sindhuri'	18.8	16.5	4.7	21.2	L	Mealy	7.6	44.8

L: Light, LB: Light brown, MB: Medium brown, GY: Golden yellow

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Later, large cabinets with solar concentrator and a home solar dehydrator were also developed by the Central Potato Research Station, Shimla (CPRI Annual Scientific Report 1980, 1984). The Central Food Technological Research Institute, Mysore (1984) fabricated a solar tent and trays for dehydrating potatoes in different forms. Potato slices, *Sewai*, granules and *papads* were dried in the solar tent and the dried products after frying in the oil were found acceptable. The dried product had a shelf life of 6 months, when packed in low density polythene bags. Solar dehydration is also used in some parts of the country to dry cooked potato slices. The procedure is similar to the one used for drying raw potato slices, except that potato tubers are cooked in boiling water for about 8 min, before peeling and slicing. Dehydration of such slices takes longer time but they take up much less cooking medium during frying than raw slices (Joshi et al. 1976). Investigations conducted at the Central Food Technological Research Institute, Mysore during 1974-1976 showed that varieties 'Kufri Chandramukhi' and 'Kufri Kuber' and hybrids 'C-990' and 'VB-8' were most suitable for making dehydrated dices.

Eapen and Ramanathan (1966a) after the evaluation of a number of varieties and hybrids reported that 'Kufri Chandramukhi', 'Kufri Sindhuri', 'Kufri Kuber', 'Kufri Jeevan' and 'C-990' were the most suitable for the preparation of vacuum-puffed products. Instant mashed potato could also be prepared in the form of vacuum–puffed product. The mash was passed through a granulator to form beads of 0.6 x 0.6 cm. These beads could be reconstituted into mashed potatoes by soaking them for about 30 min in hot water. The product could be stored for one year without any change in the texture or flavour in sealed bags (Eapen and Ramanathan 1966b).

Flakes of excellent quality were prepared from 'Up-to-date' and 'Craig's Defiance', while the flakes prepared from 'Kufri Red' were not acceptable due to unattractive colour of the product. Sharma and Ramachandra (1978) reported that 'Kufri Chandramukhi' and 'Kufri Jyoti' were the most suitable for the preparation of potato flakes, based on the yield and properties of the potato flakes. They obtained high yield of potato flakes from potatoes of higher specific gravity and observed greater discoloration in the flakes prepared from cold–stored potatoes.

Preparation of potato flour: Potato flour can be prepared by two methods. The most simple and widely used procedure consists of dehydrating potatoes in the form of slices and then grinding them to make flour (Srivastava et al. 1973). But for large scale production, a faster way of drying the slices by using a kiln or a flow drier has to be adopted (Roy Choudhuri et al. 1963a). Another method of preparation of potato flour is to dry mashed cooked potatoes on a roller drier. Pant and Kulshrestha (1995) prepared potato flour from 6 potato varieties by pressure cooking the potatoes at 10 lb/cubic inch for 22 min, cooling under running water to room temperature within 3 min and further drying in a cabinet drier at 60°C. They also studied the physical characteristics of potato flour made from these varieties and reported that maximum yield of flour was obtained from 'JH 222'.

Further work conducted at the Central Potato Research Station, Jalandhar during 1995-96 showed that the recovery of potato flour from 3 Indian varieties was quite high, when prepared by drying the boiled mashed potatoes than by drying the blanched slices. Peeling losses were also very high in the later method and the addition of sodium metabisulphite (0.25%) during boiling improved the colour of flour in both the methods (Marwaha and Sandhu 1996). Roy Choudhuri et al (1963a) reported that the addition of hydrogenated groundnut oil at a level of 5% improved the shelf life of the potato flour at 37°C. The quality of potato powder remained unchanged for one year at -18°C.

Manufacture of starch from potatoes : Work on starch manufacturing from potatoes in India is very limited because of the fact that cheap sources of starch such as maize and tapioca are available in the country. High cost of production of potatoes and the unavailability of the raw material round the year are the main causes, which make potatoes unsuitable for the manufacture of starch. Investigations conducted at the Central Potato Research Station, Jalandhar during 1985-86 revealed that the recovery of starch from large potatoes was 67-75% as against 38-67% from small tubers. There was no difference in the percent starch recovery either from green or non–green potatoes (CPRI Annual Scientific Report 1986). About 20% reduction in starch recovery occurred, when extracted by hand grinding method. It was further reported that excessive maceration of tuber tissue for longer duration significantly reduced the starch content, while potassium content increased, causing variation in the intrinsic viscosity of starch. A varietal difference in the viscosity of starch was also reported. Pant and Kulshrestha (1995) after

conducting ultrastructural studies in six potato varieties reported varietal variations in the shape of starch granules and free starch. Marwaha (1987) reported a large variation in the starch content among 10 varieties grown at Jalandhar in Punjab and found 'Kufri Dawa' as the most suitable variety for high yield of starch.

Work on utilization of potato starch for the development of different products was initiated at the Central Potato Research Station, Jalandhar during 1996. Good quality potato biscuits were made, when half of the wheat flour (*maida*) was replaced by the potato starch. Similarly, different approved colours and flavours were added to the starch to make custard powder. The potato custard, when prepared and compared with the commercially available corn starch custard showed its superiority in taste over corn custard and was widely accepted and appreciated. Chandrasekhara and Shurpalekar (1984 a, b) also reported the use of potato flour in soft dough biscuits and in bread.

Canning of potatoes : Canning of potatoes on commercial scale is not carried out in this country mainly because of the high cost of can. However, some quantities of potatoes are canned to meet the requirements of the armed forces. In view of this, potato varieties grown in India have been evaluated from time to time for their suitability for canning. Varieties like 'Up-to-date', 'Kufri Alankar', 'ON-208' could be canned without calcium chloride treatment, while 'Kufri Chandramukhi', 'Kufri Jyoti', 'ON-2236', 'K-122' and 'Military Special' required calcium chloride treatment before canning. Marwaha (1987) reported 'Gulmarg Special' as the most suitable variety for canning, based on its dry matter and chemical composition. It is known that potatoes with a specific gravity of less than 1.075 can generally be canned without disintegration or sloughing during processing even without the use of calcium salts. Sloughing can usually be prevented in lots with a specific gravity of 1.075-1.095 by addition of the recommended amounts of calcium chloride (Talburt 1987b). Work conducted at the Central Food Technological Research Institute (1979) showed that the extent of tuber cracking and disintegration in canning was substantially lower in cold-stored potatoes than in freshly harvested ones, though, cold storage of potatoes for 6 months before canning impaired the taste of canned potatoes.

Nutritional changes during processing

Several nutritional changes occur in potatoes, when they are processed into different processed products. Peeling by any of the methods removed significant amounts of minerals, as these are proportionately in greater amounts in the outer tuber layers. An abrasive peeling resulted in the loss of juice containing soluble constituents, including mineral salts (Zobel 1979). About 10% loss in content of absorbic acid occurred, when potatoes were peeled by abrasion. Sulphiting reduced the thiamine content by 32% in preserved boiled potatoes and 44% in French fries (Mapson and Wager 1961). Swaminathan and Gangawar (1961) observed that considerable quantities of vitamin C of the potato tubers were lost and that the extent of losses depended upon the method of cooking. Losses of vitamin C were lowest (15.0-17.3%), when unpeeled potatoes were boiled, but frying in fat resulted in very high losses (55.3-58.2%). Peeling of tubers before boiling also resulted in high losses (34.5-41.9%) Roy Choudhuri et al (1963b) reported that vitamin C contents of processed potatoes were lower than the raw potatoes. Losses of vitamin C due to different methods of processing were, 20-28% in water-cooked, 50-56% in baked, 50-59% in deep-fat-fried and 65-70% during canning. Burton (1989) compiled the average losses of vitamin C during various methods of processing, which were 20% in unpeeled-boiled, 10-15% in unpeeled-steamed, 20% in unpeeled-baked, 25% in microwave cooked, 25% in peeled-boiled, 30% in French fries, 30-35% in chips and 70% in reconstituted instant powder and flakes.

Total N in French fries was reduced to 85% of its original value in large sized potatoes during blanching of fries in water (Augustin et al. 1979). Losses of amino acids occurred to a small extent through Maillard browning during frying in French fries, but about 7-10% were lost during blanching. Losses of vitamins in French fries mainly depended on the previous storage of raw material, size of French fry cut, type of blanching and finishing operations (frying or oven-heating). No investigations on the effects of freezing on nutrient content of frozen French fries are reported. Overall losses of vitamins in the finished French fries were 44% ascorbic acid, 44% thiamine, 39% riboflavin and 24% niacin (Gorun 1978).

When fresh potatoes were fried into chips, about 50-60% losses in free amino nitrogen and about 70% losses in reducing sugars were reported (Fitzpatrick et al. 1965; Fitzpatrick and Porter 1966). Accumulation of reducing sugars during cold storage increased losses of free amino acids on frying from 85% to 88%. Pelletier et al (1977)

reported about 30-85% losses in ascorbic acid in the preparation of chips. No information is available on mineral losses during chipping. However, it seems likely that losses through leaching may be substantial during washing and blanching. In spite of the substantial losses of nitrogen compounds and vitamins during processing, chips are still a good source of these nutrients, because of their low moisture content. Chips are a highly concentrated form of energy, because they contain large quantities of fat and carbohydrates. It is also suggested that potato chips should be produced from unpeeled potatoes so as to increase the yield and nutritive value of the finished product and to decrease the waste disposal problem (Shaw et al. 1973).

Dehydration had little effect on the nitrogen content of granules, slices and dices, but considerably reduced in flakes. The overall retention values for total N were 83% (granules), 85% (slices), 86% (dices) and 70% (flakes) (Weaver et al. 1983). Protein and vitamin losses during manufacture of potato granules and flakes as well as dehydrated slices and dices were generally high, whenever potatoes were exposed to high temperature for prolonged periods of time. The addition of sulphites had a deteriorating effect on thiamine, resulting in losses upto 96%. The other vitamins most severely affected were ascorbic acid and folic acid, with retention values as low as 40%. In the granule making process, vitamin losses were greatest during the mixing and mashing steps, while during flake operation, water blanching and the drum drying operation resulted in maximum losses. Retention of thiamine was relatively high (64%) during the production of potato flakes (Augustin et al. 1979). Steele et al (1976) reported about 74% losses in ascorbic acid in granules. Out of all the other dehydrated products, maximum retention of ascorbic acid was reported in flakes (Augustin et al. 1982). It was reported that there was some loss of minerals during processing of potato flour, which was due to leaching during blanching and sulphite dipping (Roy Chaudhuri et al. 1963a). Losses of vitamin C were also observed by Roy Chaudhuri et al (1963a) during preparation of potato flour. The vitamin C content of the potato flour was about 50% of the raw tubers. Vitamin C was also lost during 6 months of storage of potato flour in sealed polythene bags at 37°C. They also observed about 90% loss in thiamine during the preparation of potato flour.

There is little information on the changes in nutrient values during canning. It was reported that much nutrient loss from the solids was actually due to a transfer into the surrounding liquid. It was recommended that the liquid surrounding the canned potatoes should be used in soups and stews. About 22% of the N lost was found to be present in the brine solution, as a result of leaching during processing. Roy Choudhuri et al (1963b) also observed loss in protein during canning of potato tubers. Canned potatoes contained only about 80% of the protein present in raw potatoes. Jaswal (1973) reported a significant loss of both bound and free amino acids on canning. The losses in ascorbic acid on canning vary considerably from about 6 to 8% (Witkowski and Paradowski 1975) from 65 to 70% (Roy Choudhuri et al. 1963b). No difference was observed in iron or phosphorus contents between fresh and canned potatoes, while calcium content was slightly higher in canned potatoes. This was probably due to the soaking of potatoes in calcium chloride, followed by washing before blanching, filling and canning.

Conclusion

Traditionally processed potato products known as *chuno* and *papa seca*, which are about 2000 years old, still form the diet of people in highland areas of Peru and Bolivia and are produced by the methods unchanged over these years. Processing is mainly confined to developed countries and it is only in its infancy in most of the developing countries with the exception of China (12%), Korea DPR (6%) and Mexico (8%). The most popular processed potato products are chips and French fries, although the frozen French fries have recently superseded the chips in the USA and UK. Starch production is maximum in the Netherlands, while there is a large scale production of dehydrated products in France.

Although no Indian variety was bred specifically to meet the requirements for processing industry, many of the present day Indian varieties are suitable for the production of various processed products on the basis of tuber characters, dry matter content, reducing sugars content and reconditioning behaviour. Research work at the Central Potato Research Station, Shimla is presently focussed on breeding varieties suitable for processing. In the recent past, several cultivars containing high dry matter and low reducing sugar content have been identified, which have performed very well for chip and French fries processing.

Processing, in general, has deleterious effects on the contents of nutrients in potatoes. The highest levels of nutrients are found in freshly

harvested potatoes, which have been cooked without peeling. Processing operations such as frying, drum-drying and canning, which involve high temperatures, reduce the levels of amino acids and reducing sugars considerably. Cooking and processing enhance digestibility of potato starch, which is indigestible in the raw potatoes. Ascorbic acid and folic acid suffer large losses during cooking and processing as a result of leaching, heat destruction and oxidation. Thiamine is destroyed by sulphiting. Losses in minerals during processing are presumed to be mainly due to leaching in blanching water.

Fast growth in processing sector is expected to occur in both developing and developed countries. The general trend towards easily prepared meals and fast food is increasing, particularly, in the urban areas in India and processed potato products such as chips and French fries are likely to become more popular. However, the consumption of these products may be limited only upto the rich urban class.

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Received 4 April 1997; revised 17 May 1997; accepted 30 May 1997

Changes in the Fresh Yield, Dry Matter and Quality of Ginger (*Zingiber officinale* Rosc.) Rhizomes During Development

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Four genotypes of ginger were studied for fresh yield, dry weight, essential oil, oleoresins and crude fibre contents at different stages of rhizome development. Both fresh and dry weights of rhizomes increased steadily upto 225 days after planting. Thereafter, the change was insignificant. On % dry weight basis, the essential oils declined continuously with rhizome maturity. The oleoresins also followed a declining trend upto 210 days, beyond which the contents increased in one genotype, while remained unchanged in others. The crude fibre after an initial rise, decreased gradually, till 210 days and increased further with rhizome age. The absolute contents of essential oil peaked at 210 days, while the oleoresins were the highest between 225 and 240 days. Except the initial stage of rhizome development, the fresh rhizomes had minimum level of crude fibre at 210 or 195 days in different genotypes.

Keywords : *Zingiber officinale*, Ginger, Rhizome, Quality, Oleoresins, Essential oils, Dry matter, Harvest.

Ginger crop is cultivated for its variety of uses. As a spice, it is consumed since ancient times. The medicinal properties (e.g., carminative, diuretic and expectorant) of ginger are well known (Cost 1989; Jain 1995). Its effectiveness against migraine headache (Mustafa and Srivastava 1990) and diarrhoea (Huang et al. 1990) has also been proved. Ginger is used both in fresh and dried forms. Dry ginger is the raw material for ginger powder, oil and oleoresins. Essential oil (volatile oil) and oleoresin represent the aroma and flavour of ginger, respectively. These preparations are used for flavouring alcoholic beverages and various confectionery products (Govindarajan 1982). The fresh ginger is used for preparing syruped ginger, crytallized ginger, jam, marmalade, sauce, pickle and chutney (Edwards 1975; Govindarajan 1982). Ginger with low fibre and mild pungency is a prerequisite for this purpose. Thus, the amounts of essential oil and oleoresins (especially pungent constituents) together with texture determine the quality of ginger.

The stage of rhizome maturity has a significant influence on its quality characteristics (Purseglove et al. 1981). The change in climate has also considerable effect on maturity and quality components. There is a need to conduct a study to identify the appropriate stage of harvest for cultivars grown in different regions. Therefore, the present study was conducted with 4 potential ginger genotypes in order to maximize the crop usage and quality. The rhizomes were harvested at different stages of development and evaluated for fresh yield, dry weight, essential oil, oleoresin and crude fibre.

Materials and Methods

Four ginger genotypes viz., 'SG-547', 'SG-666', 'SG-674', and 'SG-675' were planted in randomized block design (Cochran and Cox 1957) in three replications in a plot size of 10 x 1 m with 30 x 20 cm spacing. The recommended cultural practices (Kohli and Saini 1986) were followed to raise the healthy crop. The meteorological data during the crop season are given in Fig. 1. The place of investigation falls in the sub-temperate zone of Western Himalayas at an altitude of 1200 meters a.m.s.l. Ten randomly selected plants were harvested at 15 days interval after the initiation

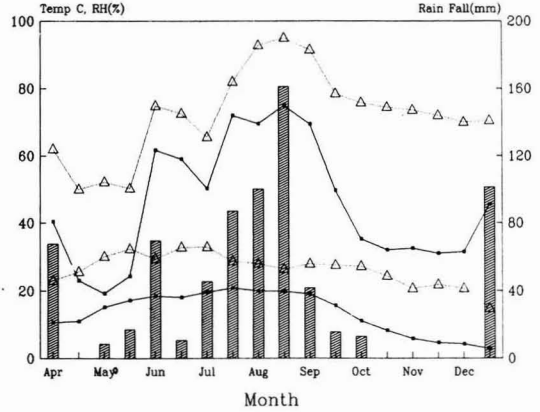

Fig. 1. Meteorological data during rhizome development. Maximum temperature --Δ--, minimum temperature - □ -, maximum relative humidity (RH)--Δ--,minimum RH-■-, rain fall ▨ The values are mean of 15 days.

* *Corresponding Author*

of rhizomes, beginning 165 days after planting (DAP). After trimming the stems and foliage, the rhizomes were washed thoroughly in running water to remove any adherent. The surface water was allowed to evaporate and the rhizomes were weighed. For determination of % dry matter, the rhizomes were dried in a hot air oven to 5% moisture level (Goyal and Korla 1993).

The oleoresins were extracted with acetone AR grade by cold percolation (Purseglove et al. 1981). Ten g of dry ginger powder was taken in the glass column of the size of 2 (d) x 40 (l) cm. The contents were exposed to acetone overnight. The oleoresin extract was collected and the residue was again flushed with the solvent. The solvent in the pooled extract was evaporated in a hot air oven. The contents were cooled in a desiccator and weighed to obtain oleoresin value. The method of AOAC (1975) was followed for the determination of essential oil and crude fibre. The data recorded in two repeats were statistically analyzed, following completely randomized design (Cochran and Cox 1957).

Results and Discussion

Both fresh and dry yield of ginger increased with age (Fig. 2 and 3). However, beyond 225 DAP,

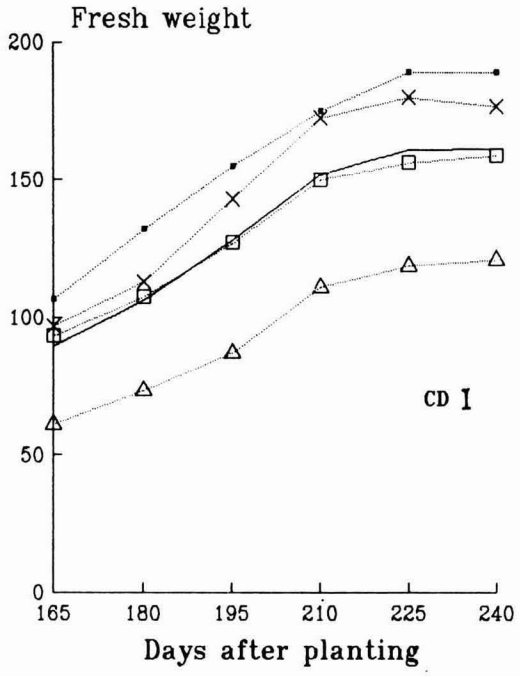

Fig. 2. Fresh weight (g plant^{-1}) of rhizomes of different genotypes of ginger during development. 'SG-674' --□--,'SG-666' - ■ -, 'SG-675' --Δ--, 'SG-547 - X -, overall mean ——. CD (l) at 5% level of significance

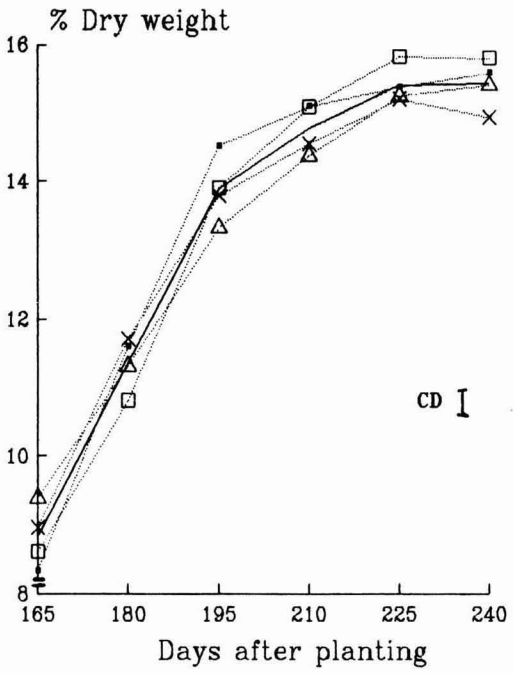

Fig. 3. Dry weight (%) of rhizomes of different genotypes of ginger during development. 'SG-674'--□--,'SG-666'-■-, 'SG-675' --Δ--, 'SG-547 - X -, overall mean ——. CD (l) at 5% level of significance

the change in fresh weight was statistically insignificant in all the genotypes. The similar results on dry matter indicate the maturation of rhizomes of different genotypes between 225 and 240 DAP. A correlation between dry ginger recovery and maturity has also been found (Nybe et al 1980). According to Shankaranarayana et al (1988), the rhizomes should be harvested after 8 to 9 months of planting for making dried ginger, while reports from Australia suggest 9–10 months for maturity (Sharpnel 1967; Leverington 1975). The variation in maturity is possibly due to different planting dates and climatic conditions.

The essential oil content on dry weight basis decreased throughout the season (Fig. 4). The different genotypes at 240 DAP experienced reduction in oil from 45 to 65% of the values at 165 DAP. A similar reduction in volatile oil was reported in the 12 out of 14 ginger cultivars studied by Ratnambal et al (1987). Other than for the initial rise, Winterton and Richardson (1965) also noticed a sharp decline in volatile oil. In contrast, the oil increased continuously with age or remained unchanged in some cultivars (Natarajan et al. 1972). How the different agro-climatic conditions

lead to a different pattern of accumulation is difficult to explain. In all the genotypes, the absolute amounts of essential oils (µl plant^{-1}) in rhizomes peaked at 210 DAP (Table 1). Further decline in contents may be due to decrease in oil synthesis activity. It may be coupled with the conversion of volatiles to some other non-volatile compounds. However, only a scientific investigation can confirm this view point. The decrease in oil content together with rapid deposition of the constituents other than essential oils during the development of rhizomes seems to be responsible for steep decrease in % essential oil value in dry rhizomes. In fresh rhizomes, the volatiles were highest during 210–195 DAP (Table 1). The results suggest that the crop should be harvested one month earlier than maturity (at 210 DAP) to maximize the essential oil yield.

The oleoresins content (on dry weight basis) fell sharply upto 195 DAP, followed by a gradual decrease with growth and development of rhizomes (Fig.5) in 'SG–666'. However, the contents increased at 240 DAP. Mathai (1975) also observed a parallel decrease in oleoresins with increase in dry weight. As explained earlier for essential oil, the rapid accumulation of bulk components of dry matter (Fig.2) upto 210 DAP accounted for the lowering of % oleorisens in dry rhizomes. On fresh weight basis, the oleoresins did not follow a definite pattern. On an average, the variation in contents at different stages of development was upto 15% (Table 1).

The results agree with those of Baranowski (1986). In comparison to essential oil, the % plant yield of oleoresins was maximum at 225 or 240 DAP (Table 1). At this stage, the average amount of oleoresins in fresh rhizomes was close to the maximum value. The results indicate a harvest of fully developed rhizome for oleoresins extraction. Similar observations were noticed by Ratnambal et

TABLE 1. ESSENTIAL OIL, OLEORESIN AND CRUDE FIBRE CONTENTS IN THE DEVELOPING RHIZOMES OF DIFFERENT GENOTYPES

DAP	Genotypes									
	'SG-674'	'SG-666'	'SG-675'	'SG-547'	Overall mean	'SG-674'	'SG-666'	'SG-675'	'SG-547'	Overall mean
	Essential oil									
	ml Kg^{-1} fresh wt					µl plant^{-1}				
165	2.6	2.2	3.2	2.7	2.6	240	232	193	260	231
180	2.8	2.8	3.1	2.9	2.9	305	373	227	330	309
195	3.3	3.2	3.3	3.1	3.2	422	493	284	443	410
210	3.3	2.9	3.1	2.8	3.0	497	512	344	477	457
225	3.0	2.8	2.8	2.4	2.7	469	524	335	422	437
240	2.8	2.7	2.4	1.8	2.4	450	500	289	330	393
CD* (development stages) : 0.25						CD (development stages) : 32				
	Oleoresin									
	g Kg^{-1} fresh wt					g plant^{-1}				
165	6.9	5.4	7.2	6.7	6.5	0.64	0.57	0.44	0.64	0.57
180	7.6	6.7	7.5	7.0	7.2	0.81	0.89	0.54	0.79	0.76
195	8.2	7.2	7.5	7.1	7.5	1.05	1.12	0.65	1.01	0.95
210	7.0	7.3	7.5	6.6	7.0	1.05	1.27	0.83	1.14	1.07
225	7.0	7.2	7.8	6.8	7.2	1.10	1.37	0.93	1.22	1.15
240	6.8	8.0	7.8	6.5	7.3	1.08	1.52	0.94	1.15	1.17
CD* (development stages) : 0.38						CD (development stages) : 0.07				
	Crude fibre									
	g Kg^{-1} fresh wt					g plant^{-1}				
165	8.3	6.6	8.5	8.1	7.8	0.78	0.70	0.52	0.78	0.69
180	11.5	10.3	10.7	11.7	11.1	1.23	1.36	0.78	1.32	1.17
195	11.9	9.0	9.6	11.2	10.2	1.42	1.40	0.84	1.60	1.31
210	9.5	8.9	10.1	9.6	9.5	1.43	1.56	1.12	1.66	1.44
225	9.8	10.2	10.5	10.2	10.2	1.53	1.93	1.24	1.84	1.64
240	11.1	11.5	11.4	10.3	11.1	1.77	2.16	1.38	1.83	1.78
CD* (development stages) : 0.37						CD (development stages) : 0.08				

CD* at 5% level of significance

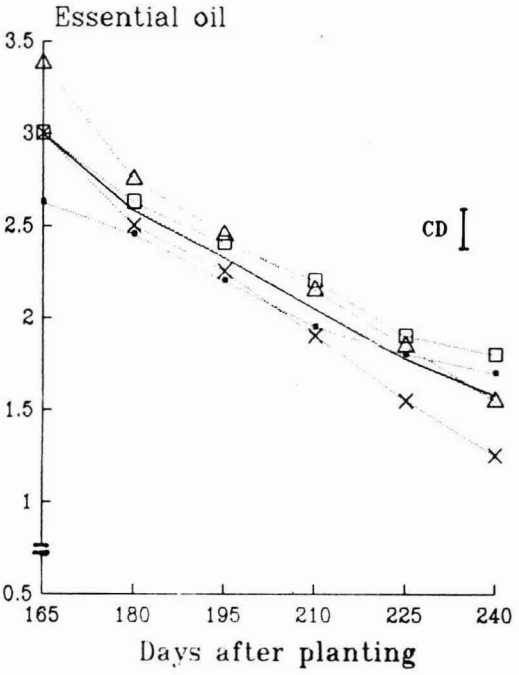

Fig. 4. Essential oil (% dry weight) of rhizomes of different genotypes of ginger during development. 'SG-674'--□--, 'SG-666'-■-, 'SG-675' --Δ--, 'SG-547 - X -, overall mean ——. CD (l) at 5% level of significance

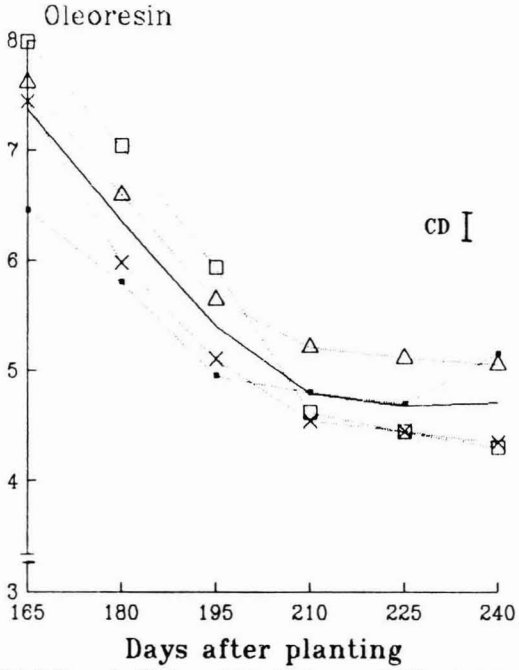

Fig. 5. Oleoresin (% dry weight) of rhizomes of different genotypes of ginger during development. 'SG-674'--□--, 'SG-666'-■-, 'SG-675' --Δ--, 'SG-547 - X -, overall mean ——. CD (l) at 5% level of significance

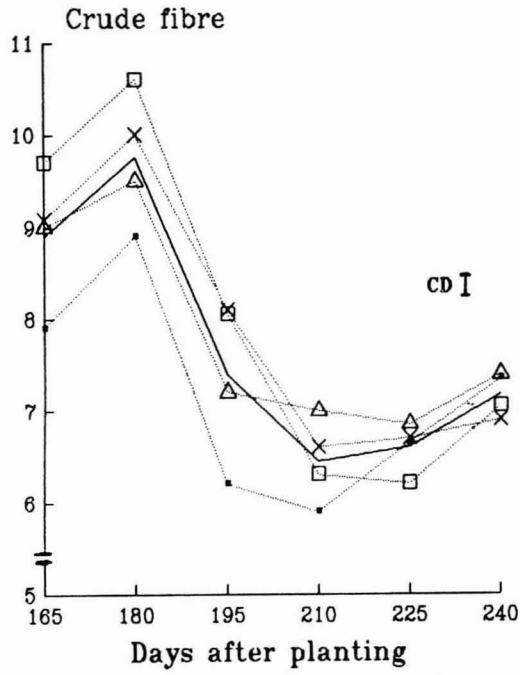

Fig. 6. Crude fibre (% dry weight) of rhizomes of different genotypes of ginger during development. 'SG-674'--□--, 'SG-666'-■-, 'SG-675' --Δ--, 'SG-547 - X -, overall mean ——. CD (l) at 5% level of significance

al (1987).

Fig. 6 shows the change in crude fibre on dry weight basis during rhizome development. The initial increase in crude fibre was followed by a sharp decline. In 'SG–666' and 'SG–547', the decline was upto 210 DAP whereas, in 'SG–674' and 'SG–675', the contents reduced till 225 DAP. Thereafter, with rhizome maturation, a gradual rise in crude fibre was noticed. Mathai (1975) also observed a similar pattern of crude fibre changes. The results are, however, in contrast to a continuous increase in crude fibre with rhizome age (Jogi et al. 1972; Ratnambal et al. 1987). The accumulation of crude fibre contents (g plant^{-1} rhizome) paralleled the development of rhizomes (Table 1). About 70% of crude fibre was deposited in one month after rhizome initiation (upto 180 DAP). During this phase, rapid cell division takes place and new fingers emerge out. Since the processed products of ginger are prepared from fresh rhizomes, the expression of crude fibre in terms of g/kg fresh weight is of importance (Govindarajan 1982). The changes in crude fibre on fresh weight basis are given in Table 1. Except at 165 DAP, where the rhizomes have no commercial value due to very low yield, the lowest amount of crude fibre

was at 210 DAP in all the 4 genotypes studied.

In conclusion, the crop harvesting between 225–240 DAP has been suggested to maximize the fresh yield, oleoresins and recovery of dry ginger. The fresh ginger was tender at 210 DAP with relatively low pungency and high amounts of volatiles. Hence, for processing of ginger, this stage appears to be the most suitable for harvest, which may result in only 6% loss of fresh yield. In fact, in the organized cooperative cultivation in Australia, depending on the post-harvest use, the ginger crop is harvested at three stages of development: one after 5–6 months of planting for a succulent, mild flavoured and low fibred tender ginger for syruping; another after 7–8 months for making dry ginger; and the third one after 9–10 months for a fully mature fibrous ginger for grinding and extraction (Sharpnel 1967; Leverington 1975).

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Received 24 August 1994; revised 12 December 1996; accepted 21 December 1996

J. Food Sci. Technol., 1997, Vol 34, No. 6. 477-482

Storage Stability and Chemical Properties of Soymilk from Sprouted Soybeans

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Four types of soymilk samples were prepared from soybeans, unsprouted and sprouted to different degrees and sterilized at 121°C for 15 min. The emulsion stability and chemical properties of these samples were studied during storage at ambient (25-32°C) for over 8 months. Stability increased with sprouting time reaching maximum at 48 h. Soymilk from unsprouted soybeans coagulated instantly after sterilization. The increase in soymilk stability with increased sprouting was partly due to hydrolysis of soybean carbohydrates and proteins. Blanching sprouted soybeans in boiling sodium bicarbonate solution also enhanced stability. Soymilk starch decreased with increased sprouting time, while soluble protein in soymilk increased to a maximum at 12 h-sprouting, but decreased thereafter. Soymilk stability was greatest (circa 8 months) in blanched 48 h-sprouted samples and loss of stability that occurred after 48 h-sprouting coincided with the largest decrease in soluble protein and smallest decrease in starch. Soybean sproutability increased from 72 to 93% during the period 12-72 h. The study has indicated the feasibility of preparation of stabilized liquid soymilk concentrates to meet the needs for milk substitutes, which can withstand storage at tropical ambient temperatures.

Keywords : Sprouted soybeans, Soymilk, Shelf stability, Blanching effect, Soluble protein, Starch hydrolysis, Tropical food.

Non-availability of soymilk off-the-shelf in many tropical countries is a major constraint to its widespread use. Soymilk has been advocated as a low-cost high protein beverage (Nelson et al. 1976; Kahn et al. 1990) suitable for developing countries (Banigo et al. 1986), where animal-based protein foods are unaffordable to the teeming millions of human population. Soymilk, being free from cholesterol and lactose is even preferable to cow's milk, especially for people prone to cardiovascular diseases and those who are allergic to cow's milk (INTSOY 1987). Presently, in Nigeria and parts of sub-Saharan Africa, limited use of soymilk has partly been attributed to the tedious procedure involved in its preparation at homes, (Nsofor and Anyanwu 1992b). Frequent preparation could be avoided by developing a process for the production of shelf-stable soymilk.

Limited success has so far been achieved in the stabilization of soymilk, eventhough various process modifications have been evaluated (Wei et al. 1985; Kahn et al. 1990; Nsofor and Anyanwu 1992 b; Nsofor et al. 1993). Presently, severe stability problems are encountered during storage of liquid soy concentrates at ambient temperatures in the tropics (Nsofor, unpublished). Ihekoronye (1991) in a related study, had investigated the stability of powdered high protein beverage prepared from "red skin" groundnut (*Arachis hypogaea*) during ambient and refrigerated storage and observed increases in density throughout the storage periods. Apart from the problem of stability created by the tropical storage environment, easily reconstitutable low-cost powdered vegetable-based milk substitutes may not be feasible because of high spray-drying and instantization costs. Besides, reconstitution of spray-dried soymilk powders is often poor (Wei et al. 1985). Therefore, a process to prepare stabilized, inexpensive single strength and concentrated liquid soymilk is needed.

The potential of soybean-sprouting to stabilize soymilk for ambient tropical storage was noted by Nsofor and Maduako (1992). They postulated that hydrolysis of soybean macromolecules by sprouting, limited the cross-linking of denatured protein, and possibly carbohydrate molecules during and after heat treatment, inhibiting early coagulation of soymilk during storage. However, evaluation of the effects of variation in sprouting time and the interactions of blanching with sprouting, as means of stabilizing liquid soymilk for ambient storage need to be investigated. Blanching has been observed to denature soybean proteins, thereby limiting both solubility (Che Man et al. 1989) and soy solids extractability (Nsofor and Maduako 1992). The present work deals with the storage stability (at 25-32°C) of heat-sterilized soymilk prepared from blanched soybeans sprouted for variable periods. Hydrolysis of soybean proteins and starch by sprouting with the associated changes in soymilk total solids was also studied.

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Materials and Methods

Preparation of soymilk extracts from sprouted soybeans : Four 1 kg lots of 'TGM 579' variety of soybeans were sorted, cleaned, separately steeped in tapwater for 12 h, drained and spread on clean jute sacks as previously described (Nsofor and Maduako 1992). The bean lots were then sprinkled with water daily and allowed to sprout for 12, 24, 48 and 72 h, respectively. Unsprouted beans from each of these lots were sorted, weighed and discarded. The sprouted soybeans were weighed and used in the preparation of soymilk. A fifth lot of 1 kg soybeans designated as control, was not allowed to sprout after steeping for 12 h and was directly used for the preparation of soymilk. The control and treated lots were each divided into two batches, one blanched for 20 min in boiling solution of 0.5% $NaHCO_3$ while the other was steeped in hot water (60°C, 30 min). Each batch was then processed by hand dehulling and the cotyledons milled to a fine slurry (1.5 l) with hot water (93°C) in a variable speed kitchen blender, Osterizer (Oster Sunbean Corporation, Milwaukee, USA) inside a pyrex glass pitcher. Milling was done stepwise at low, medium and highest speeds for a total of about 5 min. The slurry was filtered thereafter with gauze metal and calico, as described by Nsofor and Maduako (1992). Ten ml aliquots of each soymilk extract were pipetted into clean test tubes, stoppered with rubber corks and sterilized (121°C, 15 min). One hundred millilitres unsterilized quantities of each soymilk extract were used for chemical analysis.

pH, total solids and starch determinations: The pH and total solids of each soymilk extract were determined as described by Nsofor and Anyanwu (1992a). Starch was estimated in soymilk samples by absorbance of the iodine complex at 620 nm (Hyun and Zeikus 1985). One half ml of each soymilk extract was dispensed in duplicate test tubes and 9.5 ml sterile water was added to each tube followed by addition of two drops of 10% standard iodine solution. Ten ml sterile water with 2 drops of iodine, was used as blank.

Protein solubility: Extent of hydrolysis of soybean protein by sprouting was estimated by spectrophotometric absorbance at 280 nm of soymilk protein that is soluble in trichloroacetic acid (TCA) (Ibiama and Griffiths 1987). One half ml of each soymilk extract was dispensed in duplicate test tubes. Nine ml distilled water was added, followed by addition of 0.5 ml of 3% TCA and the mixture was incubated (37°C, 10 min). The tubes were centrifuged in a Gallenkamp CFD-400 centrifuge (Gallenkamp, UK) at 3000 x **g** for 30 min and the absorbance of the decantate was measured in the spectrophotometer. The blank was 9.5 ml distilled water with added 0.5 ml TCA, incubated and centrifuged as described above.

Ambient storage stability : The coagulation time (Nsofor and Maduako 1992; Nsofor and Anyanwu 1992b) of soymilk samples was determined during storage at ambient tropical room condition (25-32°C) and adopted as index of stability. All determinations were carried out in duplicates.

TABLE 1. EFFECTS OF SOYBEAN SPROUTING AND BLANCHING ON SOYMILK STABILITY AND CHEMICAL PROPERTES[1]

Soybean treatment	Stabilitity,[2] days	Total solids, %	Starch[3] absorbance, 620 nm	Soluble protein absorbance, 280 nm	pH	Percent[4] sprouting
Sprouting time, h						
0	0	12.0	0.456	0.083	6.66	0
12	78	10.4	0.300	0.209	6.55	74.6
24	150	10.1	0.259	0.154	6.53	82.3
48	204	9.2	0.142	0.154	6.62	87.0
72	101	4.9	0.123	0.036	6.57	92.5
(Blanching)						
0.5% $NaHCO_3$ @ 100°C, 20 min	126	8.7	0.220	0.134	6.82	NA[5]
Hot water steeping (reference)	88	9.9	0.291	0.119	6.35	NA

[1] Each data point under "sprouting time" is the mean of duplicates for sprouted-blanched and sprouted-unblanched samples; "blanching" represents mean of duplicates for all sprouted/unsprouted-blanched samples

[2] Stability= coagulation time. [3] Starch/soluble protein absorbance = concentration index of each substance

[4] Weight ratio of wet sprouted seeds to total wet seeds. [5]NA = not applicable

Results and Discussion

Effect of sprouting time on soymilk stability and chemical properties: The main effects of sprouting time on stability and chemical properties of soymilk extracted from blanched and unblanched soybeans are shown in Table 1. Each data point presented under "sprouting time" in the Table was the mean of duplicates for sprouted-blanched and sprouted-unblanched samples, that is the mean of sprouted samples regardless of blanching. Coagulation time (stability index) increased with sprouting time up to 48 h, after which it decreased. Conversely, soymilk total solids decreased with sprouting time. The control, that is, soymilk extract from unsprouted soybeans coagulated instantly following sterilization and it had the highest mean total solids content, (12%). The extract from soybeans sprouted for the longest period, i.e., 72h, had the least mean total solids, (4.9%,) which resulted from intensive sprout growth at that time, causing about 30-50% reduction in the original sizes of the seeds immediately after water-steeping. Starch was highest in the control and decreased progressively with sprouting time. Decrease in starch indicated release of sugars, which were likely absorbed by the growing sprouts. Soluble protein was greatest in the 12 h-sprouted samples and decreased thereafter to a minimum in the 72 h-sprouted sample. The starch and soluble protein absorbances in Table 1 were indices of concentration of these subtances. Soluble carbohydrate concentration was not measured in this study. The changes in pH of the soymilk samples did not show a definite trend as sprouting time increased. The per cent sprouting increased with increased holding time and maximum sprout length of about 1.6 cm was observed. The sprouts were broken off during hand-dehulling and discarded before milling of the cotyledons. Vanderstoep (1981) indicated that the changes, which occurred in germinated legumes, included increase in soluble amino nitrogen and noted that at 54 h germination, soybean cotyledons contained significant quantities of most vitamins. Cruz and Park (1982) noted that raffinose declined in concentration in soybean cotyledons during germination. Generally, there are advantages to soymilk extracted from germinated soybeans. These include enhanced shelf-stability, even in ambient tropical storage, increased levels of nutrients and enhanced organoleptic properties (Vanderstoep 1981) and greater digestibility (Cruz and Park 1982).

Effects of blanching : The main effects of blanching on stability and chemical properties of soymilk extracted from sprouted soybeans and from the control (soybeans not allowed to sprout) are also shown in Table 1. Each data point shown under "blanching" in the Table is the mean of duplicates for all the control and sprouted samples that were blanched (100°C, 20 min) compared to the reference (hot water-steeped), in which each data point is the mean of all sprouted and control samples that were unblanched. Increased stability of the blanched relative to the unblanched samples was partly attributed to the higher mean pH of 6.82 for the former, compared to 6.35 for the latter. Sodium bicarbonate was utilized as a blanching additive and was responsible for the higher pH of the blanched samples. Nsofor and Anyanwu (1992b) established a strong correlation between soymilk pH and shelf-stability. In their report, a negative correlation of 0.89 existed between coagulation time and pH of freshly coagulated concentrated soymilk. Ihekoronye (1990) indicated that a vegetable protein isolate-milk beverage was stabilized with citrate/phosphate buffer "miltone" and noted that the beverage is consumed in India. Proteins precipitate at their isoelectric pH (Kinsella 1985; Nsofor et al. 1993). Lower starch and total solids contents observed in the blanched samples relative to the unblanched (Table 1) indicate that less solids and starch were extracted from blanched soybeans. Blanching was indicative to insolubilize soy solids in the cotyledons (Nsofor and Maduako 1992). Reduced content of extracted solids is expected to limit the number of macromolecular cross-links in soymilk. Extensive cross-linking of molecules causes precipitation or gelation. Soymilk of lower total solids (16%) is more stable to heat treatment than the higher solids-containing (22 and 32%) counterparts (Nsofor and Anyanwu 1992b). Less variation occurred in soluble protein content of blanched and unblanched samples. Blanching or dry heat treatment is applied in soybean processing to inactivate lipoxygenase (Nelson et al. 1976), which is the enzyme that catalyzes the hydrolysis of unsaturaed soybean oil, resulting in the production of ketones and aldehydes responsible for the beany and grassy odours in non-heat treated milled soybeans (How and Morr 1982).

Interactions of sprouting and blanching: The interactive effects of soybean sprouting time and blanching on soymilk stability and chemical properties are summarized in Fig. 1. Stability (coagulation time) increased in blanched and unblanched samples till 48h-sprouting, after which decreases became apparent (Fig.1a). Coagulation of

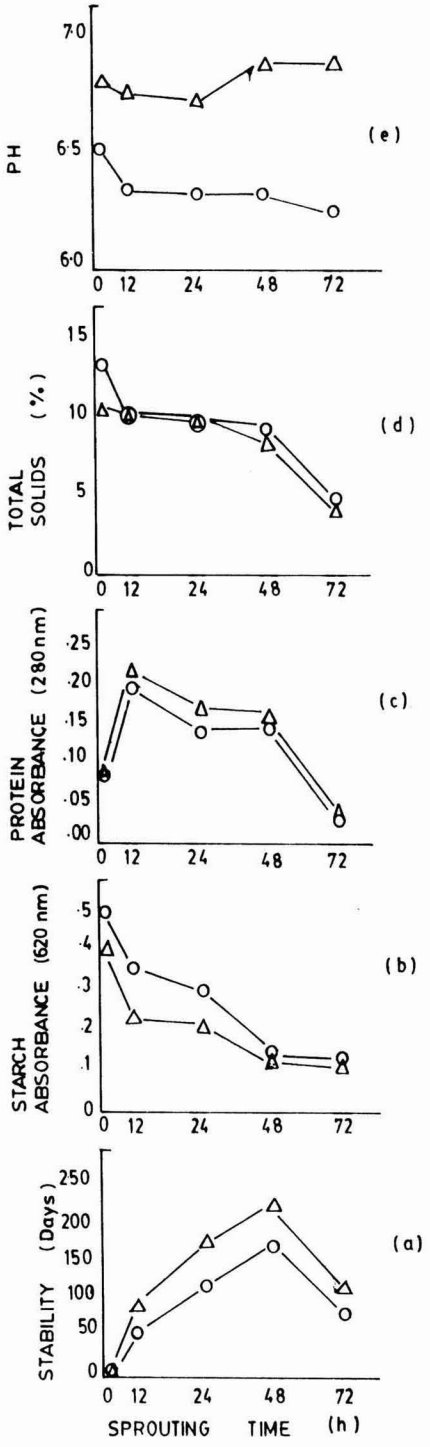

Fig. 1. Interactive effects of soybean sprouting time and blanching treatment (Δ = blanched O = unblanched) on soymilk stability and chemical properties: (a) coagulation time (stability) (b) starch (c) soluble protein (d) total solids (e) pH

blanched and unblanched control (unsprouted) samples was observed right after sterilization. Chemical changes that occurred in the extracts, consequent to sprouting and blanching are illustrated in Fig. 1b to 1e. Starch content decreased progressively with increased sprouting time in blanched and unblanched samples. The differences in starch content as a result of blanching decreased as sprouting time increased (Fig. 1b). Soluble protein increased remarkably at 12h-sprouting in blanched and unblanched samples and decreased thereafter (Fig. 1c). Germination was clearly evident after 12 h-sprouting time and soluble protein decreased thereafter. Most likely, absorption of soluble protein by the growing sprouts caused the decrease. The largest decrease in soluble protein occurred at 72 h-sprouting, relative to the value at 48h. Minimal decrease in soluble protein occurred between 24 and 48h-sprouting. Minor differences generally occurred in soluble protein content of blanched and unblanched samples.

The variations that occurred in soymilk total solids with sprouting, in blanched and unblanched samples, are shown in Fig. 1d. Largest variations occurred between the blanched and unblanched control samples, with a total solids difference of 3.4%. The most apparent single stage decrease in total solids was observed at 72 h-sprouting and could be attributed to rapid solids uptake by the actively growing sprouts. pH was generally higher in the blanched, compared to the unblanched samples and it showed no definite trend with increased sprouting time (Fig. 1e). Overall, the stability and chemical properties of the soymilk extracts partly depended on sproutability of the soybean seeds. Seed drying method, storage history and variety may affect sproutability. The 92.5% sprouting observed at 72h-holding in this tudy (Table 1) for 'TGM 579' soybean variety after about 8 months ambient storage is at variance with 85% sprouting for 'TGX 923-2E' variety stored for 1.5 months (Nsofor and Maduako 1992). Recent sprouting experiments (Nsofor unpublished) with the same batch of soybeans as above ("TGX 923-2E") after 24 months' ambient tropical storage, showed zero per cent sproutability, after 72h in ambient sprouting condition. These changes are expected to affect protein and carbohydrate solubilities, solids extractability and other chemical properties of the resultant soymilk extract.

Interrelationship between soymilk stability and chemical properties: Increased soymilk stability and simultaneous decrease in starch during the 0-48h

sprouting interval (Fig. 1) suggest the direct involvement of starch with soymilk storage instability. Thus, if soybean starch and possibly other polysaccharides like cellulose, a natural plant cell wall material, are hydrolyzed to oligosaccharides and simple sugars by sprouting, macromolecular cross-linking, which usually occurs during heat processing, would be minimal. This expectedly would limit gel development or coagulation of the soymilk during storage. Instant coagulation of heat-sterilized soymilk extracts from unsprouted soybeans (control) (Fig.1) supports the above soymilk stability/polysaccharide hydrolysis theory. No other chemical changes showed clearly apparent relationships with soymilk stability during the 0-48 h sprouting interval in Fig. 1. However, the relative instability observed between 48 and 72 h-sprouting (Fig. 1) coincided with sharp decreases in both soluble protein and total solids and minimal decrease in starch. It is strongly suspected that relative instability of the 72 h-sprouted sample may be as a result of heat-induced cross-linking of insoluble protein-carbohydrate complexes still present. At 72 h-sprouting, it is envisaged that the rapidly growing sprouts would have absorbed most of the available hydrolyzed/soluble sugars and amino acids,leaving the insoluble components unabsorbed in the cotyledons. Thus, soymilk extracted at that sprouting stage (72 h) would likely contain a lot of insoluble components, partly similar to the control samples. It appears from Fig. 1, that the rate determining sprouting interval is the 0 to 12 h period, since it was at that interval that the most apparent chemical changes generally occurred during the period of increased soymilk stability.

Further development of stabilized soymilk: Sensory evaluation of stored soymilk samples from sprouted soybeans is crucial, since lipolytic activity is strongly anticipated and this may lead to rancidity. Preliminary/informal sensory evaluation by the authors of the present work, however, showed that freshly extracted and sterilized soymilk from blanched soybeans sprouted for 48 h, was tasting bland, cream coloured and generally acceptable. The control (unsprouted) sample had cereal-like after -taste and slightly chalky mouth feel. Also, storage stability of concentrated soymilk from sprouted soybeans needs investigation, in view of the various uses of concentrated milks (Nsofor and Anyanwu 1992a; Lo et al. 1968; Wei et al. 1985).

Conclusions

Soybean sprouting/blanching followed by heat-sterilization of the extract was observed as a potential food process operation that could produce liquid soymilk with prolonged stability in ambient storage, even under tropical conditions.

Increased stability of the stored soymilk from soybeans sprouted for 12 to 48 h showed relationships with hydrolysis of soybean polysaccharide (starch) and polypeptide.

Loss of stability occurred at 72 h-sprouting and this coincided with rapid decreases of soluble soybean proteins and total solids in soymilk.

Blanching of sprouted soybeans increased stability and pH of the soymilk extracts, but decreased total extracted solids and starch from the cotyledons.

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Received 15 November 1995; revised 29 March 1997; accepted 12 April 1997

J. Food Sci. Technol., 1997, Vol 34, No. 6. 483-487

Pyrazines Formation in Cocoa Beans: Changes During Fermentation

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Fermentation of cocoa beans led to the formation of 2-methyl-, 2,5-dimethyl-, 2,6-dimethyl-, 2,3-dimethyl-, 2,3-5-trimethyl- and 2,3,5,6-tetramethylpyrazine. No pyrazines were detected in unfermented cocoa beans. Tota pyrazines (437.53 µg/100g), tetramethyl-(295.56µg/100g), trimethyl- (126.07 µg/100g) and 2,5-dimethylpyrazine (6.01µg/100g) reached maximum concentrations on the 4th day of fermentation. The formation of total pyrazines and trimethylpyrazine was more influenced by an increase in the aeration time, whereas that of the tetramethylpyrazine was dependent on fermenting mass. Optimum conditions for maximum formation of total pyrazines, trimethyl-and tetramethylpyrazine could be achieved at fermenting mass of 85-88 kg and an aeration time of 5.5-5.7 min.

Keywords : Fermentation, Cocoa beans, Trimethylpyrazine, Fermenting mass, Aeration time, Tetramethylpyrazine.

Pyrazines (1,4 diazines) represent about 40% of the compounds, identified in the aromatic fraction of chocolate (Maga 1992). Thus, they are significant contributors to the flavour of roasted cocoa and other heated foods. Even though pyrazines are normally found during cocoa roasting through Maillard non-enzymatic browning reaction (Barel et al. 1984; Maga 1992; Reineccius et al. 1972; Silwar 1988), they have have also been isolated and detected in foods (Kosuge and Kamiya 1962; Zak et al. 1972).

Most of the research findings on pyrazines have been related to cocoa roasting and only very few are related to fermentation. Quantitative studies by Reineccius et al (1972) showed that tetramethyl-pyrazine was the only pyrazine present in unroasted and well fermented cocoa beans. In addition, Bauermeister (1981) reported the presence of the monomethyl-, 2,3-dimethyl-, trimethyl- and tetramethyl-pyrazines are the two-naturally occurring pyrazines formed in substantial quantities in fermented, unroasted cocoa beans. This finding was supported by Jinap et al (1984), who showed the presence of trimethyl-and tetramethyl-pyrazine in Malaysian cocoa beans. Hashim and Chaveron (1994) have detected the monomethyl-2,5-dimethyl-, 2.6-dimethyl, 2,3-dimethyl-, trimethyl- and tetramethyl-pyrazine in Ivory Coast cocoa beans.

The present investigation was carried out to determine the pyrazines in cocoa beans during a 6- day cocoa fermentation and to study the effect of fermenting mass and aeration time on formation of pyrazines using Response Surface Methodology (RSM).

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Materials and Methods

Ripe cocoa pods (mix hybrid) were purchased locally. The cocoa pods were extracted manually and subjected to 6 days fermentation in a rotary drum reactor (Arbakaria et al. 1989). The reactor consisted of a stainless steel shaft and arms in the middle of a wooden drum. The dimensions of the reactor were 98 cm in length x 60 cm in diameter. The drum was rotated at 3 rpm, twice a day after 48 h of fermentation. Samples were taken daily and immediately frozen at -20°C and lyophilized in freeze-dryer (Labconco USA).

Response surface methodology was followed in the experiment (Giovanni 1983), which consisted of two independent variables, fermenting mass (10-100 kg) and aeration time (0-10 min). Five levels of each of the two factors were chosen. The values of the independent variables in each fermentation

TABLE 1. RESPONSE FROM THE ANALYSIS OF VARIANCE OF SECOND DEGREE POLYNOMIAL

Fermenting mass, kg	Aeration time, min	Response		
		Trimethyl-pyrazine	Tetramethyl-pyrazine	Total pyrazines
23	1.5	29.18	83.34	54.24
87	1.5	11.93	64.26	78.74
23	8.5	22.69	104.19	50.19
87	8.5	32.19	75.65	84.43
10	5.0	2.22	2.69	16.11
100	5.0	46.88	148.27	227.65
55	0.0	6.49	61.21	4.35
55	10.0	48.51	77.15	106.22
55	5.0	75.61	103.09	121.28
55	5.0	91.69	94.47	191.61
55	5.0	103.31	113.57	197.31
55	5.0	80.29	105.69	124.44
55	5.0	81.39	86.18	117.78

treatment were coded as -1.414, -1, 0, +1, +1.414. Altogether 13 combinations (including five replicates of the centre points) were chosen in random, according to a central composite rotatable design configuration for two factors (Cochran and Cox 1957). The actual values of the two independent variables together with the responses are shown in Table 1. The responses measured refer to the slope from the regression analysis (SAS) of the changes in the concentration of total pyrazines, trimethyl-and tetramethylpyrazine against days of fermentation.

The analysis yielded a second degree polynomical equation as follows:

$$y=b_0+b_1X_1+b_2X_2+b_{11}X_1X_1+b_{22}X_2X_2+b_{12}X_1X_2 \quad ....(1)$$

where y= response=pyrazine concentration (µg/100g)

X_1= fermenting mass (kg)

X_2 = aeration time (min)

$b_0b_1b_2b_{11}b_{22}b_{12}$ = coefficients (constant)

The coefficients from the polynomial second degree (Table 2) were used to plot three dimension peak on the response surface, which was generated by Statgraphic software version 400 (STSC Inc., Rockville, MD, USA).

Lyophilized cocoa beans were deshelled and degermed. The beans were ground in a Waring blender (Braun, Germany). Small pieces of solid carbon dioxide were added, occasionally, to prevent the melting of cocoa lipids. The ground samples were then passed through 850 µm sieve and used for analysis.

The water content of lyophilized ground cocoa beans was determined after drying at 104°C (AOAC 1990). Simultaneous steam distillation and extraction (SDE) was done using a modified Likens and Nickerson apparatus to extract pyrazines from cocoa powder. A mixture of 100 g cocoa powder and 200 ml of distilled water was distilled for 1h by the simultaneous steam distillation and extraction (SDE) method. The flavoured extract was collected in 30 ml of pentane. Anhydrous sodium sulphate was added to the distillate and set aside for 2 h to absorb moisture. The distillate evaporated to less than 1 ml, using a stream of nitrogen.

Analysis of different types of pyrazines was carried out by gas chromatography (Hewlett-Packard 5890, USA), using pyrazine as an internal standard through capillary column of fused silica BP 20 (50 m x 0.33 mm x 0.25 µm), using a nitrogen phosphus detector (NPD). The column temperature was programmed to increase from 50°C to 140°C at 3°C/min. The carrier gas employed was nitrogen at 0.9 ml/min; carrier and makeup gas was at 30 ml/min. Both the detector and injector temperatures were set at 220°C.

TABLE 2. REGRESSION COEFFICIENT FOR DEPENDENT VARIABLES

	Trimethyl-pyrazine	Tetramethyl-pyrazine	Total pyrazines
b_0	86.46	100.60	150.48
b_1	24.60	19.78	44.73
b_2	9.15	6.85	9.37
b_{11}	-12.71	-10.18	-22.85
b_{22}	-36.23	-13.33	-43.64
b_{12}	6.69	-2.37	2.43
From RSM plot :			
Value of fermenting mass, kg	87.60	85.30	86.40
Value, of aeration time, min	5.70	5.60	5.50

Results and Discussion

Formation of pyrazines: A typical chromatogram of the pyrazines fraction recovered from fermented cocoa beans is shown in Fig. 1. Peaks 2 through 7 represent the pyrazines isolated from the beans, while peak 1 is an internal standard (pyrazine). The formation of the different pyrazines in fermented cocoa beans at 55 kg fermenting mass and an aeration time of 5 min is presented in Fig. 2a and 2b. No pyrazines studied were detected in unfermented cocoa beans. On day 1 of fermentation, 2,5-dimethyl-, 2,3-dimethyl-, trimethyl-and

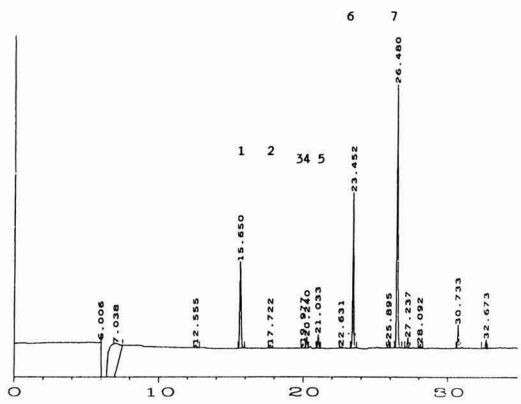

Fig. 1. Gas chromatographic analysis of formented cocoa seed extract 1) pyrazines (internal standard); 2) 2-methylpyrazine; 3) 2,5-dimethylpyrazine; 4) 2,6-dimethylpyrazine; 5) 2,3-dimethylpyrazine; 6) 2,3,5-trimethylpyrazine and 7) 2,3,5,6-tetramethylpyrazine

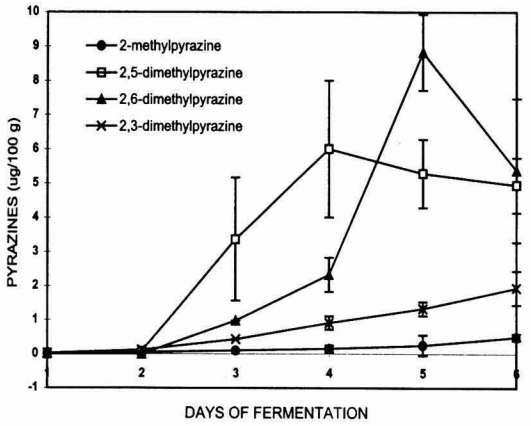

Fig.2a. Formation of pyrazines during cocoa bean fermentation. Fermenting mass 55 kg and aeration time 5 min

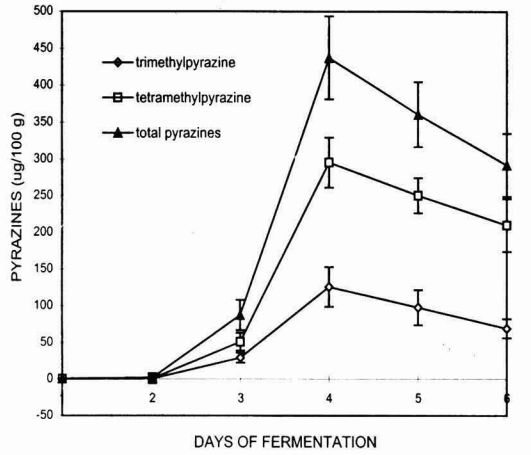

Fig.2b. Formation of pyrazines during cocoa bean fermentation. Fermenting mass 55 kg and aeration time 5 min

the tetramethylpyrazines were 0.02, 0.02, 0.22 and 0.27 µg/100g, respectively, which were very low. These results are in agreement with those resported by Hashim and Chaveron (1994) except that tetramethylpyrazine concentration was 30 µg/100g. The 2-methylpyrazine could be detected only after 2 days of fermentation (0.08 µg/100 g). In fact, the pyrazines could be detected better after the 3rd day of fermentation. The observation of Bauermeister (1981), who could detect the presence of monomethyl-, 2,3-dimethyl-, trimethyl- and tetramethylpyrazines is in conformity with the results obtained by Hashim and Chaveron (1984), who detected the monomethyl-, 2,5-dimethyl-and 2,6-dimethylpyrazines in cocoa beans after 3 days of fermentation.

The major components of these pyrazines were trimethyl-and tetramethylpyrazines, the latter being the predominant one. This result agrees with Barer et al (1984), Humbert and Sandra (1987) and Hashim and Chaveron (1994), who have reported that tetramethylpyrazine is formed not only by cocoa roasting, but also during cocoa fermentation. The concentrations of pyrazines increased very rapidly with time and reached the maximum on the 4th day of fermentation and declined afterwards. This was true with total pyrazines. Jinap et al (1994) have observed a high correlation (R=0.9) between pyrazines formation and the growth of *Bacillus* especially *B. subtilis* and *B. megatrium* at this day of fermentation. Similar findings were reported by Zak et al (1972) on the biosynthesis of tetramethylpyrazines by *B. subtilis* and the decrease of its concentration was explained by the decline of the microorganism activity. The concentration of 2-methyl-and 2,3-dimethylpyrazines was very low. However, it was found to increase, as the fermentation progressed.

Effect of aeration : For the response surface methodology (RSM) evaluation, a second degree polynomial equation (equation 1) was fitted to the experimental data as shown in Table 1. From the variance analysis (Table 1), fermenting mass and aeration time appeared to influence the response. The relationship between these two variables to the formation of the trimethyl-, tetramthylpyrazine and total pyrazines are represented by the three dimensional surface plot (Fig. 3,4 and 5). The

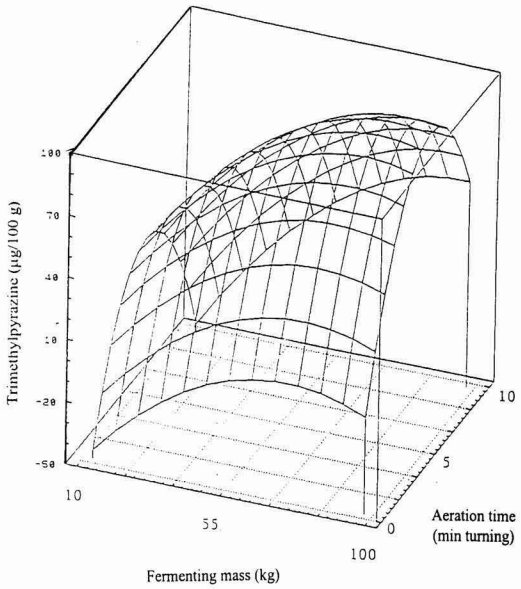

Fig.3. Effect of fermenting mass and aeration time on trimethylpyrazine during cocoa bean fermentation

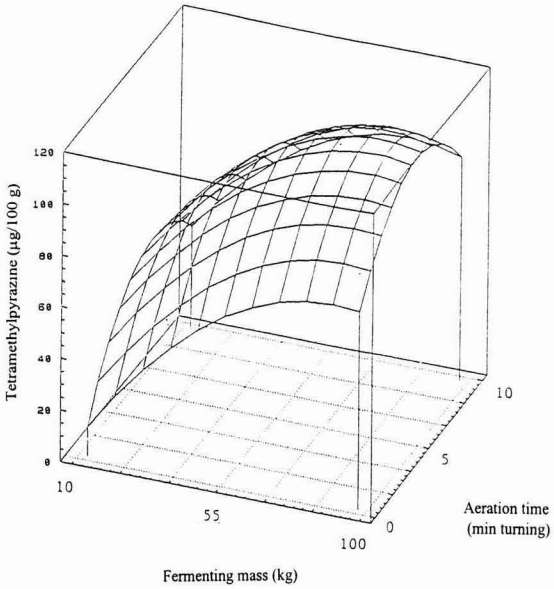

Fig.4. Effect of fermenting mass and aeration time on tetramethylpyrazine during cocoa bean fermentation

concentration of trimethylpyrazine and total pyrazines at lower aeration (0 min) was negligible (Fig. 3 and 5). However, the concentration increased sharply as the aeration time increased to about 5.7 and 5.5 min, respectively. At high fermenting mass, trimethylpyrazine and total pyrazines concentrations decreased slowly with an increase in aeration

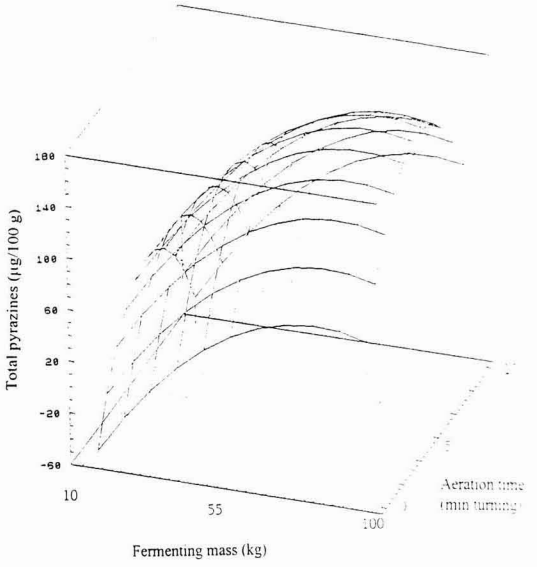

Fig.5. Effect of fermenting mass and aeration time on total pyrazines during cocoa bean fermentation

time but, at low fermenting mass, it decreased at a much rapid rate. The same trend was observed for tetramethylpyrazine (Fig. 4), but the rate of decrease was much slower. The initial concentration of tetramethylpyrazine was high (60 µg/100g) at 100 kg fermenting mass compared to that at 10 kg mass. Thus, in the present study, trimethylpyrazine was more affected by an increase in aeration time. The increase in trimethyl- and tetramethylpyrazine concentration could be due to microbial synthesis. Kosuge and Kamiya (1962) found tetramethyl-pyrazine as a metabolic product of *B. subtilis*, grown on certain types of media. Of significant is the fact that Ostovar and Keeney (1973) identified several species of this organism in a fermenting mass of Trinidad cocoa beans. Similar findings were also reported by Zak et al (1972), using Trinidad and Brazilian cocoa beans. Even though the concentration of trimethyl-, tetramethylpyrazine and total pyrazines increased, when the aeration time was increased upto about 5.7, 5.6 and 5.5 min, respectively. Their concentrations later declined with further increase in aeration time. This could be attributed to the fact that higher aeration caused loss of heat, leading to reduction of temperature (Said and Samarkhody 1984). The high aeration, in turn, accelerated the overall process, causing an increased loss of substrates for the microorganism, the metabolism of which ceased earlier.

Effect of fermenting mass : The concentrations of trimethyl-, tetramethylpyrazine and total pyrazines (Fig. 3,4 and 5) increased, as the fermenting mass increased, but remained constant at around 85-88 kg and then declined slightly, when the mass was further increased to 100 kg. For tetramethylpyrazine, the rate of formation was the same at high and low aeration times, suggesting that it was affected more by fermenting mass than aeration. The increase in trimethylpyrazine and total pyrazine concentration with an increase in fermenting mass, however, was higher at 10 min than at 0 min. Further increment in fermenting mass resulted in higher pyrazine formation. Said and Samarkhody (1984) had shown that an increase in cocoa mass would lead to higher mass temperature. The tetramethylpyrazine in fermented beans might arise through thermally initiated reactions and would readily form during roasting at 150°C, which accounted for almost all the pyrazine concentrations of cocoa beans for 30 min at 70°C (Reineccius et al. 1972). Since the core temperature of a fermenting cocoa mass may reach 50°C, it was

suggested that thermal initiation of the tetramethylpyrazine formation would seem plausible. The temperature of cocoa mass was found to be around 46°C during the 4th day of fermentation. This temperature could initiate a mild Maillard reaction between preformed flavour precursors during fermentation.

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Received 4 January 1996; revised 17 May 1997; accepted 29 May 1997

J. Food Sci. Technol., 1997, Vol 34, No. 6. 488-493

Studies on the Mycological Quality of Milk Powder

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Fifty random samples of milk powder, representing 7 brands (A, B, C, D, E, F and G) were collected from different pharmacies in Assiut City. Each sample was evaluated for its mycological quality. Thirty nine species and one variety belonging to 17 genera of fungi were identified. The most contaminated samples were found to belong to brands A, C and D, while the least were F and G brands. The most frequent genera were *Alternaria, Aspergillus, Emericella* and *Penicillium. Aspergillus niger* was the only fungus, found to contaminate all brands (72% of the total samples). *A flavus* was recovered only from D (50% of samples tested) and G (37.5%) brands. *Alternaria alternata, Emericella nidulans, Fusarium oxysporum, Penicillium aurantiogiseum, P. chrysogenum* and *P. citrinum* were prevalent in some brands of milk powder. Public health implications of these findings are discussed.

Keywords : Milk powder, Mycological quality, *Asperigillus, Penicillium, Alternaria, Emericella.*

Attention has been focussed in the last two decades on the contamination of food with those fungi causing considerable hazards to health, associated with liver damage and carcinogenicity and also considerable economic losses through spoilage and discoloration (Mossel 1982).

Now-a-days, the growing use of milk powder for infant feeding has made its microbial quality of primary concern due to susceptibility of children to food-borne diseases. Moulds gain entry to milk powder either from the milk used or from polluted air or utensils and their presence in milk powder is indicative of unsatisfactory sanitation during processing and handling of the product.

Jesenska and Hrdinova (1981) found that moulds were present in 53% of examined milk powder samples for infants, while Moustafa et al (1984) tested 30 samples of dried baby foods with milk base and found that moulds were present in 28 samples. Contamination of infant milk powder was also reported by Sabreen (1986).

As the mycological quality of milk powderreflects the care with which the milk was produced and the identification of the contaminating mycoftoxins, which might be produced, this study was undertaken to enumerate and identify moulds that may be present in milk powder.

Materials and Methods

Milk powder samples : Fifty samples of milk powder at the stage of consumption from pharmacies of Assuit City, Egypt were randomly obtained. These samples belonged to seven brands viz., A (5 samples), B (5), C (7), D (6), E (9), F (10) and G (8). A was the only brand that was locally packaged.

Mycological analysis : The dilution-plate method was used for detection of viable fungal propagules in milk powder samples. Two types of media and two incubation temperatures were used. Malt extract agar (Harrigan and McCance 1976) and dicloran-rose bengal medium (King et al. 1979) were used for the enumeration of mesophiles at 25°C. Thermophiles were enumerated only on dicloran agar medium at 45°C. Triplicate plates for each medium were incubated for 7-10 days and the fungi were counted and identified.

Identification was based on macro-and microscopic characteristics (Cooney and Emerson 1964; Raper and Fennell 1965; Ellis 1971; Booth 1977; Pitt 1979; Samson and van Reenen-Hoekstra 1988; Kozakiewicz 1989).

Results and Discussion

Thirty nine fungal species and 1 variety belonging to 17 genera were isolated from 50 samples of 7 different brands of milk powder. It was observed that 5 of the 50 samples tested were completely free from fungi on the two selective media at 25°C and 45°C and these samples belonged 1 to brand D, 2 to E and 2 to G. Sutic et al (1979) found that 223 out of 1000 samples of milk and milk products were contaminated with moulds. The counts of fungi widely fluctuated and ranged from 6.7 to 21000, and 10 to 430 colonies/g milk powder on dicloran malt at 25°C and dicloran agar at 45°C, respectively. The most encountered genera were *Alternaria, Aspergillus, Emericella* and *Penicillium* and this is in agreement with the findings of Torrey and Marth (1977) and Sutic et al (1979).

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Mesophilic fungi recovered at 25°C

Fungi recovered on dicloran agar: Out of 44 samples of milk powder tested were found to be contaminated by fungi. Ten genera and 28 species were encountered on dicloran agar at 25°C with the most common genera being *Aspergillus* (9 species) and *Penicillium* (8). These two genera were found in 80% and 44% of the samples and accounted 68.8% and 20.5% of total fungi, respectively. Sutic et al (1979) found that *Aspergillus* and *Penicillium* comprised 3.2% and 59.1% of the total mould strains, obtained from milk and milk products. It could observed that brands A and D followed by C were the most contaminated samples and F and G were the least (Table 1). *Aspergillus niger* was the only contaminating fungus found in all brands of milk powder (72% of the samples). Its counts represented 73.6% of those of the genus and 50.6% of total fungi. Many reports on dairy products recorded that *A. niger* was of high incidence (Bullermin 1980; El-Bassiony et al 1980; Ibrahim 1987). The second most frequent species was *Penicillium chrysogenum*, which was reported from all milk products except brand A. It accounted 7.9% of the genus and 1.6% of total fungi. *A. flavus* was recovered only from brand D (3 of 6 samples)

TABLE 1. COUNTS OF MESOPHILIC FUNGI (C. PER G DRY MILK POWDER) AND THE NUMBER OF CONTAMINATED SAMPLES (NS) OF VARIOUS BRANDS OF MILK POWDER ON DICLORAN AGAR AT 25°C.

Fungi	Brand A (5)		Brand B (5)		Brand C (7)		Brand D (6)		Brand E (9)		Brand F (10)		Brand G (8)	
	C	NS	C	NS	C	NS	C	NS	C	NS	C	NS	C	Ns
Acremonium strictum	–	–	–	–	–	–	–	–	–	–	126.7	3	–	–
Alternaria alternata	–	–	–	–	–	–	1333	1	666	1	–	–	33	1
Aspergillus	24470	5	8896	5	18073	7	44026	5	7343	6	280	6	2473	6
A. flavus	–	–	–	–	–	–	19666	3	–	–	–	–	733	3
A. flumigatus	–	–	–	–	–	–	–	–	666	1	40	2	–	–
A. melleus	–	–	–	–	–	–	–	–	666	1	–	–	–	–
A. niger	24470	5	8793	5	12403	7	24026	4	6010	5	240	5	1706	5
A. parasiticus	–	–	–	–	4666	1	–	–	–	–	–	–	–	–
A. proliferans	–	–	–	–	666	1	–	–	–	–	–	–	–	–
A. sydowii	–	–	–	–	333	1	333	1	–	–	–	–	–	–
A. tamarii	–	–	–	–	333	1	333	1	–	–	–	–	33	–
A. versicolor	–	–	103	1	–	–	–	–	–	–	–	–	–	–
Cladosporium	20	1	–	–	–	–	666	–	1	–	–	–	40	–
C. cladosporioides	20	1	–	–	–	–	–	–	–	–	–	–	33	–
C. sphaerospermum	–	–	–	–	–	–	666	1	–	–	–	–	6	–
Cochliobolus	–	–	–	–	1333	1	666	1	–	–	–	–	–	–
C. lunatus	–	–	–	–	1333	1	–	–	–	–	–	–	–	–
C. spicifer	–	–	–	–	–	–	666	1	–	–	–	–	–	–
Emericella	33	1	–	–	666	1	–	–	10000	2	–	–	–	–
E. nidulans	33	1	–	–	333	1	–	–	1000	2	–	–	–	–
E. quadrilineata	–	–	–	–	333	1	–	–	–	–	–	–	–	–
Fusarium oxysporum	33	1	33	1	–	–	–	–	–	–	–	–	–	–
Mucor racemosus	–	–	66	1	–	–	–	–	–	–	–	–	33	1
Penicillium	21000	3	766	5	4070	5	1000	2	3666	2	276	3	733	2
P. aurantiogriseum	20000	1	3	1	3	1	–	–	–	–	–	–	–	–
P. brevicompactum	–	–	3	1	666	2	–	–	–	–	–	–	–	–
P. chrysogen	–	–	270	2	66	1	100	2	333	1	110	2	333	2
P. citrinum	333	1	–	–	–	–	–	–	–	–	–	–	–	–
P. Pinophinum	–	–	–	–	3000	1	–	–	3333	1	166	1	1	–
P. puberulum	–	–	390	3	–	–	–	–	–	–	–	–	–	–
P. variabile	–	–	100	1	333	1	–	–	–	–	–	–	–	–
P. waksmanii	666	1	–	–	–	–	–	–	–	–	–	–	–	–
Rhizopus stolonifer	333	1	–	–	–	–	333	1	–	–	–	–	–	–
Total fungi	45890	5	9763	5	24143	7	48026	5	21676	6	683	10	3313	6
Yeasts	–	–	750	1	–	–	–	–	–	–	–	–	–	–
Bacteria (*Bacillus* spp.)	44000	3	25383	4	–	–	–	–	333	1	–	–	–	–

TABLE 2. FUNGI ASSOCIATED WITH MILK POWDER SAMPLES

Fungi	Mesophiles								Thermophiles			
	Dicloran agar				Malt agar				Dicloran agar			
	C	%C	NS	%F	C	%C	NS	%F	C	%C	NS	%F
Acremonium strictum W. Gams	126	0.08	3	6	10	0.04	1	2	–	–	–	–
Alternaria alternata (Fr.) Keissler	2033	1.33	3	6	4250	16.83	8	16	–	–	–	–
Aspergillus	105563	68.78	40	80	5450	21.58	12	24	230	30.67	17	34
A. aureolatus Munt-Cvet. & Bata	–	–	–	–	10	0.04	1	2	–	–	–	–
A. flavus Link	20400	13.29	6	12	1000	3.96	1	2	–	–	–	–
A. fumigatus Fresenius	706	0.46	3	6	–	–	–	–	–	–	–	–
A. fumigatus var. albus Rai, Tewari & Agarwal	–	–	–	–	–	–	–	–	40	5.33	1	2
A. melleus Yukawa	666	0.43	1	2	–	–	–	–	–	–	–	–
A. niger van Tieghem	77650	50.59	36	72	3340	13.23	8	16	120	16.00	13	26
A. parasiticus Speare	4666	3.04	1	2	–	–	–	–	–	–	–	–
A. proliferans G. Smith	6	0.43	1	2	–	–	–	–	–	–	–	–
A. sydowii (Bainier & Sartory) Thom & Church	336	0.22	2	4	–	–	–	–	–	–	–	–
A. tamarii Kita	366	0.24	2	4	–	–	–	–	–	–	–	–
A. terreus Thom	–	–	–	–	–	–	–	–	70	9.33	5	10
A. ustus (Bainier) Thom & Church	–	–	–	–	1000	3.96	1	2	–	–	–	–
A. versicolor (Vuill.) Tiraboschi	103	0.07	1	2	100	0.40	1	2	–	–	–	–
Cladosporium	726	0.47	4	8	100	0.40	1	2	–	–	–	–
C. cladosporioides (Fres.) de Vries	53	0.04	2	4	–	–	–	–	–	–	–	–
C. sphaerospermum Penz.	673	0.44	2	4	100	0.40	1	2	–	–	–	–
Cochliobolus	2000	1.30	2	4	120	0.48	3	6	–	–	–	–
C. lunatus Nelson & Haasis	1333	0.87	1	2	–	–	–	–	–	–	–	–
C. spicifer Nelson	666	0.43	1	2	120	0.48	3	6	–	–	–	–
Emericella	10700	6.97	4	8	1200	4.75	3	6	500	66.67	3	6
E. nidulans (Eidam) Vuillemin	10366	6.75	4	8	1200	4.75	3	6	500	66.67	3	6
E. quadrilineata (Thom & Raper) Benjamin	333	0.22	1	2	–	–	–	–	–	–	–	–
Fusarium oxysporum Schlecht.	66	0.04	2	4	250	0.99	5	10	–	–	–	–
Gibberella acuminata Wollenweber	–	–	–	–	400	1.58	1	2	–	–	–	–
Malbranchea sp.	–	–	–	–	–	–	–	–	10	1.33	1	2
Mucor racemosus Fresenius	100	0.07	2	4	–	–	–	–	–	–	–	–
Paecilomyces variotii Bainier	–	–	–	–	10	0.04	1	2	–	–	–	–
Penicillium	315133	20.53	22	44	11240	44.52	21	42	–	–	–	–
P. aurantiogriseum Dierckx	20006	13.03	3	6	–	–	–	–	–	–	–	–
P. brevicompactum Dierckx	670	0.44	3	6	–	–	–	–	–	–	–	–
P. chrysogenum Thom	2513	1.64	10	20	4540	17.98	6	12	–	–	–	–
P. citrinum Thom	333	0.22	1	2	6390	25.31	16	32	–	–	–	–
P. corylophilum Dierckx	–	–	–	–	100	0.4	1	2	–	–	–	–
P. pinophilum Hedgecock	6500	4.24	3	6	210	0.83	2	4	–	–	–	–
P. puberulum Bainier	390	0.25	3	6	–	–	–	–	–	–	–	–
P. variabile Sopp	433	0.28	2	4	–	–	–	–	–	–	–	–
P. waksmanii Zaleski	666	0.43	1	2	–	–	–	–	–	–	–	–
Rhizomucor pusillus (Lindt) Schipper	–	–	–	–	–	–	–	–	10	1.33	1	2
Rhizopus stolonifer (Ehreng.) Lindt	666	0.43	2	4	1200	4.75	3	6	–	–	–	–
Setosphaeria rostraa Leonard	–	–	–	–	10	0.04	1	2	–	–	–	–
Stachybotrys chartarum (Ehrenb : Lindt) Hughes	–	–	–	–	10	0.04	1	2	–	–	–	–
Trimmatostroma betulinum (Corda) Hughes	–	–	–	–	1000	3.96	1	2	–	–	–	–
Total fungi	153496	100	44	88	25250	100	28	56	750	100	19	38
Yeasts	750	–	1	2	–	–	–	–	220	–	4	8
Bacteria (*Bacillus* spp.)	69716	–	8	16	1010	–	2	4	–	–	–	–

C : counts of fungi per g milk powder in 50 samples tested
%C : percentage count calculated per total fungal counts
NS : number of contaminated milk powder samples out of 50
%F : percentage frequency of fungi calculated per 50 samples

and G (3 of 8 samples) and accounted 40.9% and 22.1% of total fungi recovered from the two brands, respectively. *A. flavus* and *P. chrysogenum* were previously encountered from various dairy products (Bullerman 1980; Aran and Eke 1987; Ibrahim 1987). *Penicillium aurantiogriseum* was recovered from 8 samples one from each of brands A,B and C. Its counts in A were relatively high (43.58% of total fungi). This species was isolated from 19% of Damiatta cheese samples (Ibrahim 1987) and 68.6% of Turkish cheese samples (Aran and Eke 1987). The other *Aspergilli* and *Penicillia* were recovered infrequently and with low counts in one or two brands (Tables 2 and 3).

The other fungal genera and species were also recovered infrequently from only one, two or three brands (Table 3). Most of the encountered moulds were reported previously from milk and other dairy products (Seham et al. 1983; Aran and Eke 1987; Ibrahm 1987; Abdel-Sater and Ismail 1993; Ismail 1993).

Fungi recovered on malt agar: Only 28 out of the 50 samples tested on malt agar were found to be contaminated with fungi. Sabreen (1986) could detect mould in 70, 50 and 65% of examined samples (E, F and G) of infants's milk powder. Twenty one fungal species belonging to 14 genera were collected on malt agar plates at 25°C (Tables 2 and 4). The counts in all samples were relatively low (25250 colonies/g) compared to those recovered on dicloran agar (153496). Brands C and B were the most contaminated ones. *Aspergillus* (24% of the samples) and *Penicillium* (42.%) were the prevalent genera and encountered in all milk powder brands except G. They accounted 21.6% and 44.5% of total fungi, respectively. *A. niger* (8 samples), *P. chrysogenum* (6) *P. citrinum* (16) were the most frequent species. *A. flavus* was isolated from one sample of brand D (Table 3). These fungal species were also isolated previously from different milk products (Bullerman 1980; Seham et al. 1983; Ibrahim 1987).

Alternaria (*A. alternata* and *Fusarium* (*F. oxysporum*) were the second most frequent genera and recovered only from 4 brands. They were encountered in 16% and 10% of all samples tested

TABLE 3. COUNTS OF MESOPHILIC FUNGI (C. PER G DRY MILK POWDER) AND THE NUMBER OF CONTAMINATED SAMPLES (NS) OF VARIOUS BRANDS OF MILK POWDER ON DICLORAN AGAR AT 25°C.

Fungi	Brand A (5)		Brand B (5)		Brand C (7)		Brand D (6)		Brand E (9)		Brand F (10)		Brand G (8)	
	C	NS	C	NS	C	NS	C	NS	C	NS	C	NS	C	Ns
Acremonium strictum	–	–	–	–	10	1	–	–	–	–	–	–	–	–
Alternaria alternata	130	2	–	–	2000	1	10	1	1110	3	–	–	1000	1
Aspergillus	110	2	1110	3	3110	3	1100	2	10	1	10	1	–	–
A. aureolatus	–	–	–	–	10	1	–	–	–	–	–	–	–	–
A. flavus	–	–	–	–	–	–	1000	1	–	–	–	–	–	–
A. niger	110	2	10	1	3111	2	100	1	10	1	10	1	–	–
A. ustus	–	–	1000	1	–	–	–	–	–	–	–	–	–	–
A. versicolor	–	–	100	1	–	–	–	–	–	–	–	–	–	–
Cladosporioides sphaerospermum	100	1	–	–	–	–	–	–	–	–	–	–	–	–
Cochiliobolus spicifer	100	1	10	1	–	–	10	1	–	–	–	–	–	–
Emericella nidulans	–	–	100	1	1100	2	–	–	–	–	–	–	–	–
Fusarium oxysporum	130	2	100	–	–	–	10	1	10	1	–	–	–	–
Gibberella acuminata	400	1	–	–	–	–	–	–	–	–	–	–	–	–
Paecilomyces variotii	–	–	–	–	10	1	–	–	–	–	–	–	–	–
Penicillium	470	5	1330	5	8810	0	320	3	300	1	10	–	–	–
P. chrysogenum	30	1	210	2	4100	2	–	–	200	1	–	–	–	–
P. citrinum	440	4	1120	4	4510	5	320	3	–	–	–	–	–	–
P. corylophilum	–	–	–	–	–	–	–	–	100	1	–	–	1	–
P. pinophilum	–	–	–	–	200	–	–	–	–	–	10	1	–	–
Rhizopus stolonifer	–	–	1000	1	–	–	200	2	–	–	–	–	–	–
Setosphaeria rostrats	–	–	10	1	–	–	–	–	–	–	–	–	–	–
Setosphaeria rostrats	10	1	–	–	–	–	–	–	–	–	–	–	–	–
Trimmatostroma betulinum	–	–	–	–	–	–	–	–	–	–	–	–	1000	1
Total fungi	1450	5	3660	5	15040	6	1650	5	1430	4	20	2	2000	1
Bacteria (*Bacillus* spp.)	–	–	–	4	–	–	–	–	10	1	–	–	1000	1

TABLE 4. COUNTS OF MESOPHILIC FUNGI (C. PER G DRY MILK POWDER) AND THE NUMBER OF CONTAMINATED SAMPLES (NS) OF VARIOUS BRANDS OF MILK POWDER ON DICLORAN AGAR AT 25°C.

Fungi	Branch A (5)		Brand B (5)		Brand C (7)		Brand D (6)		Brand E (9)		Brand F (10)		Brand G (8)	
	C	NS	C	NS	C	NS	C	NS	C	NS	C	NS	C	Ns
Aspergillus	20	3	90	3	10	1	40	3	10	1	40	4	20	2
A. fungigatus var. albus	-	-	40	1	-	-	-	-	-	-	-	-	-	-
A. niger	10	2	30	3	10	1	20	2	10	1	20	2	20	2
A. teerreus	10	1	20	1	-	-	20	2	-	-	20	2	-	-
Emericella nidulans	-	-	430	1	-	-	-	-	40	1	30	1	-	-
Malbranchea sp.	-	-	-	-	-	-	-	-	-	-	10	1	-	-
Rhizopus stolonifer	10	1	-	-	-	-	-	-	-	-	-	-	-	-
Total fungi	30	3	520	4	10	1	40	3	50	1	80	5	20	2
Bacteria (*Bacillus* spp.)	190	2	20	1	-	-	10	1	-	-	-	-	-	-

and 16.8% and 0.99% of total fungi, respectively. Almost similar results were obtained by Sutic et al (1979), who found that *Alternaria* and *Fusarium* accounted 11.8% and 8.5% of fungi isolated from milk and milk products.

The other fungal genera and species were infrequently isolated from only one, two or three brands of milk powder (Tables 2 and 3). Contamination with moulds in infant food was previously detected by several authors (Rosa et al. 1979; Moustafa et al. 1984).

Thermophilic fungi recovered at 45°C: The mean count of thermophilic (and thermotolerant) fungi was 40 colonies/g milk powder with a minium of 10 (in most of the samples examined) and a maximum of 430 (in brand B). Only 19 samples of the 50 tested were found to be contaminated with fungi. The most contaminated product was brand B and the least was C. Five species and 1 variety belonging to 4 genera were collected, of which *Aspergillus* (found in 17 samples and 30.7% of total counts) and *Emericella* (3 and 66.7%) were the most frequent. *Aspergillus* was represented by *A. fumigatus* var. *albus*, *A niger*, *A. terrreus* and *Emericella* by *E. nidulans*.

Malbranchea sp. and *Rhizomucor pusillus* were isolated each from one sample of brand, F and A, respectively (Table 4).

Conclusion

It was observed from the present study that many of the encountered fungi were mycotoxin-producers, notably *Aspergillus flavus*, *A. niger*, *Emericella nidulans* and *sterigmatocystin*, *Penicillium* spp. and *Alternaria alternata*. The consumption of mouldy and mycotoxin-contaminated foods, particularly by infants, can be a threat to their health (Austwick 1984; Bullerman 1986; Lacey 1988). Therefore, strict hygienic measures and regulations should be imposed during preparation, packaging, preservation and transportation of milk powder as well as other foodstuffs to safeguard consumers from being infected.

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Received 28 February 1994; revised 15 June 1997; accepted 17 June 1997

J. Food Sci. Technol., 1997, Vol 34, No. 6. 494-497

Meat Characteristics of Singed and Conventionally Dressed Chevon Carcasses

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Chevon caracasses were singed or conventionally dressed and their respective half carcasses hot or cold fabricated into wholesale cuts. Data were collected on internal temperature of 13th rib longissimus muscle at 1cm depth immediately after dressing or singeing, dressing percent, gross and conventional carcass lengths, length of leg, orientation angle of femur on pelvic axis, yield of wholesale cuts and shear values of 8 selected muscles at 24 h post mortern. Singeing imposed a 7.2°C temperature differential on the longissimus muscle post dressing above that from conventional dressing. Dressing percentage was greater, while chilling loss, orientation angle, gross carcass length of leg and rib eye area were greatly reduced by singeing treatment. Meats from singed carcasses were tougher than those from conventionally dressed carcasses. Hot fabrication had no effect on the various measured traits in both treatments except that the length of leg decreased, while shear values of some muscles increased in conventionally dressed carcasses compared with cold fabrification.

Keywords : Chevon, Singeing, Dressing, Dressing percent, Physical charateristics, Cut-out values, Quality traits.

Singeing is a method used to burn off the hair, give the carcass skin a golden brown colour and enhance smoky flavour in the meat so processed. It is widely practised in the home processing of small stocks like sheep, goats, rabbits and grass cutter. Its use in South East Asia in dressing pork carcasses was reported by Stouffer (1972). In recent years, singeing has been extended to the processing of beef carcasses as well as those of horses and camels, because it is easier and saves considerable time and energy relative to the conventional method of dressing.

Hence, there is a need to understand the consequences of singeing on the physical and qualitative attributes of meat. Previous reports by Currie and Wolf (1980), Hamm (1982) as well as Claus et al (1984) have shown that post-slaughter handling of meat carcasses affect to large extent the quality traits of the meat. In the present study, investigations on the effects of singeing on the yield, physical characteristics, cut-out values and quality traits of chevon carcasses fabricated into wholesale cuts at various times post-mortem are reported.

Materials and Methods

Twelve mature 'West African Dwarf' goats within the weight range 12.40 to 14.30 kg were slaughtered in pairs without previous immobilisation. One member of each pair was conventionally dressed. The other pair was dressed by singeing, whereby the pelt was not removed, but rather, the hair was flamed off over burning firewood with subsequent removal of the legs and head. The temperatures of the longissimus dorsi muscle in both carcasses were noted immediately after the pelt or singeing, respectively at the 13th rib with a probe type skewer thermometer at a depth of 1 cm from the muscle surface. The carcasses were washed and eviscerated. The warm carcass weight and dressing percent were determined. The chevon carcasses were split symmetrically. One half carcass from each treatment was immediately fabricated into wholesale cuts following the procedure of Field et al (1967). The intact and fabricated carcass halves from both the treatments were aged at -1°C for 24 h after which period, the intact carcass halves were similarly fabricated into wholesale cuts.

Weights and lengths of the carcasses and wholesale cuts were taken at each stage as and when necessary. The gross and conventional carcass lengths, the length of leg, rib eye area and the orientation angle of the femur on the pelvic axis were obtained, as described by Okubanjo (1985). The Warner Bratzler shear values of eight isolated muscles namely: longissimus dorsi from the rack (LDR), longissimus dorsi from the loin (LDL), gluteus medius (GM), psoas major (PM), semimembranosus (SM), semitendinosus (ST), biceps femoris (BF) and adductor (ADD) were evaluated. The data obtained were subjected to analysis of variance (Snedecor and Cochran 1973) and multiple range test (Duncan 1955), wherever necessary.

Results and Discussion

The data on the various physical parameters of conventionally dressed and traditionally singed

TABLE 1. PHYSICAL PARAMETERS, CUTTING TEST RESULTS AND SHEAR VALUES OF SELECTED MUSCLES FROM CONVENTIONALLY DRESSED AND SINGED CHEVON CARCASSES

	Conventional		Singed	
	Hot fabricated	Cold fabricated	Hot fabricated	Cold fabricated
Number	6	6	6	6
	Intact carcasses			
	Mean SD		Mean SD	
Weight of live shrunk, kg	13.40 0.82		13.33 0.86	
Dressing, %	44.14^{a} 3.72		49.67^{b} 4.21	
Temperature °C (LD 13th rib)	37.50^{a} 1.13		44.70^{b} 3.62	
Gross carcass length, cm	78.80^{b} 3.87		71.60^{a} 4.76	
Conventional carcass	43.67 2.52		41.67 2.81	
	Wholesale cuts			
Length of leg, cm	21.50^{b} 2.11	25.20^{c} 1.83	19.24^{a} 1.55	19.50 1.67
Chilling loss, %	5.45^{b} 0.55	4.61^{b} 062	3.64^{a} 0.45	3.35^{a} 0.65
Orientation angle°	129.15^{a} 4.80	133.50^{a} 6.51	66.40^{b} 5.20	68.75^{b} 4.78
Rib eye area, cm^{2}	3.33^{ab} 0.2	13.56^{b} 0.33	2.82^{a} 0.2	53.01^{ab} 0.15
	Cutting test results			
Weight of chilled half carcass, kg	2.74^{a} 0.22	2.64^{a} 0.28	3.08^{b} 0.43	3.05^{b} 0.38
Shoulder,%	20.00 1.72	19.85 1.57	19.56 2.13	20.40 1.64
Rack,%	8.22^{a} 0.64	8.18^{a} 0.46	8.37^{a} 0.52	9.24^{b} 0.90
Loin,%	7.68^{b} 0.37	7.58^{b} 0.51	6.47^{a} 0.34	6.55^{a} 0.44
Leg,%	34.41^{a} 1.50	33.34^{a} 1.41	35.90^{b} 0.92	36.35^{b} 1.38
Breast, shank and flank,%	22.61^{b} 1.23	21.85^{b} 0.81	20.66^{b} 0.96	19.55^{a} 1.53
Neck,%	6.92 0.58	7.15 0.67	7.59 0.82	6.89 0.64
	Shear force			
LDR	5.20^{b} 1.06	4.63^{a} 0.45	6.14^{c} 0.63	6.48^{c} 0.85
LDL	5.05^{b} 0.55	4.69^{a} 0.32	6.34^{c} 0.44	6.28^{c} 0.91
GM	5.82^{c} 0.82	5.23^{bc} 0.63	4.89^{ab} 0.36	4.28^{a} 0.60
PM	5.09^{b} 0.73	4.00^{a} 0.49	5.37^{b} 1.02	5.46^{b} 0.53
SM	6.33^{a} 0.66	6.09^{a} 0.51	6.50^{ab} 0.48	6.88^{b} 0.68
BF	4.72^{a} 0.90	4.47^{a} 0.63	6.95^{b} 0.84	7.32^{b} 0.67
ST	4.87^{a} 0.71	4.45^{a} 0.55	6.07^{b} 0.41	7.07^{c} 0.90
ADD	3.82^{a} 0.64	3.56^{a} 0.72	5.56^{b} 0.52	5.64^{b} 0.88

Means on same row with different superscripts differ significantly (P<0.05)

chevon carcasses and other informations are shown in Table 1. Singeing significantly (P<0.05) elevated the temperature of the longissimus dorsi muscle at a depth of 1 cm below the surface from 37.50°C observed in the conventionally dressed to 44.70°C, as observed in the singed carcass. This would suggest an even greater temperature differential on the respective carcass surfaces following the singeing process. The dressing percent increased, while the gross carcass length and chilling loss were significantly reduced (P<0.05) in the singed carcass. A slight but insignificant reduction was observed in the conventional carcass length of the singed carcass *vis-a-vis* that of the conventionally dressed caarcass. The increase in the dressing percent and reduction in the percentage chilling loss of the singed carcasses are attibutable to the added weight and protective effect of the skin, which was retained on the carcasses. Singeing significantly reduced (P<0.05) the effective length of the wholesale leg, while hot fabrication had greater effect in further reducing the length of leg, but to a greater degree in the conventional dressing treatment. Hot fabrication slightly increased chilling loss in both conventionally dressed and singed carcasses, when compared with those that were cold- fabricated due to the exposure of the cut muscle surfaces.

The orientation angles of 129.15° and 133.15° in the hot- and cold- fabricated conventionally dressed carcasses were significantly greater (P<0.05) than the 66.40° and 68.75°, obtained in the respective singed carcasses. At the elected temperature reached in the pre-rigour muscles on singeing, rigour development was accelerated, the delay phase of righour was shortened in association with rapid rate of depletion of ATP and rapid tension

development (Jolley et al. 1991: Nuss and Wolfe 1981). Work performance in the muscle of the singed carcasses would be high during rigour onset as indicated by Marsh (1954), thus causing the muscles of the carcasses to set early. The attendant heat-induced rigour shortening in contralateral muscles probably accounted for the rearrangement of the skeletal structure, resulting in a sharp reduction in the orientation angle of the femur, relative to the pelvic axis at equilibrium and a significant reduction ($P<0.05$) in the gross carcass length and the length of leg. The observed slight reduction in the conventional carcass length on singeing, when compared with changes in the gross cacass length and length of leg arose from the tempering effect of the axial skeleton on the contraction in the longissimus muscle mass. The fibres of this muscle run at an angle to the vertical axis rather than in line with it, thereby minimising the extent of shortening in the axial direction.

Rib eye area was reduced by singeing, although significant difference was observed only between the hot-fabricated singed carcasses and the cold-fabricated conventionally dressed carcasses. As indicated by Forrest et al (1975), collagen fibrils shorten to as much as one-third the original length on heating. Since the collagen content of the skin is high, the heat on singeing would enhance shrinkage of the skin, thereby causing a tightening effect around the flesh. In the loin region, a reduction in the rib eye area would, therefore, manifest as observed. A decrease in the rib eye area as in the singed carcass would also be expected, if the heat of singeing was sufficient to partially coagulate the muscle fribre protoplasm and thereby effect a decrease in fibre diameter (Draught 1972).

There was no difference in the cutting test results between hot -or cold-fabricated conventionally dressed carcasses or between the hot- or cold-fabricated singed counterpart except that cold fabrication improved the yield of the rack from the singed carcass. However, the percent yield of leg significantly increased ($P<0.05$) in the singed carcass irrespective of time of fabrication, while those of the loin as well as breast, shank and flank (BSF) significantly decreased ($P<0.05$), when compared with those of the conventionally dressed carcass. In almost all the muscles of the leg evaluated, singeing significancy increased ($P<0.05$) the shear force values. The only exception was the gluteus medius in which the shear force actually decreased. Hot fabrication did not impose any additional effect on muscles from the singed carcasses except in the case of the semitendinosus. In samples from the conventionally dressed carcasses, however, increase, in shear values were observed in all muscles, although significant effect was noted only in the longissimus dorsi from the rack, longissimus dorsi from the loin and psoas majors, as a result of hot fabrication.

Locker and Daines (1976) have shown that the history of muscle during most of the pre-rigour period is less important than conditions in the final stages of rigour onset. Rigour shortening especially during the first 24 h post-mortem is temperature dependent due to the temperature dependence of calcium release from the sarcoplasmic reticulum and such rigour shortening is very important to the ultimate meat tenderness in muscle stored at 37°C (Hetzman et al. 1993; Wheeler and Koohmaraie 1994). Thus, the rapid development of heat induced contraction and rigid setting of the various muscle fibres during the singeing operation with or without subsequent chilling to 1°C during the first 24 h post -mortem accounted for the observed toughening of the various muscles. The exception was that of the gluteus medius, which was placed in a stretched position by the rearrangement of the femur on the pelvic axis.

It is perhaps essential to distinguish between events during singeing and subsequent chilling and the previous observation of Cia and Marsh (1976) that meat cooked in the pre-rigour phase was the most tender. The temperature achieved in the longissimus muscle at 1cm depth was well below the internal temperature of 58°C to 60°C needed to cook meat to a rare state with most glycolytic enzymes inactivated (Forrest et al. 1975). In fact, at the temperature of 44.7°C achieved in the longissimus muscle during singeing, the activities of glycolytic enzymes were intact (Marsh 1954) and glycolysis would, therefore, continue till completion under subsequent rapid chilling to ensure overall toughness of the various muscles.

In conclusion, singeing of intact pre-rigour chevon carcasses with or without subsequent hot fabrication has remarkable effects on the yield and physical characteristics of the carcasses. It also imposes a toughening effect on most of the carcass muscles, whether the carcasses were subsequently chilled or not. This may be disadvantageous, if tender meats were desired.

Acknowledgement

This project was partly funded through the Senate Research Grant, University of Ibadan,

Nigeria. The author gratefully acknowledges the technical assistance rended by J.O. Kolade.

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Received 24 December 1995; revised 26 July 1997; accepted 28 July 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 498-500

Effect of Delayed Icing on the Shelf-life of Sciaenids

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The fish, sciaenids caught off Tutcorin coast were divided into two groups : (1) iced immediately and (2) held at 28 ± 2°C for 6 h and iced. The shelf-life of whole sciaenids was evaluated for quality by sensory, chemical and microbiological assessments over the period of storage. The results of sensory, microbiological and biochemical tests showed that the fish samples treated by delayed and immediate icing were acceptable for a period of 5 and 9 days, respectively.

Keywords: Sciaenids, Shelf-life, Total volatile base nitrogen, Trimethylamine nitrogen, Peroxide value, Thiobarbituric acid value, Total plate counts, Delayed icing.

An essential prerequisite for designing the infrastructure for fish handling, storage, transport and marketing is to know how long each species in the catch will keep in good condition. Projections of demand indicate that more than 100 million tonnes of food fish per year will be required by the end of this century on a global basis (Lima dos Santos et al. 1981). To meet this demand, many species that are not exploited at present, or are converted to fish meal, must be brought into production for direct human consumption. Many of these will be from tropical or sub-tropical areas, where scientific and practical knowledge is very limited (Lima dos Santos et al. 1981).

The sciaenid fish is an important component of Indian marine fishery, particularly in the east coast of India. It contributed about 7% of total marine landings of India, and its contribution to landings in Tamil Nadu coast to India was about 20% during the year 1992. The preservation of fish by chilling is important for extending the shelf-life of fish. In a developing country like India, expansion of the domestic frozen fish industry is constrained by the lack of cold storage facilities in the distribution chain. Hence, the present work was undertaken to study the effect of delayed icing on the quality of raw material and also to find out the storage life of this species, when properly iced.

The sciaenid fish, *Otolithes ruber* caught off Tuticorin coast by trawler was divided into two lots. The fish used in the experiment was in whole condition and the average weight of the fish was about 165 g. One lot was iced immediately on-board the trawler and this sample was designated as 'II' (Immediately Iced). The second lot was iced after nearly 6 h at ambient temperature (28 ± 2°C), as practised by commercial fishermen and this sample was designated as 'DI' (Delayed Iced). The samples of whole fish from the two lots were taken at intervals for testing for changes in quality, until the fish became obviously unfit for human consumption. The flesh of the raw fish sample was used for the analysis. All the samples were analyzed in triplicates for microbiological and biochemical indices.

The influence of the two methods of handling on quality of fish was studied by sensory, microbiological and biochemical tests. The fillets of fish samples were packed in polythene bags and cooked in boiling water for about 10 min. These cooked samples were tested for their sensory quality characteristics by following the technique, described by Lima dos Santos et al (1981). Microbiological quality of fish samples was assessed by enumerating the total plate counts (TPC), using plate count agar (PCA), following the standard procedure of pour plate technique (APHA 1976). Total volatile base nitrogen (TVB-N), trimethylamine nitrogen (TMA-N) and peroxide value (PV) were determined by the methods described by Lima dos Santos et al (1981). Thiobarbituric acid (TBA) values of fish samples were determined by the method of Lemon (1975).

The results of the sensory characteristics of fish samples subjected to two different handling treatments for varying periods are presented in Table 1. The fishes in the DI sample were found to be in good condition, until two days after catching and in acceptable condition for another three days. However, at the end of the ninth day, they were found to be unacceptable. According to

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TABLE 1. INFLUENCE OF HANDLING METHODS AND HOLDING PERIOD ON BIOCHEMICAL MICROBIOLOGICAL AND SENSORY CHARACTERISTICS OF FISH SAMPLES

Characteristics	Samples	Holding period, days				
		0	2	5	9	13
Biochemical						
TVB-N, mg per 100g	DI	2.97 ±0.04	7.17 ±0.06	16.02 ±0.05	21.95 ±0.06	DC
	II	1.79 ±0.03	5.21 ±0.04	9.41 ±0.02	15.29 ±0.02	22.51 ±0.02
TMA-N, mg per 100g	DI	0.34 ±0.01	1.79 ±0.03	3.58 ±0.04	6.72 ±0.03	DC
	II	0.11 ±0.02	1.40 ±0.04	2.69 ±0.03	4.09 ±0.02	7.34 ±0.05
PV, meq per kg oil	DI	2.08 ±0.08	6.32 ±0.10	13.67 ±0.10	24.96 ±0.06	DC
	II	1.60 ±0.03	3.42 ±0.03	8.08 ±0.05	15.36 ±0.04	26.96 ±0.07
TBA, mM of malonaldehyde per kg fat	DI	6.86 ±0.09	19.32 ±0.05	41.44 ±0.06	66.22 ±0.08	DC
	II	3.50 ±0.08	13.30 ±0.06	28.56 ±0.10	44.38 ±0.09	69.02 ±0.04
Microbiological						
TBC, cfu per g	DI	3.90 ±0.04 x 10^4	1.39 ±0.05 x 10^5	1.02 ±0.03 x 10^6	2.22 ±0.05 x 10^7	DC
	II	1.55 ±0.03 x 10^4	4.60 ±0.04 x 10^4	1.63 ±0.02 x 10^5	1.49 ±0.05 x 10^6	1.74 ±0.04 x 10^7
Sensory						
Appearance	DI	9.2	8.4	6.2	3.5	DC
	II	9.4	9.2	8.3	6.5	6.4
Colour	DI	9.1	7.5	5.6	3.2	DC
	II	9.3	8.7	7.5	6.4	3.8
Odour	DI	8.9	7.2	5.0	2.4	DC
	II	9.2	8.5	7.2	6.1	2.5
Taste	DI	9.0	7.5	5.3	2.5	DC
	II	9.4	8.8	7.1	5.5	2.6
Texture	DI	8.7	8.0	5.5	2.1	DC
	II	9.1	8.4	7.5	6.2	2.8
Overall quality	DI	9.0	7.5	5.5	3.0	DC
	II	9.3	8.6	7.4	6.0	3.0

DC : Discontinued, DI : Delayed Iced, II : Immediately Iced

Hansen and Jenson (1971), a few hours delay in icing of herrings on sunny days reduced the storage life considerably. Hoffman and Vidot (1978) found a definite quality deterioration in the case of fish left uniced for 6 h on deck before icing. Fishes in the II sample were judged to be acceptable upto 9 days. However, at the end of the thirteenth day, they were considered as completely unacceptable. After the ninth day of storage, the intensity of the off-odour increased and the deterioration in the texture of the fish was also appreciable. Lupin et al (1980) reported that the storage life of Potagonian hake *(Merluccius hubbsi)* in ice was not more than 9 to 10 days during summer months and 14 to 15 days during the remaining months. All these findings seem to be more or less in agreement with the findings of the present work with some variations, which may be due to the differences in the kind of fish, ambient temperature and the actual duration of the delay before icing.

Total bacterial counts of fish samples are shown in Table 1. Total bacterial counts increased from 3.90 x 10^4 to 2.22 x 10^7 g^{-1} in 9 days in the case of DI samples, whereas the II samples had the counts increased from 1.55 x 10^4 to 1.74 x 10^7 g^{-1} within 13 days. Bong, burrito and sea bream were considered unacceptable, when the bacterial population was more than 10^6 g^{-1} (Amu and Disney 1973). In the present study also, the fishes were judged as unacceptable, when the total bacterial counts exceeded 10^6 g^{-1}.

The changes in TVB-N, TMA-N, PV and TBA are given in Table 1. Both TVB-N and TMA-N contents were found to increase in both the samples, as the holding period increased. Jayaweera et al (1980) found that the TVB value was between 30 and 40 mg per 100 g at the beginning of spoilage of iced silver belly. Smith et al (1980) reported that TMA-N value of 2.1 mg per 100 g reached within 7 days in chilled scad is the limit of acceptability. However, Dagbjartsson (1975) found a TMA-N value of 13.6 mg per 100 g for blue whiting after 11 days of iced storage. The fish samples had peroxide values of above 16 meq kg^{-1} oil, when they were judged unacceptable. The TBA values of the fish samples also showed a similar trend as those of

peroxide values. In this study, the fish samples had TBA values of above 40 mM kg^{-1} of malonaldehyde in fat, when they were judged unacceptable. The results stressed the importance of proper icing of fish immediately after catch and also the temperature of storage, by which the shelf-life of fish can be prolonged.

The authors thank Dr. G. Jegatheesan, Dean-in-charge for having provided the required facilities to carry out the study. This work was supported by the Tamil Nadu Agricultural University, Coimbatore, India.

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Received 28 April 1995; revised 3 March 1997; accepted 4 March 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 501-502

Effect of Cooking on the Quality of Ostrich Muscles

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The influence of three different internal end temperatures on the cooking loss, objective tenderness and proximate composition of 2 different ostrich muscles (*Iliotibialis lateralis* and *Iliofemoralis*) were investigated. While cooking loss and moisture content progressively inceased ($P<0.05$), protein content decreased ($P<0.05$) and tenderness as well as intramuscular fat remained relatively constant with increasing internal temperatures in both muscles.

Keywords: Ostrich meat, Ostrich muscle, Cooking, Tenderness, Proximate analysis.

India is one of the countries that shows interest in the rapidly growing ostrich industry (Mak - personal communication). Although more and more emphasis is put on the ostrich as meat producer, it lacks scientific description. Broiling is recommended for ostrich meat due to a low connective tissue content (Sales 1995). Due to an increase in the degree of solubility of collagen with increasing internal temperature, differences in collagen content help to explain whether different internal end temperatures will cause a change in tenderness between muscles (Lawrie 1990). Cooking also increased the concentration of intramuscular fat, proteins and ash in meat, mainly due to moisture loss (Stadelman 1978). The aim of this study was to evaluate the influence of internal end temperature on cooking loss, tenderness and proximate composition of two different ostrich muscles.

Ostriches (12 to 14 months old), fasted for 24 h, were electrically stunned and killed in a commercial ostrich abattoir. The carcasses were allowed to chill for 6 h at ±3°C, before the *Iliotibialis lateralis* and *Iliofemoralis* were excised from the left legs. External fat and epimysial connective tissues were removed and each sample was separately ground, homogenized, vacuum-packed in plastic bags and stored at -20°C, till used.

Three steaks (around 2.5 cm thickness) were cut from each muscle and were broiled in a forced air convection oven (pre-heated to 177°C) to internal temperatures of 60 (rare), 70 (medium) and 80°C (well done), respectively. Heat penetration was recorded with a thermocouple probe at the centre of each steak. Cooking loss was determined from weights before and after cooking. Four to five cores (1.27 cm long) were removed parallel to the muscle fibres from the centre portion of each cooked steak for determination of Warner-Bratzler shear force (WBS).

Moisture contents of ground and homogenized samples were determined by drying 5 to 10 g in a moisture dish at 105°C to constant weight (Boccard et al. 1981), ashing was performed at 650°C for 2 h (Perez and Andujar 1980-81), protein content by the block digestion method and ether-extractable intramuscular fat content by solvent extraction (AOAC 1995) were also determined.

Results were analyzed according to an incomplete block design with 10 blocks and 3 treatments per block (Cochran and Cox 1957), using the General Linear Models (GLM) procedures of the Statistical Analysis System (SAS 1988). Means for individual muscles were compared, using least significant difference test (Snedecor and Cochran 1991).

Cooking loss, WBS and proximate composition (wet weight basis) of ostrich muscles, as influenced by different internal temperatures, are presented in Table 1.

While no differences ($P>0.05$) in cooking loss existed between muscles, it increased ($P<0.05$) with increase in temperature. A significant interaction between muscle and temperature with regard to WBS showed that the *Iliofemoralis* was more tender ($P<0.05$) at a temperature of 60°C than the *Iliotibialis lateralis*, but neither at 70°C nor 80°C. No differences ($P>0.05$) in WBS appeared between different temperatures in the *Iliotibialis lateralis*. However, the *Iliofemoralis* was more tender at 60°C than at either 70°C nor 80°C. A higher collagen content in the *Iliotibialis lateralis* as compared to the *Iliofemoralis* (Sales 1996) thus did not cause an increase in tenderness in the former with increase in temperature. Higher WBS values observed in the *Iliofemoralis* with temperature are in agreement with findings of Leander et al (1980) in beef muscles. Moisture content progressively decreased ($P<0.05$) as temperature was increased. A lower ($P<0.05$) moisture content was observed at 80°C in the *Iliofemoralis* than the *Iliotibialis lateralis*. Protein

TABLE 1. INFLUENCE OF DIFFERENT INTERNAL END TEMPERATURES ON COOKING LOSS, WARNER-BRATZLER SHEAR FORCE (WBS) AND PROXIMATE COMPOSITION OF TWO DIFFERENT OSTRICH MUSCLES

	Muscle					
	Iliotibialis lateralis			*Iliofemoralis*		
Internal temperature, °C	60	70	80	60	70	80
Cooking loss, %	11.98^{c}±3.186	25.64^{b}±1.552	37.34^{a}±10.697	13.98^{c}± 5.158	24.85^{b}± 2.261	38.25^{a}± 3.145
WBS, kg	3.1^{b} ±0.570	3.6^{ab} ±1.110	4.4^{ab}± 1.360	1.3^{c} ±0.700	3.8^{ab} ± 0.700	4.8^{a} ± 0.740
Proximate analysis, g/100g						
Moisture	71.96^{a}±0.815	67.39^{b}±1.052	62.04^{c}± 1.680	71.09^{a}± 1.743	67.48^{b}± 0.962	59.66^{d}± 0.800
Proteins, N x 6.25	24.82^{d}±0.866	29.48^{b}±1.403	34.54^{a}± 1.554	24.37^{d}± 1.411	28.14^{c}± 0.945	34.94^{a}± 1.075
Intramuscular fat	1.10^{c}±0.371	1.28^{c}±0.410	1.49^{c}± 0.460	2.43^{b}± 0.821	2.36^{b}± 0.442	3.03^{a}± 0.629
Ash	1.20^{b}±0.034	1.18^{b}±0.068	1.37^{a}± 0.171	1.13^{b}± 0.059	1.17^{b}± 0.063	1.38^{a}± 0.114

$^{a-d}$ Values in rows with different superscripts differ significantly (P<0.05)
Each value is a mean ± SD of five determinations

content differed (P<0.05) between the two muscles at 70°C and increased with increase in temperature for both muscles, while ash content was higher (P<0.05) for 70 and 80°C. The increase in protein content at higher temperature can be attributed to a lower moisture content. Intramuscular fat content did not differ (P>0.05) between temperatures for the *Iliotibialis lateralis*. However, it was higher (P<0.05) at 70 and 80°C in the *Iliofemoralis*. Significant differences (P<0.05) existed between muscles with regard to intramuscular fat content.

Present results are in agreement with those obtained on ostrich meat cooked to an internal end temperature of 63°C by Harris et al (1994). Ostrich meat compares well with meat from other animals. Values of 25 and 1.0% were reported for protein and ash contents of broiler meat oven-broiled between 120 and 150°C, while the corresponding values were 32 and 1.2% for turkey meat (Scott 1956). Browning et al (1990) have reported values of 30.67 g/100 protein and 5.95 g/100 g instramuscular fat for beef muscles broiled to an internal temperature of 70°C. The relatively low intramuscular fat content of ostrich meat may be an advantage in marketing strategies of the product.

Tenderness as well as instramuscular fat content of ostrich meat is markedly influenced by internal temperatures between 60 and 80°C. Cooking loss, which affects the yield of the cooked product, is minimised at the lowest internal temperature. Further research is needed to study the influence of internal temperature on the juiciness of ostrich meat.

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Received 10 July 1995; revised 9 January 1997; accepted 27 March 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 503-505

Roasted Soybean in Cookies : Influence on Product Quality

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Whole grains of soybean with 8 and 12% moisture contents were sand-roasted at 217°C for 10-45 sec and 90-120 sec, respectively. Full-fat soy flours obtained by grinding of the roasted samples, as such, were used in cookies at 30% level. Cookies were evaluated for properties and organoleptic acceptability. The product (cookies) was crisp and did not show urease activity, indicating that it was free from antinutritional factors. The fair acceptability of cookies suggested adequacy of this approach for nutritional supplementation of cookies.

Keywords: Soybean, Sand-roasting, Supplemented cookies, Engineering properties, Organoleptic acceptability.

Cookies are ready-to-eat, convenient and inexpensive food product, containing digestive and dietary principles of vital importance (Agarwal 1990). Cookies, owing to their long shelf-life, are considered useful for nutritional enrichment in feeding programmes (Agarwal 1990). Soybean, being less expensive, but rich source of good quality protein and fat, has been recognized as an ingredient for protein enrichment of bakery products (Sinha and Kulkarni 1991; Kulkarni 1992).

Differently processed soyflours have been reported to be suitable for incorporation in cookies, viz., hot water-blanched (Sinha and Kulkarni 1991), extrusion-cooked (Tsen et al. 1975) and dry heat-treated in oven (Kulkarni 1992). Various limits of incorporation in cookies, upto 30% (in Bakers %), have been reported by earlier workers (Tsen et al. 1973; Buck et al. 1987; Tsen et al. 1975; Sinha and Kulkarni 1991). It has also been established that extrusion-cooked soy products, directly processed from soybean with husk, are suitable for protein fortification (Tsen et al. 1975). High iron content of soy hull with high bioavailability (Lykken et al. 1987) coupled with cholesterol lowering effect of soy fibre (Ranhotra and Anderson 1989) provide additional nutritional advantage.

The present investigation was, therefore, undertaken to study the suitability of full-fat soy flour with husk, produced by grinding of soybeans roasted for different durations, in supplementation of cookies for deriving nutritional advantage.

Cleaned whole soybean (CV 'Punjab-1') was used for this study. Roasting experiments were conducted at two grain moisture levels i.e., 8 and 12% (db). Samples were conditioned by adding pre-determined quantities of distilled water followed by thorough mixing, sealing in polythene bags and holding at 10°C for 36 h for equilibration. Soybean in 150 g lots was roasted in a 600 g hot sand bath at 217°C by continuous stirring for varied durations, viz., 10, 20, 30 and 45 sec for sample with 8% db moisture level and 90 and 120 sec for sample pre-conditioned to 12% db moisture level. Roasted grain samples were cooled to room temperature and powdered to pass through ISS No. 30 (opening size 0.296 mm). Moisture content and urease activity of soyflours were determined by standard methods (AACC 1969), while colour of the soyflours was measured by reflectance method, using AIML digital reflectance meter (AIML Make and Model : AIM-611) with magnesium oxide (MgO) as standard for 100% reflectance.

Soyflour incorporation level in cookies was a fixed at 30% (Bakers %) to get almost equal proteins from cereal and legume components for deriving maximum nutritional benefit (Oke 1975; Yadav and Liener 1977), using the nutritive values as reported by Gopalan et al (1981) for calculations. The soy-supplemented cookies were prepared, using the following recipe: refined wheat flour-100 parts, full-fat soyflour-30 parts, sugar-40 parts, shortening-40 parts, water-32 parts, salt-1 part, baking powder-1 part and baking soda-0.8 parts. The process included creaming of sugar and shortening followed by mixing of other ingredients, sheeting of mixed dough to 3 mm thickness, cutting using 49.3 mm diameter die and baking at 200°C for 15 min. Cookie properties such as diameter, thickness, mass, spread ratio (ratio of cookie diameter to thickness) and hardness (breaking strength) were determined. Instron Universal Testing Machine was used for determination of hardness. Urease activity of cookies was determined to serve as an index of the antinutritional factors in the end product (Wapinski 1977).

TABLE 1. PROPERTIES OF ROASTED SOYBEAN, FULL FAT SOYFLOUR SUPPLEMENTED COOKIES AND THEIR ORGANOLEPTIC ACCEPTIBILITY SCORES

	Properties of roasted soybean			Properties of cookies supplemented with full fat soyfloor					
Roasting duration, sec	Moisture, %, db	Colour of soyflour, %, whiteness	Urease activity, ΔpH	Moisture, %, db	Thickness*, mm	Diameter,* mm	Spread* ratio	Mass*, g	Hardness, N
Initial moisture, 8%, db									
Raw	8.38	68.0	1.75	2.33	4.87±0.04	48.50±0.48	9.96	5.53±0.11	9.85
10	6.65	68.0	1.60	2.31	4.93±0.03	48.64±0.52	9.87	5.52±0.10	9.41
20	4.97	67.0	1.08	1.63	4.34±0.07	48.40±0.77	11.13	5.17±0.10	9.22
30	4.60	66.0	0.27	2.44	4.13±0.05	48.90±0.11	11.86	5.33±0.05	10.20
45	4.14	64.7	0.14	2.43	4.16±0.04	48.08±0.52	11.56	5.22±0.10	9.22
Initial moisture 12% db									
90	4.46	63.1	0.05	1.88	4.03±0.10	47.30±0.81	11.74	5.12±0.10	4.36
120	3.16	60.7	0.02	2.34	4.13±0.03	47.68±0.33	9.54	5.20±0.06	5.49

	Organoleptic acceptability scores for cookies supplemented with differently processed soyflour									
Roasting duration, S	External	Size	Shape	Thick-ness	Colour	Internal	Texture and grain	Flavour	Taste	Overall
Initial moisture, 8%, db										
Raw	30.6	8.1	7.5	7.7	7.3	42.9	7.4	14.2	21.3	73.5
10	29.5	7.8	7.2	7.2	7.4	42.8	6.9	14.5	21.3	72.3
20	30.7	8.1	7.9	7.7	6.9	47.0	8.1	15.9	23.0	77.7
30	31.0	8.3	7.7	7.7	7.3	43.9	7.5	15.1	21.4	74.9
45	30.0	7.9	7.5	7.6	6.9	45.3	7.8	15.3	22.2	75.3
Initial moisture 12% db										
90	30.7	7.9	7.4	7.6	7.8	46.5	7.7	15.8	23.0	77.2
120	30.3	7.7	7.7	7.4	7.5	43.8	7.3	15.0	21.5	74.8
Max. Score	40.0	10.0	10.0	10.0	10.0	60.0	10.0	20.0	30.0	100.0

* Mean of 5 determinations ± SD

The organoleptic acceptability of cookies was evaluated by a panel of 15 judges following composite score test procedure (ISI 1971). The cookies were evaluated for external characteristics (size, shape, thickness and colour) and internal characteristics (texture and grain hardness, flavour and taste). The data were analyzed by following standard statistical procedures (ISI 1983 and 1984).

Quality of roasted soybean and soyflours : Soybean samples roasted under different grain moisture and roasting conditions showed variation in the quality. Grain moisture content, colour (% reflectance) and urease activity of the flour obtained from whole soybean roasted for different intervals of time are reported in Table 1. At 12% moisture content (db) and 90 sec roasting duration, the colour of soyflour was 63.10, which was closer to one obtained after a roasting duration of 45 sec at 8% db (Table 1). Grain moisture content, urease activity and colour of flour decreased with increase in heat treatment or roasting duration.

Properties of soy supplemented cookies : Cookies supplemented with full-fat soyflour, produced by roasting of soybeans, were found to possess variation in the product quality (Table 1). Hardness, of a product like cookies, which decides the crispness and in turn, the acceptability, was found to be higher or almost double for cookies supplemented with soybean roasted at lower moisture content (8% db), compared to those obtained with supplementation by soybean roasted at 12% db. In general, the properties of cookies supplemented with differently processed soyflours did not differ appreciably, but for hardness.

Antinutritional factors in cookies : Cookie samples supplemented with differently processed soyflours did not show any urease activity, which was taken as an index of presence of antitryptic activity. Hence, cookies obtained for all the experiments were considered safe for human consumption.

Organoleptic acceptability : Evaluation of cookies supplemented with differently roasted soybean flour revealed the acceptability of product on different accounts (Table 1) External characteristics of cookies viz., size, shape, thickness and colour were more or less equally acceptable and did not change

appreciably with the duration of roasting of soybean. Scores for internal characteristics viz., texture and grain, flavour and taste were highest for cookies supplemented with soybean roasted at 8% db for 20 sec and 12% db for 90 sec. From the overall acceptability point of view, these two treatments were found best, followed by others. However, statistical analysis revealed non-significant difference in acceptability of cookies supplemented with soybeans roasted under different conditions. The off-flavour development in cookies was minimal, as the roasting imparted a pleasant flavour to the beans and nullified the effect of its enzyme activity. Further, baking of cookies at high temperature provided additional roasting effect and developed an acceptable flavour.

Though, statistically insignificant, but considering the highest overall scores obtained for cookies supplemented with soybean roasted for 20 sec at 8% moisture content (db) and 90 sec at 12% moisture content (db), the processing of soybean under these two conditions is suggested for incorporation in cookies. Also, the 30% level of supplementation of cookies with soyflour, which was essential to derive maximum nutritional advantage, was found to be fairly acceptable on organoleptic accounts. The soybean processing mode of sand roasting and supplementation level can be considered appropriate on the basis of organoleptic evaluation and product properties. Further, the cookies were found free from antinutritional factors, as evidenced by absence of urease activity.

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Received 7 April 1995; revised 6 May 1997; accepted 12 May 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 506-508

Incidence of Aflatoxin M_1 in Milk Samples Around Chennai (Madras) City

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A survey was undertaken to study the incidence of aflatoxin M_1 in milk in and around Chennai city. A total of 325 milk samples were collected. Of these, 36 samples (11%) were found to have aflatoxin M_1 in the range of 0.1 to 1 µg/l. Milk samples analyzed in this study showed a slightly higher level of aflatoxin M_1, which suggested a need for improvement of quality control procedures in feeds.

Keywords: Aflatoxin M_1, Aflatoxin B_1, Milk, High performance liquid chramatography, Feed.

Aflatoxin M_1, a hydroxylated metabolite of aflatoxin B_1 is an important toxin present in the milk of lactating animals fed with aflatoxin B_1 contaminated feeds. Presence of aflatoxin M_1 in milk is a public health hazard. Aflatoxins are a group of mycotoxins produced as secondary metabolites by the species of genus *Aspergillus*. Aflatoxicosis in cattle and poultry is becoming a major problem due to the heavy aflatoxin contamination of feed materials during improper storage. Aflatoxin B_1, a potent carcinogen, teratogen and mutagen (DiPaola et al. 1967; Epstein and Shafner 1968), when fed to cows, excreted a small, but a significant amount of its carcinogenic metabolite aflatoxin M_1 in milk. Aflatoxin M_1 was found in the blood, urine and milk samples of ailing dairy cows with symptoms of anorexia and loss of condition (Maryamma et al. 1991). Acute toxicity of aflatoxin M_1 is the same as aflatoxin B_1, while its carcinogenicity is lower than that of aflatoxin B_1 (Riberzani et al. 1983). Hsieh and Ruebner (1984) reported that aflatoxin M_1 in milk and dairy products led to the risk of liver cancer.

The presence of aflatoxin B_1 was detected in 162 samples of feeds, 46 samples of feed mixtures and 24 samples of stored paddy straw collected from different parts of Sikkim (Balaraman and Gupta 1990). Cattle feeds in Bihar were found to be contaminated with aflatoxin B_1 (Jeswal 1990).

Aflatoxin M_1 was detected in 25 of 60 milk samples collected from different parts of Gwalior (Tiwari and Chauhan 1991). In a survey conducted in Brazil (Prado et al. 1994), 9 milk samples out of 50 samples tested showed positive results (18%). Aflatoxin M_1 content in milk was not completely eliminated by the processing methods. Aflatoxin M_1 was detected in 44 of the 272 cheese samples analyzed in Japan (Tabata et al. 1987). Ingestion of milk and milk products containing aflatoxin M_1 could cause severe health hazards to consumers. It was suggested that the analysis of aflatoxin M_1 in milk samples is a better indicator of contamination than the analysis of aflatoxin B_1 in feed (Corbett et al. 1987). Systematic survey on the presence of aflatoxin M_1 in milk in Tamil Nadu has not been carried out so far. Hence, it was decided to estimate the level of aflatoxin M_1 in milk samples consumed by the public in and around Chennai (Madras) city during 1993.

Aflatoxin M_1 standard was obtained from Sigma, USA. Standard stock solution was prepared by dissolving in chloroform to give a concentration of 2 µg/ml. Milk samples of 50 ml volume were collected at random from both cows and buffaloes from individual milk vendors and dairy farms in Chennai city during different months of the year. The samples were stored in the freezer, until analyzed. A total of 325 milk samples were collected for this study.

Milk samples of 50 ml each were extracted with chloroform and purified, using silica gel column chromatography (AOAC 1990). The purified samples were evaporated to dryness and added 200 µl of mobile phase (acetonitrile : water, 35:65) and mixed in a Vortex mixer for 11 min and analyzed in a Shimadzu HPLC system with fluorescence detector. CLC-ODS column C-18, reverse phase was used with acetonitrile : water (35:65) as mobile phase with flow rate of 1 ml/min. Twenty µl of the samples were injected into the system and measured at excitation wavelength of 365 nm and emission wave length of 425 nm. The amounts of aflatoxin M_1 in the milk samples were determined by calibrating with aflatoxin M_1 standard. The results

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TABLE 1. AFLATOXIN M_1 LEVELS IN MILK SAMPLES COLLECTED FROM DIFFERENT LOCALITIES IN CHENNAI CITY

Locality	No. of samples analyzed	Number positive	Conc. of aflatoxin M_1, µg/litre
Kattupakkam	25	5	0.30–1.00
Thousand lights	20	2	0.15–0.30
Kilpauk	24	3	0.23–0.40
Royapettah	23	2	0.12–0.25
Madras Veterinary College	25	4	0.41–0.50
Washermenpet	22	1	0.34
Madhavaram	24	3	0.26–0.35
Ayanawaram	21	3	0.17–0.84
Perambur	25	2	0.30–0.47
Mylapore	23	3	0.45–0.90
Saidapet	20	4	0.26–0.45
T. Nagar	24	2	0.20–0.43
Purasawalkam	24	2	0.31–0.50

Five samples each from Ambattur, Anna Nagar, Meenjur, Adyar and Nanganallur were analyzed and found to be negative for aflatoxin M_1

were expressed as µg of aflatoxin M_1 per litre of milk.

The HPLC method is one of the sensitive methods for detection of aflatoxin in milk. In this study, 36 milk samples were positive for aflatoxin M_1 out of 325 samples tested, giving an incidence rate of 11% (Table 1). The concentration of aflatoxin M_1 present in the positive samples varied from 0.1 to 1µg/l. Three milk samples out of 36 were found to have more than 0.5 µg/1. Standard aflatoxin M_1 showed a single peak with the retention time of 3.2 min. The milk samples tested also showed a peak at the same retention time, indicating the presence of aflatoxin M_1.

The presence of aflatoxin M_1 in milk indicates that the animal gets the toxin through contaminated feed. Aflatoxin B_1 from such feed gets metabolised into aflatoxin M_1 and excreted in milk. The high content of aflatoxin M_1 observed in few of the milk samples in this study could be due to the high content of aflatoxin B_1 in the feed, especially the groundnut, which could get contaminated during the monsoon season. The 11% incidence of aflatoxin M_1 in milk observed in this study could be attributed to the poor quality control during processing and suggests a need for improvements in quality control procedures.

In a survey conducted in UK, aflatoxin M_1 level was less than 0.03 µg/kg in 98% of the samples (Gilbert et al. 1984). In another survey in Spain, aflatoxin M_1 level was found to be in the range of 0.02 to 0.04 µg/l (Burdaspal et al. 1982). In the present study, the aflatoxin M_1 levels ranged from 0.1 to 1 µg/l.

The maximum limit for aflatoxin B_1 in dairy cattle feed is 20 µg/kg and for aflatoxin M_1 in milk is 0.5 µg/l. The rate of conversion of aflatoxin B_1 into M_1 in milk ranged from 2–5%. When compared to this, the present results indicate a slightly higher contamination of cattle feeds with aflatoxin B_1.

It is evident from this study that the milk samples are contaminated with aflatoxin M_1 and the source for this could be the feed. The long term, low level exposure is a potential health hazard to man and animals. Hence, control measures are to be undertaken to avoid fungal contamination of feeds due to poor handling and storage conditions. Further studies are required to find out the source and the extent of feed contamination with mycotoxins.

The National Dairy Development Board is acknowledged for the financial support for the project. The authors thank the Dean, Madras Veterinary College for providing necessary facilities.

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Received 14 December 1995; revised 5 May 1997; accepted 14 May 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 509-512

Extrusion Cooking of Soy-cereal and Tuber Blends : Product Properties

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Full fat, medium fat and defatted soy flours were blended individually with cereal flours and tuber. These were extrusion-cooked in a laboratory model single screw extruder. Dimension, expansion ratio, hardness, colour, oil content and free fatty acid contents of the product were determined. The properties of commercially available extrudates and pasta products were also studied for comparison. Addition of soyflours affected the expansion ratio and hardness and varied in the range of 1.28-2.59 and 74.6-119.7 N. The whiteness of the extrudates before and after frying ranged from 40-65 and 27-43. It was influenced by oil uptake, expansion ratio after frying and raw material properties. Commercial products also showed the same trend for colour. However, frying reduced the hardness by 50 to 80% in all the products. Pasta extrudates expanded more (2-3 times) in terms of thickness, compared to 1.5-2.0 times in length. All types of soyflours, thus, can be blended with cereals/tubers for extruded products.

Keywords: Extrusion, Soy-cereal/tuber blend, Extrudate properties, Hardness, Expansion ratio, Colour.

Soybean, a rich source of good nutritional quality, contains about 40% proteins and 20% oil. Owing to its high protein content, it can be effectively utilized for nutritional improvement of cereal-based extrudates (Kulkarni and Joshi 1992). Though, soy protein has good functional properties, these alone are not enough for making good quality balanced food with reference to nutrition, taste and shelf-life. The extrusion technology allows to process and provide a wide range of shaped, pre-cooked-texturised foods with a single machine (Chuhan and Bains 1988). Extrusion technology has been used to process different food raw materials and the effect of variables on different product characteristics has been studied (Linko et al. 1982, Marsman et al. 1993, Vanzuilichem et al. 1988, Areas 1992). Since, soybean is nearly devoid of starch, extruded soy products may not show good expansion (Kulkarni and Joshi 1992). So, the present study was undertaken to study the properties of extruded products, based on raw materials like soybeans, cereals, tuber with varied oil, protein and starch contents.

Commercial products : Extruded products were obtained from M/s Surya Agroils, Bhopal and some from local market. Ready-to-eat (RTE) type and pasta products were also selected (Table 1).

Soy-blends : Different combinations of blends were chosen (Table 2) after sieving with Indian Standard Sieve (ISS) No. 30. Stored potatoes available in local market were used after peeling and cutting into small pieces of 5-8 mm. The amount of water to bring the mass to 30% db was estimated by mass balance and slowly added to the blend, uniformly mixed by hand and equilibrated for 1 h. The moisture contents of the conditioned blends and extrudates were determined by hot air oven method (AACC 1969). The mass mean diameter of a blended feed conditioned to about 30% moisture (Table 2) was 0.50-0.55 mm, depending on the ingredients. The blend of raw material was extruded at a feed rate of 40 kg/h, using Wenger X-5 extruder with a screw speed of 450 rpm, die diameter of 3.44 mm and barrel temperature at the die of 110-115°C. The arrangement of screw heads recommended by the manufacturer (Anon 1985) for such blends was used for experiments as follows: First head, -Straight rib; Second head, -Spiral rib; Third head, -Spiral rib; Fourth head, -Spiral rib; Fifth head, -Straight rib; Sixth head, -Straight rib; Seventh head, -Straight rib and Eighth head, -Spiral rib. The properties of the commercially available extruded products and laboratory extruded products were determined by following standard techniques.

Dimensions : The dimensions viz., length, width, thickness, diameter were measured using a dial vernier caliper having a least count of 0.02 mm.

Hardness : The hardness of the sample was measured, using a Kiya hardness tester (Seisakusho Co Ltd., Japan) with 0-196 N range and a least count of 1.96 N. The plunger of 4 mm diameter was used to judge the breaking strength of product. Ten replications were taken.

Colour : The AIMIL digital reflectance meter with magnesium oxide as a white standard was used to determine the colour (% whiteness) of the

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TABLE 1. PROPERTIES OF COMMERCIAL PRODUCTS

Product	Size		Thickness		Expansion		Hardness		Colour		FFA, %	Oil AF, g/100g
	BF, mm	AF, mm	BF, mm	AF, mm	S	T	BF N	AF N	BF, %	AF, %		
Ready-to-Eat												
Corn crax puffs (RE1)	32.08± 0.894	NA	11.99± 0.302	NA	NA	NA	13.7± 0.8	NA	NA	69	1.6	NA
Crax fun balls (RE2)	13.99± 0.604	NA	NA	NA	NA	NA	11.8± 1.4	NA	NA	56	0.23	NA
Pasta products												
Wheat-based												
Wheel shape (CE1)	15.32± 0.159	23.17± 0.03	1.93± 0.03	3.67± 0.174	1.5	1.9	22.6± 1.9	10.8± 0.5	25	40	NA	21.31
Wheel shape (CE2)	23.34± 0.527	38.87± 1.121	1.83± 0.128	3.48± 0.246	1.7	1.9	29.4± 4.0	10.8± 1.4	25	42	NA	19.83
Square shape (CE3)	32.48± 1.257	47.85± 2.961	1.66± 0.09	3.72± 0.387	1.5	2.2	15.7± 1.1	6.9± 1.7	38	57	NA	12.28
Oval shape (CE4)	23.07± 1.017	42.68± 0.894	1.47± 0.227	4.74± 0.324	1.9	3.2	106.0± 15.1	20.6± 1.3	25	48	NA	10.67
Tapioca-based (CE5)	12.57± 0.221	25.04± 0.949	5.44± 0.27	10.21± 1.583	2.0	1.9	39.2± 4.6	11.8± 0.8	35	37	NA	25.55

AF = After frying, BF = Before frying ± S.D., N.A. = Not applicable

powdered extrudates before and after frying. The frying of extrudates was done at 180°C, using filtered soybean oil for complete frying.

Oil content : The oil content of the products was estimated, using Soxhlet apparatus and hexane as solvent (AOAC 1984).

Free fatty acids : The free fatty acid (FFA) content was estimated by the method of Saio et al (1980) and expressed as % oleic acid.

Expansion ratio : The expansion ratio of the extrudates i.e., the ratio between extrudate diameter and die diameter was determined (referred to as R1 for lab extruded products and R2 for the ratio between the dimension of the product after and before frying).

All the above properties of the samples were determined before and after frying in soybean oil. Results of the study are discussed below :

Commercial products : Properties of commercial products are given in Table 1. In ready-to-eat type products, crax fun-balls were found to be softer (11.8 N) than corn puffs (13.7 N). However, corn puffs had a better degree of whiteness (69%) than fun-balls (56%). FFA content of corn puffs was 1.6%, which was higher than the safe level of 1.0% (Mustakas and Griffin 1964), only after 4 months of product packaging.

The pasta products (CE1 to CE4) were wheat-based and the product (CE5) was tapioca-based. It can be seen from Table 1 that after frying, the expansion in thickness was more than the length/ diameter for all products, but for CE5. It was observed that the puffing was more, when the initial product thickness was less, perhaps because of more layers in thick sample, restricting the swelling compared to thinner sample. The maximum expansion ratios for size and thickness were observed in CE4 and 1.9 and 3.2, respectively.

Frying decreased the hardness of all the products. Reduction to about 1/5th was in CE4 and 1/2 to 1/3 for other products (Table 1) and this may be due to expansion and development of crisp texture during frying. The colour of all products improved on frying (Table 1). However, for tapioca-based extrudate, the improvement was negligible. The oil uptake was found to be more in less expanded products. It was maximum of about 21 g oil/100 g product for CE1 amongst wheat-based products in which expansion was very low (Table 1) and minimum of about 12 g/100 g for CE4, whose expansion was maximum.

Laboratory extruded products : The expansion ratio R1, was more (2.98) for corn (S1) and rice (S9) - 2.62 (Table 2) compared to 1-2.5 for other products. The low expansion in potato extrudates (S4) is attributed to high sugar content (950-1500 mg/100g) of stored - sprouted potatoes, causing restriction in swelling of starch. This may hold good for potato-based blends in this study.

The addition of different types of soy flour with cereals showed different characteristics and could be related to their fat and protein contents. The expansion ratio of S5 was more than that of S2,

TABLE 2. PROPERTIES OF SPU EXTRUDED PRODUCTS

Product	Size		Expansion raio		Hardness		Colour		Oil		Moisture content	
	BF, mm	AF, mm	R1	R2	BF N	AF N	BF, %	AF, %	BF, %	AF, %	BF, %	AF, %
Corn (S1)	10.26± 0.373	10.58± 0.489	2.98	1.03	53.0± 7.8	13.7± 1.8	50	27	0.3	10.84	30.2	13.4
Corn + MFSF 70 + 30 (S2)	4.41± 0.285	4.74± 0.294	1.28	1.07	84.4± 4.6	72.6± 3.2	46	43	4.6	11.99	30.0	13.6
Corn + Potato 100 + 40 (S3)	7.23± 0.047	7.44± 0.047	2.10	1.03	125.6± 20.1	45.1± 8.2	40	35	0.3	11.38	29.4	13.7
Potato only (S4)	3.618± 0.118	4.50± 0.115	1.05	1.25	196	88.2± 2.8	50	41	0.4	14.33	78.9	14.0
Corn + DFSF 90 + 10 (S5)	8.52± 0.358	9.00± 0.323	2.47	1.06	74.6± 8.2	60.8± 11.2	53	28	1.5	16.94	31.4	11.0
Corn + DFSF + Potato (S6) 90 + 10 + 10	8.06± 0.455	8.84± 0.892	2.34	1.10	80.4± 15.6	29.4± 12.2	56	27	0.60	15.35	30.4	12.3
Corn + FFSF+ Potato 90 + 10 + 10 (S7)	7.74± 0.54	9.19± 0.787	2.25	1.19	119.7± 11.9	64.8± 16.6	61	38	2.30	12.30	31.2	12.0
Rice + DFSF 90 + 10 (S8)	8.90± 0.410	9.56± 0.999	2.59	1.07	100.1± 22.2	41.2± 10.2	62	30	0.50	14.86	30.0	12.7
Rice (S9)	9.0± 0.431	10.29± 0.412	2.62	1.27	114.8± 25.9	28.5± 12.0	65	32	0.40	16.20	32.5	13.4
Maida (S10)	8.46± 0.383	10.72± 0.363	2.46	1.27	92.2± 6.8	77.5± 5.4	56	33	2.70	12.30	31.20	14.4

AF = After frying, BF = Before frying, SF = Soy flour, DF = Defatted, FF = Full fat, ± S.D.

due to varying oil content in defatted (1% oil) and medium fat (7% oil) soy flour. Similarly, defatted soyflour (DFSF) mixed with corn and potato (S6) expanded better than FFSF with the same combination (S7) (Table 2). This change might be due to starch lipid interaction as well as protein starch interaction.

The addition of defatted soy flour (S6) caused appreciable reduction in hardness, compared to the addition of full fat soyflour (S7). The better expansion obtained for sample with defatted soyflour (S6) due to lower oil content (1%) over full-fat soy-flour 20% (S7) has resulted in lower value of hardness (Table 2). Addition of potato starch increased the hardness to a great extent (S3 and S7). Amongst the cereal-based extrudates, the minimum hardness was in corn (S1) and highest in rice (S9) and *maida* (S10). Addition of defatted soy flour to corn (S5) showed increase in hardness. However, increase was more in medium fat soy flour (S2), which may be due to less expansion for high oil uptake.

The % whiteness of extruded products varied with composition from 40 to 65%. For corn and potato extrudates, the colour value was same. But for their mix, it was reduced to 40%. Table 2 shows that in extrudates S-1, S-4, S-9 and S-10, whiteness varied from 50-65% and potato and maize were at par. When formation of Maillard product is limited, the colour may be attributed to low degree of caramelization because of short cooking time. In other cases (S1, S9 and S10), the susceptibility of thermal breakdown of a starch may be the responsible factor for giving different whiteness values. Also, the smaller size of starch (5 micron) compared to 15 micron for wheat (Rutenberg 1980) may also be a responsible factor for better whiteness in rice extrudates, mainly because of lower susceptibility of the smaller starch molecules to thermal hydrolysis.

Considering potato corn blend (S3) to only potato (S4), the lower moisture content of S3 might have been responsible for the deterioration of its colour (Eichner and Karel 1972). The content of protein available for 1 g of corn, when computed, is about 5.5 g/100 g of mix in S5, as against 20 g/100 for S2. This resulted in higher whiteness value in S5. This is also applicable in case of rice (S9). Addition of potato alongwith the full fat (40% protein) and defatted soyflour (50% protein) improved the colour, because of lower protein content of potato (S6) and still lower protein was available in (S7) for Maillard reaction over S6.

Oil content before and after frying : The oil content of extrudate increased due to addition of different types of soyflour in different quantities (Table 2). The oil contents of extrudates after frying,

were also affected by the original levels before frying but the real oil uptake should be taken from the difference of oil contents before and after frying. It reveals that the type of soyflour and their levels were major factors in determining the oil uptake. In case of corn, rice and *maida*, the oil uptake by extrudates seems to be affected by granule size, because this is one of the factors for complexing oil as evidenced by S–1, S–9 and S–10 samples, where the average granule size for corn is 15 and for rice is 5 micron (Rutenberg 1980). Table 1 and 2 indicate that oil contents of commercial products after frying (CE–1, 2 and 5) were considerably higher (around (8–10%) than the laboratory product due to non–incorporation of soybean.

Conclusion

Addition of soyflour namely, full–fat, medium fat and defatted gave a harder product with corn, which was also true for fried products. The level of protein and oil in these soyflour affected the colour and oil uptake. The oil uptake of laboratory extruded products was less compared to commercial products analyzed.

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Received 8 September 1995; revised 6 May 1997; accepted 14 May 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 513-515

Preparation of Vermicelli from Wheat Flour - Pulse Blends for Geriatrics

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Traditional vermicelli prepared from *maida* (refined wheat flour) was modified, replacing 25% *maida* with pulse flour to make it more nutritious. Recipes prepared from modified vermicelli on a home scale was evaluated for physico-chemical properties and acceptability. The samples blended with pulse showed increased water uptake, weight gain after cooking and increased cooking time. The protein content increased in pulse-blended variety, compared to traditional *maida* - based vermicelli. Blackgram and greengram *dhal* powders blended well, while *Bengal*gram *dhal* flour showed the least tendency to blend. Judges were unanimous in their opinion, regarding the suitability of pulse-based vermicelli preparations to the elderly.

Keywords: Pasta, Vermicelli, Enrichment, *Maida*, Extruder, Mutual supplementation, Pulse flour, Foods/Products for geriatarics.

The current size and rate of increase of elderly population indicate that there is a need to know and learn more about the particular wants, needs, likes and dislikes of this group (Dichter 1992). The ultimate goal of programmes aiming to fulfil the nutritional needs of older people is to improve the quality of life rather than longevity (Joseph et al. 1992). Due to changing values, modernization, urbanization, the elderly are left alone and have to provide themselves their own diet. Such situation tends to render the diets of elderly to be nutritionally unbalanced and lack variety in menu (Vijayalakshmi 1988). Hence, they need simple, but nutritious supplement or mini-meal, which should be easy-to-cook and ready-to-eat, as and when necessary (Pasricha and Thimmayamma 1992; Mitsuko 1992).

Pasta products are good sources of complex carbohydrates and a moderate source of proteins, some essential vitamins and minerals and are low in sodium (Cook and Welsh 1987). There are already many varieties in the market and most are suitable without any modification, except perhaps changing their nutritional contents rather than textural properties (Peleg 1993). The present study was aimed to incorporate different pulses in vermicelli to enrich its nutritive value and to prepare different breakfast and snack items to suit the needs of the elderly.

Refined wheat flour (*maida*), *Bengal*gram *dhal*, greengram *dhal* and blackgram *dhal* were purchased from local super market. The pulses were cleaned and ground in a Cyclotec 1093 sample mill. Blends of *maida* and pulse flour were prepared by mixing in the ratio of 75:25. Four types of vermicelli were prepared using the above blends. The blends were mixed with water (40%) and made into a very stiff dough. The dough was, then, extruded through traditional vermicelli extruder (hand-operated) into thin strands of vermicelli. The extruded vermicelli was shade-dried overnight and sun-dried for 1 h and stored in air-tight stainless steel tins, until further use.

Physical characteristics like appearance, colour and water uptake, time taken for cooking and weight increase after cooking were studied. The proximate composition of different vermicelli was determined by standard procedures. Moisture content was estimated in dough, freshly extruded and dried vermicelli (AACC 1983). Protein and fat estimations were done by micro-kjeldahl and petroleum ether extraction methods of AACC (1983). Energy value was computed from the Table of nutritive value of Indian foods (Gopalan et al. 1989) and carbohydrate content was calculated by difference.

Different types of breakfast/meal items and snack items (sweet/savoury) were prepared, using 4 types of vermicelli by standard methods. The organoleptic studies were carried out by 10 trained judges, who were staff and post-graduate students on a 5 point Hedonic scale.

The moisture contents of vermicelli at different stages of preparation are given in Table 1. While making the dough, greengram and blackgram blends took little higher amounts of water than *maida* alone. Moisture content of the dough (estimated) was comparatively less than the quantity

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TABLE 1. PHYSICO-CHEMICAL PROPERTIES AND COST OF DEVELOPED VERMICELLI

Parameters	Type of vermicelli			
	Maida (100:0)	*Maida*+ Green-gram (75:25)	*Maida*+ Black-gram (75:25)	*Maida*+ *Bengal*-gram (75:25)
Water added while making dough, ml	40	45	42	40
Moisture content of dough, g%	33.5	33.5	32.5	29.3
Freshly extruded vermicelli	33.0	29.9	30.6	27.6
Dried vermicelli	10.2	9.9	8.7	7.9
Physical parameters				
Weight of sample before cooking, g	50	50	50	50
Water used for boiling, ml	400	400	400	400
Time taken for cooking, min.	3	4	4	4
Water uptake, ml	175	186	235	185
Weight of sample after cooking, g	160	190	216	180
Chemical composition				
Proteins, g	9.4	16.3	15.8	15.3
Fat, g	0.74	0.91	1.03	1.82
Carbohydrates, g	79.6	72.9	74.7	75.9
Energy, kcal	348	354	348	348
Cost/kg, Rs. Ps.	8.0	10.0	10.25	9.75

of water added. The decrease in moisture content could be due to evaporation during preparation. A further decrease in moisture in freshly extruded vermicelli was due to the heat generated inside the extruder, while extruding. The yield of dried vermicelli varied from 95 to 90%.

The pulse-blended vermicelli comparatively took longer time for cooking. Water uptake and weight gain after cooking were also higher (Table 1). Blackgram *dhal* blend absorbed maximum water and increased weight gain, which could be due to higher mucilages present in the blackgram.

The protein content enhanced in pulse-blended vermicelli (15 to 16 g %) than the vermicelli made out of only *maida* (9 g%). The fat content in *Bengal*gram *dhal*-blended vermicelli was slightly higher than other blends. The carbohydrate content slightly reduced in pulse-blended vermicelli and there was no significant difference among the samples in energy value.

The cost of the pulse-blended vermicelli was higher than *maida* (cost calculated as per the prevailing market rates). The *Bengal*gram *dhal* blend showed flavour change after storage for a period of one week. The other samples did not show any change in their characteristics even after 3 months. This could be due to higher fat content in *Bengal*gram *dhal*, which might become rancid after a few days of storage.

Using the four types of vermicelli, different preparations were made and evaluated by a trained taste panel consisting of 10 judges, using a 5-point Hedonic scale. The items were divided into breakfast/meal items like *upma*, *pulihora*, *curdbath*, tomato *bath*, *pongal* and *idli* and snacks (savoury and sweet) like *pakoda*, *cutlet*, *vada*, *halwa*, *payasam*, *pudding*, *poli* and *laddu*. Initially, the raw and just boiled vermicelli were evaluated. The results indicate that *Bengal*gram-blended vermicelli was slightly yellowish in colour and the raw flavour of *Bengal*gram was predominant in vermicelli. However, these were marked in the preparations like *pulihora* and tomato *bath*. The overall acceptability of *Bengal*gram-blended vermicelli was low as compared with 3 types, especially in sweet preparations. Regarding the order of preference among the 4 samples, blackgram stood first, greengram blend next on par with *maida* and *Bengal*gram blend in the 4th position.

Organoleptic evaluation revealed that all the recipes were suitable to the elderly except *pakoda*, which was found to be too crisp. The crispness could be reduced and made more acceptable to the dentition of the elderly. The protein and calorie contents of different recipes were calculated by using the mean protein and calorie values of four types of vermicelli per 100 g. The protein and calorie contents for breakfast items ranged from 16.5 to 29 g% and 456 to 749 kcal and for snacks 9 to 21g% and 479 to 910 kcal, respectively. The enhanced values of protein and calories in these products were not only due to blending with 25% pulse, but also due to other ingredients incorporated during preparation. Atleast 1/4th of the calorie requirements of elderly person can be met by including one of the recipes in the daily diet.

It is well known that vermicelli is easily available under a number of brand names and they are also easy-to-cook with least effort and time. Since the commercially available vermicelli is made out of only refined wheat flour/semolina, the calorific value as well as protein content and quality rank equally with any other cereal. Mutual supplementation of legume with cereal would be a positive approach to improve the protein quality. Vermicelli made out of cereal, blended with pulse

had an added advantage of easy digestibility and quality/quantity of protein is a suitable choice of preparing geriatric foods.

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Received 30 October 1995; revised 7 June 1997; accepted 11 June 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 516-518

Effect of Amylases and Proteases on Bread Making Quality of Durum Wheat Flour

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Loaf volume, external and internal characteristics of breads made from durum wheat flour and bread wheat flour (control) with increasing levels (0-30 mg/kg) of added enzymes (α-amylases, protease and mixture of α-amylase-protease) were determined and compared. Loaf volumes of both flours increased as a function of increasing levels of each enzyme added. Durum wheat flour with added fungal α-amylase produced breads with higher loaf volumes than did with bacterial α-amylase. Of the enzymes added, the mixture of α-amylase protease produced breads from durum wheat flour with more acceptable quality characteristics.

Keywords: Durum wheat, Bread wheat, Baking, Bread quality, Amylases, Proteases.

The development of new durum wheat cultivars with high yielding potential, more resistant to disease and wide environmental adaptability has led to an increase in the production of durum wheat in Latin America. Although the main use of durum wheat has been in the production of high quality pasta in industrialized countries, other products such as leavened and unleavened bread, couscous and bulgars are produced from durum wheat in developing countries (Anon 1992).

Results of recent work on the utilization of durum wheat for breadmaking (Boyacioglu and D'Appolonia, 1994a, b, c and d) have shown that it is possible to produce bread with acceptable characteristics from blends, containing durum flour or durum first clear flour. Pena Valdivia (1981) and Salazar Zazueta (1994) showed that blends of soft wheat (40%) and durum wheat (60%) flours could be used for the production of a variety of breads widely consumed in Mexico, such as *bolillo* (French type) and sweet breads.

The objective of this investigation was to study the use of commercial enzymes on the baking performance of a durum wheat flour and a bread wheat flour.

Flour samples: Flours used in this study were milled on a experimental Buhler mill from a commercial sample of the durum wheat 'Mexicali' and the bread wheat 'Opata', which were grown during 1987 in the Northwest Experimental Station of Agricultural Research, located in the Yaqui Valley, Mexico.

Commercial enzymes : Commercially available enzymes (α-amylases and protease) were purchased in Mexico City. The reported activities of the bacterial and fungal α-amylases were of 3550 and 4000 Sandstedt-Kneen-Blish (SKB) units/g, respectively. The protease preparation had an activity of 3733 Haemoglobin Units (HU)/g. The mixture of fungal α-amylase and protease had activities of 230 SKB/g and 1448 HU/g, respectively.

Flours samples with added enzymes: To 2 kg of each flour sample, enzymes preparation were added from 5 mg to 30 mg per kg of flour. All samples were kept in a cold room (4°C) and removed as required for analysis.

Quality analysis : Test weight was measured, using the Ohaus scale equipped with a 0.5 litre measure and cox funnel. An electronic seed counter was used to determine thousand kernel weight. Protein, pigment and ash contents, diastasic activity and farinograph were determined as per AACC (1983) methods. The mixograms were determined on 10 g mixograph at 60 % absorption according to Voisey et al (1966) and the Glutamatic model 2100 (Falling Number AB, System Perten, Sweden) was used to determine gluten content.

Baking: Baking trials were performed in duplicate on different days in randomized order. Breads were made with 100 g formula, using the straight dough baking test 10-10 of the AACC, adjusting water absorption to attain a dough consistency as judged by the baker as desirable for bread making. The standard deviation of duplicate for loaf volumes was 15 cc. Crumb structure was scored on the basis of visual assessment of gas-cell-size and distribution.

Quality characteristics of wheat cultivars : Quality characteristics of wheat cultivars used in

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TABLE 1. QUALITY CHARACTERISTICS OF BREAD WHEAT AND DURUM WHEAT CULTIVARS

Characteristics	Bread wheat 'Opata'	Durum wheat 'Mexicali'
Test weight, kg/hL	79.00[a]	80.30[a]
Thousand kernel weight, g	36.50[a]	50.20[b]
Pearling resistance, %	42.00[a]	39.00[a]
Wheat proteins, N x 5.7, 14% mb	11.50[a]	11.50[a]
Yellow pigment, mg/kg	1.70[a]	5.80[b]
Buhler flour yield, %, 14% mb	72.00[a]	50.30[b]
Flour proteins, N x 5.7, 14% mb	10.30[a]	10.20[a]
Ash, %	0.47[a]	0.92[b]
Starch damage, Farrand units	34.00[a]	49.00[a]
Gluten (on wet basis), %	30.00[a]	27.00[b]
Mixograph development time, min	2.15[a]	2.30[a]
Farinograph water absorption, %	60.50[a]	69.50[a]
Farinograph peak time, min	2.54[a]	3.54[a]
Mixing tolerance index, min	54.00[a]	50.00[a]

Values followed by the same superscript letter within a row are not different at P=0.05 level of Tukey's Test

this study are presented in Table 1. Durum wheat 'Mexicali' had higher value for test weight, thousand kernel weight, hardness, pigment and protein content than bread wheat 'Opata'. Flour yield for durum wheat was low and it had a distinct yellowish colour. Protein contents of durum wheat and bread wheat flours were similar, but gluten content was higher for the bread wheat flour. According to Boyacioglu and D'Appolonia (1994a), durum wheat flours had higher protein and gluten contents than did bread wheat flours. These differences with the results of the present work might be due to differences in cultivars and environments. Untreated flour obtained from bread wheat 'Opata' had superior rheological and baking properties to flour from durum wheat 'Mexicali'. As expected, durum wheat flour showed higher amounts of starch damage and farinograph absorption than the bread wheat flour did, indicating greater milling severity. Durum wheat flour produced a very low loaf volume with open and coarse crumb grain characteristics and yellow colour.

Effect of added enzymes on gasing power: The initial amount of gas produced from the durum wheat 'Mexicali' was 420 mm, whereas 'Opata' flour produced a mean value of 453 mm. It would be expected that durum wheat flour would have higher values for gasing power, because they require a more severe grinding during the milling process. Both durum wheat flour and bread wheat flour gave similar values of gasing power with increasing levels of fungal α-amylase. However, there were differences for both the flours, when bacterial α-amylase was added. The addition of bacterial α-amylase increased the amount of gas produced by the durum wheat flour during dough fermentation. These differences may be due to differences in optimal levels needed for each flour and the purity of enzyme in each preparation used as well as the initial starch damage in the flours (Table 2).

The addition of mixtures of α-amylase and proteases produced higher values of gasing power, as levels were increased. Preparation of amylase and protease mixture of lower activity (230 SKB/g and 1448 HU/g) gave lower values of diastasic activities than the preparation with higher activity (520 SKB/g and 1813 HU/g) (results not shown). The addition of proteases is not a common practice in Latin American countries for the production of panbread, but they are added to obtain weaker dough for the production of cookies.

Breadmaking quality of flours with added enzymes: Loaf volumes of both flours increased with increasing levels of the different enzyme preparations used in this study (Table 2). The addition of fungal α-amylase was more effective in increasing loaf volume than bacterial α-amylase for the durum wheat flour. The initial durum wheat flour loaf volume increased from 365 cc to 520 cc, when 5 mg of fungal α-amylase was added. Preliminary experiments showed that amounts above 30 mg of all enzymes added, produced lower loaf volumes with interior bread quality due to changes in rheological properties of doughs.

The addition of protease preparation gave lower loaf volumes than when the mixture of α-amylase-protease was added to durum wheat flour. All breads from durum wheat flour with added enzymes had improved external and internal characteristics, but breads made from bread wheat flour were always of superior quality. The grain and texture of durum wheat breads without the addition of enzymes were coarse, dense and dough (Table 2). Boyacioglu and D'Appolonia (1994a) reported low loaf volumes for all different types of durum wheat flours studied and the addition of an oxidizing agent gave even higher loaf volumes than the weak bread flour used as control. They also found that all durum wheat flours had lower scores for external appearance, grain and texture than did the bread flours.

The present results have shown that there is an increase in loaf volume with improved internal

TABLE 2. EFFECTS OF ENZYME ADDITION ON GASING POWER AND BREADMAKING CHARACTERISTICS OF A DURUM WHEAT FLOUR ('MEXICALI') AND A BREAD WHEAT FLOUR ('OPATA')

	Enzyme mg kg^{-1} of flour	Gasing power		Bread properties: Loaf volume, cm^3		External appearance		Grain and Texture	
		'Mexicali'	'Opata'	'Mexicali'	'Opata'	'Mexicali'	'Opata'	'Mexicali'	'Opata'
Bacterial α-amylase	0	420[a]	453[a]	360[a]	651[a]	5.0	7.0	3.0	7.0
	5	500[a]	500[a]	413[a]	726[b]	5.0	7.0	3.5	7.0
	10	550[a]	436[a]	453[a]	760[b]	5.0	8.0	3.5	7.5
	20	566[a]	500[a]	446[a]	766[b]	5.0	8.0	4.0	8.5
	30	580[a]	506[a]	506[a]	806[b]	5.0	9.0	5.0	8.5
Fungal α-amylase	0	420[a]	456[a]	360[a]	651[b]	5.0	7.0	3.0	7.0
	5	500[a]	500[a]	533[a]	746[a]	5.0	8.0	4.5	8.0
	10	510[a]	456[a]	566[a]	740[a]	5.0	8.0	4.5	8.0
	20	500[a]	506[a]	606[a]	746[a]	6.0	8.0	6.0	8.0
	30	510[a]	516[a]	600[a]	760[a]	6.0	8.0	6.0	8.0
Protease	0	ND	ND	360[a]	651[b]	5.0	7.0	3.0	7.0
	5	ND	ND	353[a]	746[b]	4.0	8.0	3.5	8.5
	10	ND	ND	440[a]	773[b]	4.0	8.0	3.5	8.5
	20	ND	ND	486[a]	793[a]	4.0	9.0	3.5	9.0
	30	ND	ND	513[a]	780[a]	4.0	9.0	3.5	9.0
α-amylase-protease	0	420[a]	450[a]	360[a]	651[b]	5.0	7.0	3.0	7.0
	5	500[a]	440[a]	453[a]	683[a]	6.0	8.0	4.5	8.0
	10	520[a]	420[a]	506[a]	666[a]	6.0	8.0	5.5	8.0
	20	570[a]	435[a]	526[a]	686[a]	6.5	8.0	6.0	8.0
	30	575[a]	490[a]	513[a]	713[a]	6.0	8.0	6.0	8.0

Scores 1-10 (1=lowest, 10=highest)

ND=Not determined

Values followed by the same superscript letter within a row are not different at P=0.05 level of Tukey's Test

and external characteristics of breads made from durum wheat flour with the different enzymes added. However, these improvements would not add value in the production of pan white bread in developed countries.

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Received 24 October 1995; revised 7 June 1997; accepted 11 June 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 519-522

Comparative Efficacy of Wax Emulsion and Rice Starch on the Post-harvest Shelf Life of Fully Ripe Guava Fruits

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Efficacy of wax emulsion and rice stach on the post-harvest shelf life of guava cv. 'Allahabad Safeda' was studied. Wax emulsions at 6 and 12% and rice starch at 3 and 6% levels with and without gum were used. The fruits treated with either 3% rice starch or with 12% emulsion were found to retain good fruit quality. Therefore, it is suggested that 3% rice starch treatment can be used as a substitute for extending the post-harvest shelf life of fully ripe guava fruits upto 12 days.

Keywords: Rice starch, Guava fruits, Wax emulsion, Shelf life, Sensory characteristics, Physico-chemical properties.

Guava is one of the most common sub-tropical fruits grown in India and occupies the fourth place in area and production. The fruit is highly perishable and every year large quantities of fruits are lost due to spoilage. Some research has been carried out to improve the shelf life of guava, using wax emulsion (Hussain 1973; Singh and Chouhan 1986). Although wax emulsion extends the shelf life of guava, there is a need to develop an alternative edible coating material for extending its shelf life. Recently, in a preliminary trial, rice starch as coating material was tried and it had proved to be quite promising in prolonging the shelf life of fruits (Mohammed and Singh 1990). Rice starch has good film forming quality and is much cheaper than wax emulsion. Besides, it is edible and can be easily prepared at home, using even inferior quality rice. Film forming quality of rice can further be enhanced by adding gum in starch solution. Therefore, the possibility of using rice starch with or without gum as a substitute for wax emulsion in improving the post-harvest shelf life of guava fruits was examined.

Fully ripe fruits of guava cv. 'Allahabad Safeda' were obtained from the Horticultural farm, Rajasthan College of Agriculture, Udaipur. After removing dirt, dust and other extraneous materials, fruits were placed in 12 groups, keeping 16 fruits in each group. Fruits were treated with 0, 6 and 12% emulsion, prepared by CFTRI, Mysore and 0, 3 and 6% rice starch with babool gum and without gum and allowed to dry. Total number of treatments used were 7 and replicated thrice under Factorial Randomized Block Design. The treated fruits were stored at room temperature, ranging from 16.5° to 22.5°C and examined for physical and chemical changes at an interval of 4 days.

Physical characteristics viz., texture, flavour, taste and appearance were judged organoleptically by a panel of 4 judges, whereas weight loss was determined by weighing the fruits. Total soluble solids (TSS) content was estimated by Zeis Hand Refractometer. The acidity of fruits was determined by titrating the juice against N/10 NaOH, using phenolphthalein as an indicator. Ascorbic acid content of juice was determined by diluting the known volume of juice with 3% metaphosphoric acid and titrating with 2, 6-dichlorophenol indophenol solution (AOAC 1960), until a faint pink colour appeared. The result was expressed as mg of vitamin C (ascorbic acid) in 100 ml of juice.

For sugar analysis, a weighed sample of juice was taken. Saturated lead acetate solution was added to clarify the pulp and then raised to a known volume. The solution, thus, obtained was filtered and later freed from lead by addition of potassium oxalate crystals and again filtered. The reducing and non-reducing sugars were estimated by the Fehlings method (Lane and Eynon 1923). The data obtained were analyzed statistically.

Physiological loss in weight (PLW): The treatments (wax emulsion and rice starch) significantly reduced the physiological losses in weights of fruits (Table 1). The 12% wax emulsion treatment recorded the minimum PLW (4.24%), followed by 6% wax emulsion (5.10%) and 6% rice starch without gum treatment (5.65%), whereas maximum PLW (9.52%) was observed in control. The maximum PLW (13.98%) was observed after 12 days and minimum after 4 days (4.45%) of storage period. Jain (1986) reported that wax emulsion at

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TABLE 1. EFFECT OF WAX EMULSION AND RICE STARCH WITH AND WITHOUT GUM ON WEIGHT LOSS, FLAVOUR TEXTURE, APPEARANCE AND TASTE OF GUAVA FRUIT DURING STORAGE PERIOD

Treatment	Weight loss, %				Flavour*				Texture*				Appearance*				Taste			
	storage, days				storage, days				storage, days				storage, days				storage, days			
	4	8	12	Mean	4	8	12	Mean	4	8	12	Mean	4	8	12	Mean	4	8	12	Mean
Wax emulsion 6%	3.68	7.00	9.75	5.10	8.83	6.16	4.83	7.45	8.83	7.00	4.66	7.62	8.83	6.83	5.16	7.70	8.83	6.00	4.83	7.41
Wax emulsion 12%	2.69	5.92	8.38	4.24	8.50	7.00	4.66	7.54	8.50	8.00	4.16	7.66	8.50	6.16	5.00	7.41	8.50	6.50	5.00	7.58
Rice starch 3%	5.28	10.09	15.05	7.60	9.00	6.16	5.66	7.70	9.00	7.16	5.16	7.83	9.00	6.83	5.66	7.87	9.00	7.16	5.66	7.95
Rice starch 6%	3.43	7.04	12.13	5.65	9.00	6.50	6.00	7.87	9.00	8.16	4.50	7.91	9.00	6.00	5.83	7.70	9.00	7.16	6.16	8.08
Rice starch 3% + gum	5.00	9.25	15.46	7.42	9.00	6.66	6.33	8.00	9.00	8.16	4.00	7.87	9.00	7.16	5.16	7.83	9.00	6.83	6.00	7.95
Rice starch 6% + gum	5.20	9.40	16.32	7.73	9.00	6.83	6.00	7.95	9.00	6.83	5.16	7.75	9.00	6.16	6.08	7.81	9.00	7.50	6.16	8.16
Control	5.89	11.38	20.83	9.52	8.00	4.83	2.33	6.29	8.00	4.00	2.00	6.00	8.00	4.00	2.16	6.04	8.00	4.33	2.00	6.08
Mean	4.45	8.58	13.98		8.76	6.30	5.11		8.76	7.04	4.28		8.76	6.15	5.02		8.76	6.54	5.11	
	Treatment	Storage days	Interaction	Treatment	Storage days	Interaction	Treatment	Storage days	Interaction	Treatment	Storage days	Interaction	Treatment	Storage days	Interaction					
SEM ±	0.64	0.48	1.28	0.06	0.04	0.12	0.05	0.04	0.11	0.05	0.04	0.10	0.04	0.03	0.09					
C.D. at 5%	1.77	1.33	1.88	0.17	0.13	0.35	0.16	0.11	0.32	0.14	0.11	0.29	0.13	0.10	0.27					

* Initial value - Flavour - 10.00, Texture - 10.00, Appearance - 10.00, Taste - 1.00

higher concentration was more effective in reducing weight losses of guava fruits and thus support the present findings. Since, wax emulsion forms thinner layer than rice starch, it effectively checks the moisture loss through transpiration.

Flavour: Data presented in Table 1 indicate the highest flavour value at 3% rice starch solution with gum treatment (8.00) and the lowest value in control (6.29). The flavour value of rice starch treated fruit was higher than that treated with wax emulsion. Fruits after 12 days of storage recorded low flavour value (5.11), as compared to 4 days of storage period (8.76). Jawanda et al (1978) reported that kinnow mandarin treated with 6% wax emulsion retained the usual flavour of fruit upto 40 days.

Texture: All the rice starch treatments with and without gum were found to give significantly higher texture values, as compared to wax emulsion treatments and control (Table 1). The highest texture value (7.91) was found with 6% rice starch without gum treatment. After 12 days, however, there was no significant difference in the texture values among rice starch with and without gum treatments. Vihol (1982) reported that mangoes treated with 8% wax emulsion along with 100 and 200 ppm 2, 4-D were most fit for marketing. It may be possible that rice starch and wax emulsion reduce microbial activity and respiration rate of cells, thereby helping in retaining good fruit firmness.

Appearance: From the results presented in Table 1, it is clear that the highest appearance value was recorded in fruits treated with 3% rice starch without gum (7.87), followed by 3% rice starch with gum (7.83) and 6% rice starch with gum (7.81). The mean appearance value (6.04) was recorded in control, which was significantly lower than all the other treatments. The treatment with rice starch with and without gum resulted in significantly higher values for fruit appearance than 12% wax emulsion treatment (7.41).

Taste: Rice starch and wax emulsion treatments significantly helped in retaining the taste of fruits after 12 days of storage period (Table 1). The highest taste value was recorded at 6% rice starch with gum treatment (8.16). The lowest taste value (6.08) was recorded in control. The taste values of fruits treated with the rice starch solution with and without gum were significantly higher than those of the wax emulsion-treated ones. Mohammed and Singh (personal communication) found that banana fruits treated with rice starch with and without gum possessed better taste than wax emulsion-treated and control fruits after storage period.

Total soluble solids (TSS): Rice starch and wax emulsion treatments significantly arrested the

TABLE 2. EFFECT OF WAX EMULSION AND RICE STARCH WITH AND WITHOUT GUM ON TOTAL SOLUBLE SOLIDS (TSS) ACIDITY, ASCORBIC ACID, REDUCING, NON-REDUCING AND TOTAL SUGARS OF GUAVA FRUIT DURING STORAGE PERIOD

Treatment	TSS (°B)*				Acidity, %*				Ascorbic acid, mg/100g*				Reducing sugars, %*			
	storage, days				storage, days				storage, days				storage, days			
	4	8	12	Mean	4	8	12	Mean	4	8	12	Mean	4	8	12	Mean
Wax emulsion 6%	10.33	10.33	9.66	10.83	0.27	0.25	0.25	0.27	110.33	165.66	119.14	118.28	2.96	2.48	2.40	2.94
Wax emulsion 12%	11.33	1.66	8.66	10.91	0.36	0.17	0.17	0.25	110.00	163.66	118.50	117.54	2.98	2.60	2.46	2.96
Rice starch 3%	12.33	11.33	8.16	10.20	0.36	0.27	0.25	0.30	120.66	160.66	111.23	117.64	2.72	2.46	2.05	2.79
Rice starch 6%	12.16	11.33	9.16	11.41	0.44	0.25	0.21	0.30	118.66	188.00	123.72	126.98	2.79	2.54	2.08	2.83
Rice starch 3% + gum	10.66	11.33	9.33	10.70	0.29	0.23	0.23	0.27	114.00	171.00	118.50	120.38	2.21	2.16	2.13	2.61
Rice starch 6% + gum	10.33	11.66	9.16	11.29	0.32	0.29	0.27	0.30	121.66	167.66	114.39	120.43	2.74	2.22	2.04	2.74
Control	9.66	10.33	7.83	10.58	0.29	0.19	0.17	0.24	109.00	165.66	113.13	116.45	3.10	2.82	2.14	3.00
Mean	10.97	11.00	8.85		0.33	0.23	0.23		114.90	170.80	116.87		2.77	2.48	2.04	

	Non-reducing sugars, %*				Total sugars, %*			
	storage, days				storage, days			
	4	8	12	Mean	4	8	12	Mean
Wax emulsion 6%	6.98	5.78	4.97	6.37	10.31	8.55	7.72	9.68
Wax emulsion 12%	6.35	5.33	4.05	5.87	9.28	8.48	6.72	9.14
Rice starch 3%	7.15	6.53	3.92	6.34	10.00	9.60	6.15	9.47
Rice starch 6%	7.17	6.35	4.77	6.52	10.11	9.51	7.10	9.71
Rice starch 3% + gum	5.40	5.36	4.97	5.87	9.64	8.18	6.85	9.20
Rice starch 6% + gum	6.69	5.80	4.72	6.24	9.20	8.32	7.13	9.20
Control	6.21	5.73	3.83	5.88	8.38	7.73	7.46	8.93
Mean	6.56	5.84	4.45		9.56	8.62	7.02	

	Treatment	Storage, days	Interaction	Treatment	Storage, days	Interaction	Treatment	Storage, days	Interaction	Treatment	Storage, days	Interaction	Treatment	Storage, days	Interaction	Treatment	Storage, days	Interaction
SEM ±	0.07	0.05	0.14	0.01	0.01	0.02	1.45	1.09	2.91	0.02	0.02	0.05	0.05	0.04	0.10	0.09	0.07	0.18
C.D. at 5%	0.20	0.15	0.40	0.03	0.02	0.06	4.04	3.04	8.06	0.07	0.05	0.14	0.14	0.11	0.29	0.26	0.19	0.52

* Initial value -TSS - 13.00, °B Acidity - 0.32, % Ascorbic acid - 78.02 mg/100g, Reducing sugars - 3.95 % Non-reducing sugars - 7.78 %, Total sugars - 12.14 %

progressive decrease in TSS content of guava after 4, 8 and 12 days (Table 2). After 12 days of storage, the highest TSS was recorded at 6% wax emulsion treatment (9.66°B) and the lowest value of TSS (7.83°B) in control. But the mean highest TSS value was recorded in 6% rice starch without gum treatment (11.41°B) and the lowest mean TSS value in control (10.58°B), which was significantly lower than all the other treatments. Wax emulsion and rice starch solution seemed to reduce the rate of respiration, which may be responsible for higher retention of TSS in treated fruits during storage (Rameshwar and Rao 1979). Progressive overall decline in TSS with the advancement of storage period may be attributed to conversion of sugars into acids.

Acidity: Acidity of guava fruits fluctuated during the storage period as a result of treatment (Table 2). The maximum acidity (0.30) was recorded in 6% rice starch without gum treatment and minimum in control (0.24). The acidity increased after 4 days of storage period (0.33), followed by decrease after 8 days (0.23) and 12 days (0.23) of storage period. Rice starch with or without gum helped in higher retention of acidity of fruits of guava, as compared to other treatments and this may be attributed to lower conversion of acids to sugar and other products (Dalal et al. 1962).

Ascorbic acid: Table 2 indicates that the maximum ascorbic acid (126.98 mg/100 g) was recorded in 6% rice starch without gum treatment and the minimum in control (116.45 mg/100 g). There was significant difference in ascorbic acid content between 6% rice starch without gum treatment and all the other treatments. Ascorbic acid increased upto 8 days of storage period, followed by a decrease after 8 days of storage period. Minimum ascorbic acid on the basis of storage days recorded at 0 day (78.02 mg/100 g)

of storage period and the mean maximum after 8 days of storage period (170.80 mg/100 g fruit pulp). Increase in ascorbic acid content may due to conversion of sugars to acid (Dhoot et al. 1984).

Sugars: The highest amounts of non-reducing (6.52%) and total sugars (9.71%) were recorded in 6% rice starch without gum treatment (Table 2). The highest reducing sugar content (3.00%) was recorded in control. The maximum reducing sugars (3.95%), non-reducing sugars (7.78%) and total sugars (12.14%) were recorded at 0 day. Garg et al (1971) reported that reducing sugars were greater in untreated mangoes than the treated ones. By and large, 6% rice starch solution followed by 6% wax emulsion were effective treatments in retaining the non-reducing and total sugars. Jain (1986) concluded that wax emulsion (9%) helped in retaining TSS, non-reducing and total sugars in guava fruits as compared to control.

From the results, it is clear that application of rice starch has proved to be at par or superior to wax emulsion treatments. Therefore, it is suggested that rice starch may be used as a substitute for wax emulsion in prolonging the shelf life of guava fruits.

The authors thank the Department of Horticulture, Rajasthan College of Agriculture, Udaipur for providing necessary facilities and encouragement.

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Received 22 August 1995; revised 9 June 1997; accepted 12 June 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 523-525

Assessment of Chemical Composition and Yield of Queso Blanco (White Cheese) Made with *Calotropis Procera* and Lemon Juices

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Queso blanco was made from standardized cow's milk, by using *C. procera* and lemon juices as coagulants. The total solids, total proteins and fat contents in the cheese prepared with *C. procera* juice were lower than those in lemon juice cheese. The values of pH, ash and as well as yield were high in *C. procera* cheese compared to the product, based on lemon juice. The results showed that *C. procera* juice can be used to make a soft white cheese, which can stand with that made by acidification.

Keywords: Cheese, *Calotropis procera* juice, Lemon juice.

Queso blanco (White cheese) is a broad term describing a group of cheeses widely consumed in Latin America, United States and some Asian countries. Queso blanco is made from whole milk or partially skimmed milk by action of rennet or by addition of a food-grade acid or fruit juice, such as glacial acetic acid and lemon juice acidulants (Kosikowski 1977). It is generally an unripened cheese and highly salted acid in flavour (Chandan et al. 1979). It has also good slicing properties and possesses the ability to resist melting at frying temperature (Siapantas and Kosikowski 1967). The cheese has also high protein contents due to high cooking temperature (82±1°C), involved in the preparation the whey proteins associated with casein, thus improving the nutritional value and yield. In comparison with other cheese preparations, relatively few research studies have been carried on Queso blanco. Suitability of various coagulants was studied by Siapantas and Kosikowski (1967) and Chandan et al (1979), who recommended adding 10% solutions of acetic and citric acids to hot milk.

The present work was undertaken to compare the chemical composition and yield of Queso blanco made with an indigenous plant, *Calotropis procera* and lemon juices.

Sample collection and juice extraction: The leaves were harvested from lower, medium and upper of *C. procera* in order to obtain leaves of different range sizes from 12-24 x 8-16 cm. The leaf samples were collected about 110 km South-east of Addis Ababa, Ethiopia and transported in plastic bags to the Dairy Technology Unit at Debre Zeit Research Station, International Livestock Research Institute. The leaves were washed with tap water, carefully wiped with a clean muslin cloth, divided into 400 g samples, cut into small pieces before shredding in a mortar and subsequently pressed, using a separator (moulinex) in order to achieve a thorough extraction. The leaf extract (juice) was filtered through a triplicate layer of cheese cloth. The volume and pH of the filtrate were recorded and the residues were discarded.

Cheese manufacture: The litres of raw milk standardized to 3% fat was heated to 83±1°C in two different cheese vats. When the milk temperature reached 83°C, 0.3% of *C. procera* juice or 4.2 ml of pure lemon juice per 100 ml of milk were added and stirred to ensure even distribution of the juices. The milk-juice mixture was held at 83°C, until a firm coagulum obtained. The curd was cut into small pieces and after draining the whey, 3% NaCl (estimated curd weight) was added, thoroughly

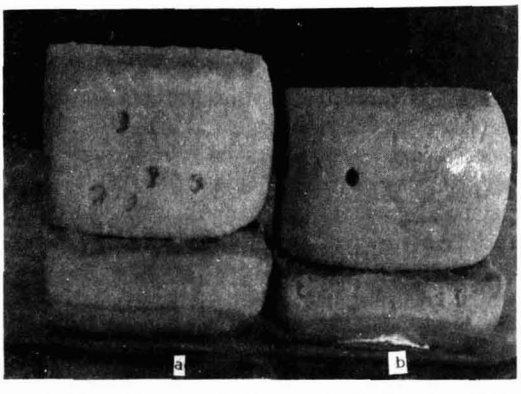

Fig. 1. Cheese (a) was made from standardized cow's milk by using lemon juice, and *C. procera* juice as coagulants. Cheese (b) was slightly greenish, which was due to the content of chlorophyll in *C. procera* juice

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mixed and pressed in wooden cheese moulds for 16 h. The cheese, thus, obtained was weighed and placed in a refrigerator, until analysis. (Fig. 1).

Chemical analyses of cheese: pH of the cheese was measured, using a pH meter (Phillips Scientific pH-meter, Cambridge, UK). The fat content was determined by Gerber method (British Standards 1989). The moisture, total solids and solid non-fat in cheese were determined by AOAC (1990) methods. Protein was determined by micro-Kjeldahl method (AOAC 1990). Lactose was calculated by difference of SNF and protein-ash. Ash was determined by gravimetric method (AOAC 1990). Cheese yield was calculated as a weight of cheese divided by weight of milk. All analyses of cheese samples were performed in duplicate and the components in the cheese were expressed as percentage.

Statistical analysis: The data were analyzed statistically, using the general linear model (GLM) procedure of SAS (1988).

The effects of coagulants *C. procera* and lemon juices on chemical composition and yield of Queso blanco were investigated. Cheese making process of the two coagulants was expected to be different, because *C. procera* juice contained a proteolytic enzyme, which hydrolysed casein (Ibiama and Griffiths 1987; Aworh and Nakai 1988). Therefore, curd produced by *C. procera* juice was softer, smoother, shrinkable and more elastic than the curd produced with lemon juice, which was in granular form and inelastic, due to precipitation of casein at pH near its isoelectric point. Furthermore, the results indicated that *C. procera* juice could be used for the preparation of Queso blanco, which could stand with that prepared by acidification procedure and had an excellent texture and sliceability (Fig. 1a, b).

Chemical composition and cheese yield: The chemical composition of cheese made with *C. procera* and lemon juices are presented in Table 1. The pH of cheese made with lemon juice was lower than that of *C. procera* cheese. This may be due to the characteristic acidity of lemon juice. Estelle et al (1985) reported that pH of Queso blanco made with citric acid varied in the range 5.00-5.48. The total solids, solids-not-fat, total proteins and fat in the cheese prepared with *C. procera* juice were lower than those in lemon juice cheese. These discrepancies might be due to proteolytic activity of *C. procera* coagulant, which hydrolysed more protein bonds and caused protein and fat to be lost in the whey. According to Siapantas and Kosikowski (1967), the total protein and fat contents of Latin American white cheese are 29.9% and 19%, respectively. O'Mahony and Peters (1987) reported 24% of proteins and 23% of fat in Queso blanco prepared by acidification. These values are high compared to the protein and fat contents of *C. procera* cheese (Table 1). The cheese produced with *C. procera* coagulant retained higher moisture content than that made with lemon juice. Several authors have reported different values of moisture contents in Queso blanco. For instance, Estelle et al (1985), Siapantas and Kosikowski (1967) and Chandan et al (1979) reported moisture values of 49.41-53.52%, 49.8-60.0% and 51.5-60.7%, respectively, in Quesco blanco prepared by acidification and these values are in agreement with those reported in the present study. However, O'Mahony and Peters (1987) reported a lower value of 46% of moisture content in Queso blanco. The lactose contents of the two products were high and not significantly different (Table 1). These high values of lactose content were reasonable, since, starter cultures were not added into the cheese milk, in order to ferment lactose. Normanella and Chandan (1991) reported that Latin American white cheese possessed several nutritional advantages, such as high protein and low lactose contents. This is especially important in conditions of protein deficiency and lactose intolerance. The cheese prepared with *C. procera* juice was slightly higher in the ash content than that made with lemon juice. This showed that, in the curd formed by acidification, the insoluble salts were rendered soluble by acid and were lost largely in the whey. O'Mahony and Peters (1985) reported a value of 3.0% for ash, which was lower than the value presented in Table 1. The yield is one of the most economically

TABLE 1. CHEMICAL COMPOSITION AND YIELD OF QUESO BLANCO MADE WITH *CALOTROPIS PROCERA* AND LEMON JUICES

Parameters	T1	T2	SEM	Significance
pH	6.35	5.86	0.18	*
Fat, %	16.33	19.58	0.47	***
Total solids, %	45.75	51.57	0.25	***
Solids-not-fat, %	29.42	32.07	0.41	***
Moisture, %	54.25	48.43	0.25	***
Total proteins, %	21.53	24.91	0.22	***
Lactose, %	3.94	3.91	0.25	NS
Ash, %	4.00	3.50	0.11	*
Cheese yield, %	12.57	10.67	0.25	***

T1=Treatment with *C. procera* juice (0.3%), T2=Treatment with lemon juice (4.2ml/100ml), SEM=Standard error of mean, NS=Not Significant *p<0.05; **p<0.01; ***p<0.001

important aspects of cheese manufacture. Abou-Donia (1986) reported certain factors that could affect the yield such as milk composition, salt addition and pasteurisation. Davis (1985) stated that the fat content of milk controlled cheese yield. The present results showed that yield of cheese made with *C. procera* juice was higher than that of lemon juice. This was due to high moisture content in *C. procera* cheese. Chandan et al (1979) reported a value of 10.8-12.5% in white cheese produced by acidification, which was very close to the present values.

The present results have shown that Queso blanco can be made by using *C. procera* juice as coagulating agent. Further studies are required to investigate its potential commercial use in the production of different types of soft and semi-hard cheese.

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Received 30 October 1995; revised 17 May 1997; accepted 15 June 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 526-528

Heat Resistance Studies of Spoilage Yeasts from Preserved Mango Slices

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Heat resistance of two spoilage yeasts viz., *Saccharomyces bailii* and *S. bisporus*, isolated from preserved ripe mango slices in sugar syrup was carried out. The ascospores of *S. bailii* and *S. bisporus* could survive on 10 min of heating at 65 and 60°C, respectively. Four to eight-fold higher heat resistance was observed in ascospores than vegetative cells of the yeasts.

Keywords: Heat resistance, Mango slices, Osmophiles, *Saccharomyces bailii*, *Saccharomyces bisporus*, Spoilage, Sugar syrup, Yeasts.

Fruits prior to processing contain a variety of microorganisms including yeasts, mould and bacteria (Veldhuis 1971). Though, heat treatment kills most of the microorganisms, processed products sometimes get spoiled, because of growth of certain ascospore forming heat-resistant moulds and yeasts. These yeasts generally originate either from the peel of the fruit or from processing equipments (Bowen and Beech 1964). Heat resistance properties of various fungi like *Byssochlamys*, *Talaromyces*, *Neosartorea* etc., have been studied in various fruit products (Splittstoesser 1994). Though, yeast ascospores do not possess that much high heat resistance, they are often 50-100-folds more resistant than their vegetative cells (Splittstoesser 1994). In the present investigations, two spoilage yeasts isolated from laboratory samples of preserved ripe mango slices were identified and studied for their heat resistance.

Isolation and identification of yeasts: Fruits cv. 'Dashehari' were washed, peeled and approximately 1 cm thickness and 4-7 cm long slices were prepared. The initial TSS and acidity of the slices were 19.8° Brix and 0.3%, respectively. The slices were immersed in boiling 40°B sugar syrup, having 350 ppm SO_2. The slices were filled hot (70°C filling temperature) in 500 ml capacity wide mouth glass jars, covered with aluminium foil and screw-capped to make them air tight (Kalra et al. 1995). The filled jars were air-cooled and stored under ambient conditions (32±5°C). The samples were analyzed for the presence of osmophiles by the method of Zottola and Walker (1984). Zero time analysis showed no detectable counts of osmophiles, but after three months of storage, spoilage was observed in a few samples of the preserved mango slices, as indicated by cap bulging and gas production in the jars. Low number of osmophiles (1.4×10^2) were also observed in other jars. The spoilage organisms were isolated by plating diluted sample on MY40 agar (HiMedia). The MY40 agar medium contained g/l water; malt extract, 20.0; yeast extract, 5.0; agar, 20.0 and sucrose, 400.0. The isolates were purified and identified by the method of Lodder (1970).

Preparation of yeast/ascospore suspension: The inoculated MY40 plates were incubated for 7 days at 28 ± 2°C. The yeast culture was harvested in 0.9 % saline solution and centrifuged at 5000 rpm for 15 min. The process was repeated twice. The yeasts were, then, resuspended in saline solution. The yeast ascospores were obtained by heavy inoculation of culture on MY40 and incubating the plates at 28 ± 2°C for 20 days. The sporing culture was centrifuged at 5000 rpm for 15 min and washed with saline solution twice. The ascospores were finally resuspended in saline solution and stored in the refrigerator.

Total counts of vegetative cells and ascospores were taken microscopically, using Haemocytometer after proper dilution in phosphate saline buffer (0.05 M, pH 4.5). Prior to heat treatment, initial viable cell counts were made in the diluted samples.

Preliminary determination of heat resistance: One ml of buffered yeast suspension was added to sterile test tube. The tubes were closed with steel caps and kept in 10 l capacity water bath. The heating lag was adjusted by putting plain water-containing tubes in the water bath. After 10 min of heat treatment at 60° and 65°C, the tubes were cooled immediately in running tap water and then 4.5 ml of MY40 broth was added to each tube. Six replicates were kept for each yeast. The tubes were incubated at 28 ± °C for one month and examined

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regularly for growth, as evidenced by gas formation and turbidity development.

Confirmation of heat resistance: Twelve replicate tubes of each yeast cell suspension were heated at 55°, 60°, 62.5° or 65°C for 10 or 20 min by the above described procedure for confirmation of heat resistance.

Heat resistance study of vegetative cells vs. *ascospores*: One ml of cell/ascospore suspension (5 replicates) was heated at 55°C for 0, 5, 10, 15 or 20 min. The tubes were cooled immediately and plated on MY40 agar. The plates were incubated at 28 ± 2°C upto 10 days and yeast colonies were counted. A curve showing log number of survivors against time was drawn and D_{55} was calculated.

The heat treatment process for acid foods such as fruit products is generally mild. For most acid food products, pasteurization at temperatures of 70-75°C is effective, as it inactivates most enzymes, yeasts and the spores of common contaminant moulds (Pitt and Hocking 1985). However, moulds and yeasts producing ascospores are capable of surviving such temperature and cause spoilage (Put and DeJong 1982a, b). In the present study, the yeast isolates were found to be osmophilic and ascosporogenous in nature and were identified as *Saccharomyces bailii* and *S. bisporus*. Besides other parameters, *S. bailii* was characterized on the basis of asci formed by conjugation of two cells on malt extract agar medium. *S. bisporus* showed similar characteristics, but the cells were smaller and were adhered in chain-like structures.

The preliminary heat resistance studies indicated the survival of *S. bailii* at 65°C for 10 min, while *S. bisporus* could not survive the temperature higher than 60°C. In confirmatory experiment of *S. bailii*, all the 12 replicates showed vigorous growth after 55 and 60°C heat treatment. After 62.5°C heat treatment, reduced growth was observed in all the tubes. Twenty percent of the tubes showed negative growth after 65°C heat treatment. *S. bisporus* showed positive growth after 55° or 60°C heat treatment. However, all the 12 replicates showed negative growth, when heated at 62.5°C for 10 min. Both the yeasts showed negative results, when heated for 20 min at 60°C and beyond. Among the two isolates, *S. bailii* was found to be more heat-resistant. *S. bailii* is an established spoilage yeast and has been reported in a number of fruit products (Put and DeJong 1982a). Its resistance to mild doses of preservative makes it more destructive in nature (Splittstoesser 1994).

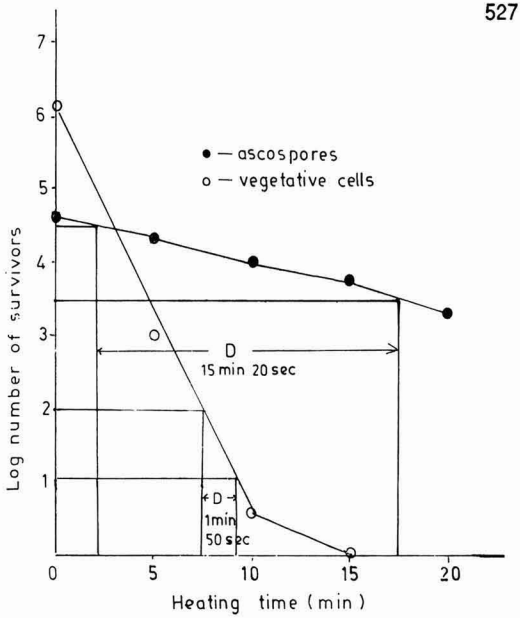

Fig. 1. Thermal death curves at 55°C of *S. bailii*. Initial number of ascospores 4.3 x 10^4/ml, vegetative cells 2.0x10^6/ml

Pitt and Hocking (1985) have reported that only five cells of *S. bailii* per can are sufficient to cause spoilage of the product, as evidenced by gas production. Central temperatures of 65-68°C are sufficient to kill most of the vegetative cells. However, Put and DeJong (1982a, b) have reported that this temperature is insufficient to kill ascospores, which are more heat-resistant. Relatively, little is known about the ascospores of *S. bisporus*. Put et al (1976) reported the survival of ascospores (5.0 x 10^4/ml) of *S. bisporus* after 10 min at 60°C.

To know the difference in heat resistance of the two cellular forms, heat resistance pattern of vegetative yeasts *vs* ascospores was studied and D_{55} values were calculated. Heating temperature of 55°C was selected, because vegetative cells of both the yeasts began to die at this temperature. D_{55} for ascospores of *S. bailii* was 15 min and 20 sec (Fig. 1), which was almost 8 times higher than that of vegetative cells (1 min 50 sec). Similarly, D_{55} values of *S. bisporus* ascospores were about 4 times higher (13 min 20 sec) than that of vegetative cells (Fig. 2). All the thermal death curves were logarithmic in nature, but a little tailing effect was observed in case of vegetative cells of *S. bailii*. This might be due to the clumping of cells. Put and DeJong (1982a) isolated *S. bailii* from spoiled processed soft drinks, soft drink raw material and canned, spoiled soft fruits in sugar syrup and reported D_{60} value of 10 min. D values, ranging from 10 to 22 min

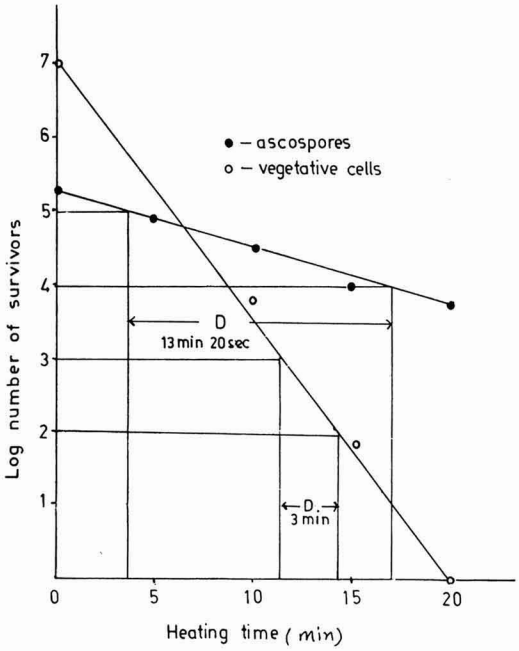

Fig. 2. Thermal death curves at 55°C of *S. bisporus*. Initial number of ascospores 1.9×10^5/ml, vegetative cells 9.2×10^6/ml

at 60°C, have been observed for the ascospores of *S. cerevisiae* (Splittstoesser et al. 1986). Filter sterilization is an effective technique for the removal of *S. bailii* and *S. bisporus*, but its use is limited to clear liquid products like cider and wine (Pitt and Hocking 1985). For products like ripe mango slices, the time or temperature of processing needs careful monitoring in order to avoid incidence of such yeasts.

Authors are thankful to the Director, CISH for providing the necessary facilities for conducting this study.

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Received 17 October 1995; revised 17 June 1997; accepted 23 June 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 529-531

Development of Soy-fortified Biscuits: II. Standardization of Fat and Sugar Levels

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Soy-fortified biscuits were compared with control biscuits for the effects of various levels of fat (20, 25, 30 and 35%) and sugar (28, 31, 34, 37, 40 and 43%), using the traditional creaming method. With increasing levels of fat and sugar in the formulation, attributes such as weight, diameter, spread ratio and percent spread factor of biscuits increased, whereas thickness and hardness of the product decreased irrespective of soy flour incorporation. The results of sensory evaluation revealed that the scores for texture and overall acceptability in control as well as in soy biscuits improved upto 30% fat level and thereafter decreased. However, the effects of increasing levels of sugar on the texture and overall acceptability scores increased upto 37% in control biscuits and thereafter decreased, whereas in soy biscuits improving effects were observed upto maximum level of sugar.

Keywords: Biscuits, Dafatted soy flour, Spread ratio, Spread factor, Hardness, Sensory evaluation.

Fat and sugar are essential components of most crackers, cookies and biscuits. The type and amount of fat in the formula affect both the machining response of the dough and the quality of the finished products (Matz 1968).

Sugar functions not only as a nutritive agent, but also as a texturizer, colouring agent and a means of controlling spread. Machining properties and response of the dough piece to oven conditions are also closely related to the type and quantity of sweetener employed (Matz 1968). The present study was undertaken to standardize the optimum levels of fat and sugar in the recipe of soy biscuits.

Soy biscuits containing 20% defatted soy flour were prepared using the traditional creaming method, described by Ranjana Singh et al (1996). For the standardization of recipe, different levels of fat (20, 25, 30, and 35%) and sugar (28, 31, 34, 37, 40 and 43%) were used to prepare biscuits. Biscuits, thus, prepared were analyzed for physical (diameter, thickness, spread ratio, percent spread factor and hardness) and sensory characteristics (appearance, colour, texture, flavour and overall acceptability), as described by Ranjana Singh et al (1996). Results were analyzed for statistical significance using the technique ANOVA (Snedecor and Cochran 1967). The levels of fat and sugar, which produced a product of good spread and best sensory characteristics were standardized in the formulation.

The proximate composition of control and soy biscuits has been given earlier (Ranjana Singh et al (1996).

The results on the effect of different levels of fat (20- 35%) and sugar (28 - 43%) on physical and sensory characteristics of biscuits are depicted in Tables 1 and 2. With increasing level of fat, the thickness of biscuits decreasd, whereas diameter, weight, spread ratio and percent spread factor of the product increased gradually, irrespective of soy flour incorporation in the formulation. The spread ratio of soy biscuits, containing different levels of fat differed significantly ($p<.01$) from one another. Increasing the fat level from 25 to 35% gave finer top grain, whereas decreasing the fat to 20% produced irregularly shaped biscuits with coarse grain top (Funney et al. 1950; Kissell et al. 1971; Tsen et al. 1973; El-Warraky et al. 1980; Abboud et al. 1985).

The result of effect of increasing level of sugar addition of physical characteristics of biscuits exhibited the same pattern as in case of fat (Table 2). A significant increase in spread ratio of control and soy biscuits was observed ($p<0.01$) with each increment of 3% sugar in formulation. Similar findings have been reported by Finney et al (1950), El-Warraky et al (1980), Abboud et al (1985) and Doescher et al (1987). Greater spread at higher sugar level was attributed to melting of sugar crystals, causing the spreading action (US Wheat Associates 1988).

Significant decrease in the hardness of control and soy biscuits was observed ($p<0.01$) with increasing level of fat and sugar in formulation (Tables 1 and 2). Sathe et al (1981) and Gupta (1988) reported that in case of fat increment, this was apparently due to mellowing action of fat on protein, which increased the spread and reduced

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TABLE 1. EFFECT OF DIFFERENT LEVELS OF FAT ON PHYSICAL AND SENSORY CHARACTERISTICS OF CONTROL AND SOY BISCUITS

Attributes	Level of fat, %			
	20	25	30	35
		Control biscuits		
Physical				
Weight,g	9.48[a]	9.68[a]	9.87[a]	9.89[a]
Thickness, T, mm	6.89[a]	6.81[a]	5.88[b]	5.25[c]
Diameter D, mm	61.70[a]	61.90[a]	63.50[b]	64.00[c]
Spread ratio*, D/T	8.96[a]	9.09[a]	10.80[b]	12.19[c]
% Spread factor	100.00[a]	101.45[a]	120.54[b]	136.05[c]
Hardness*, N	30.25[a]	26.83[b]	24.80[c]	22.60[d]
Sensory				
Appearance	7.6±0.77	8.0±0.82	8.2±0.79	8.1±0.81
Colour	8.0±0.55	8.2±0.63	8.1±0.73	8.0±0.89
Texture	6.5±0.58	7.1±0.64	8.2±0.55	7.2±0.63
Flavour	7.6±0.54	7.7±0.63	8.2±0.71	7.9±0.52
Overall acceptability*	6.6±1.11[a]	7.3±0.87[b]	8.3±0.46[c]	7.4±0.94[b]
		Soy biscuits		
Physical				
Weight, g	9.24[a]	9.26[a]	9.29[a]	9.85[b]
Thickness, T, mm	6.97[a]	6.55a[b]	6.12[b]	5.63[c]
Diameter D, mm	61.30[a]	62.70[b]	62.80[b]	64.00[c]
Spread ratio*, D/T	8.79[a]	9.53[b]	10.26[c]	11.19[d]
% Spread factor	100.00[a]	108.42[b]	116.72[c]	127.30[d]
Hardness*, N	34.21[a]	30.45[b]	28.40[c]	25.43[d]
Sensory				
Appearance	7.6±0.64	8.2±0.73	8.4±0.71	7.9±0.69
Colour	7.9±0.49	8.0±0.53	7.9±0.68	8.1±0.78
Texture	5.1±0.57	5.8±0.73	7.1±0.56	6.4±0.72
Flavour	6.8±0.82	6.9±0.38	7.1±0.65	6.9±0.64
Overall acceptability*	5.3±0.89[a]	5.7±0.64[a]	7.2±0.78[b]	6.4±0.80[c]

*Means followed by different letters in a row differ significantly at 5% level least significant difference

Spread ratio: 0.47; Hardness: 0.80; Overall acceptability: 0.50; Weight: 0.54; Thickness: 0.48; Diameter: 0.44; % sp. factor: 5.04

the hardness and compactness of biscuits. Higher level of sugar in a cookie recipe leads to shortness or tenderness, thereby reducing the hardness mainly due to its action in dispersing the flour gluten (U.S. Wheat Associates 1988).

The increasing level of fat in formulation did not help to improve the colour and flavour of either control or soy biscuits, but the appearance, texture and overall acceptability increased upto 30% level and thereafter at 35% level, these characteristics showed a decline (Table 1). It was attributed to higher concentration of fat (35%) in the formulation, which made the products too fragile, thus reducing their acceptability. On the basis of significantly higher ($p<0.01$) overall acceptability, 30% fat level was used in the formulation of control and soy biscuits.

There were marked increases in the texture scores of soy biscuits with increasing levels of sugar in formulation, whereas in control biscuits, the scores of texture increased upto 37% sugar level and thereafter decreased (Table 2). This was due to higher amount of sugar, which dispersed the proteins, thus producing a crisp product. The scores for appearance, flavour and overall acceptability of control and soy biscuits followed the same pattern, whereas those of colour did not vary much in biscuits with increasing levels of sugar. On the basis of maximum spread ratio and overall acceptability characteristics, 37% and 43% sugar levels have been found optinum, while standardizing conditions for the preparation of control and soy biscuits.

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TABLE 2. EFFECT OF DIFFERENT LEVELS OF SUGAR ON PHYSICAL AND SENSORY CHARACTERISTICS OF CONTROL AND SOY BISCUITS

Attributes	Level of sugar, %					
	28	31	34	37	40	45
			Control biscuits			
Physical						
Weight, g	9.27^{a}	9.28^{a}	9.31^{a}	9.32^{a}	9.32^{a}	9.34^{a}
Thickness, T, mm	5.81^{a}	5.76^{a}	5.48^{b}	5.43^{bc}	5.43^{bcd}	5.36^{d}
Diameter D, mm	65.80^{a}	65.90^{b}	70.10^{c}	70.60^{d}	71.50^{d}	72.00^{e}
Spread ratio, * D/T	11.32^{a}	11.43^{b}	12.80^{c}	13.14^{d}	13.27^{e}	3.42^{f}
% Spread factor	100.00^{a}	100.97^{b}	113.07^{c}	116.08^{d}	117.23^{e}	118.55^{f}
Hardness*, m N	25.12^{a}	24.40^{b}	23.23^{c}	22.50^{d}	20.71^{e}	18.32^{f}
Sensory						
Appearance	7.7±0.69	7.8±0.84	8.0±0.91	8.0±0.77	6.8±0.62	6.7±0.50
Colour	7.9±0.34	8.0±0.52	7.8±0.64	7.9±0.87	8.0±1.00	8.1±0.82
Texture	6.5±0.86	6.8±0.72	7.0±0.53	8.0±0.42	7.6±0.28	7.0±0.63
Flavour	7.2±0.18	7.5±0.98	8.0±0.43	8.1±0.38	7.8±0.54	7.4±0.88
Overall acceptability*	6.8±0.51^{a}	7.1±0.47^{a}	7.8±0.68^{b,c}	7.9±0.44^{c}	7.2±0.51^{a,b}	7.5±0.40^{a}
			Soy biscuits			
Physical						
Weight, g	9.18^{a}	9.43^{b}	9.52^{bc}	9.56^{c}	9.75^{d}	10.10^{e}
Thickness, T, mm	5.83^{a}	5.82^{a}	5.75^{b}	5.72^{b}	5.65^{c}	5.65^{c}
Diameter D, mm	62.30^{a}	64.80^{b}	64.90^{c}	65.70^{d}	66.50^{e}	70.30^{f}
Spread ratio*, D/T	10.68^{a}	11.13^{b}	11.28^{c}	11.48^{d}	11.76^{e}	12.44^{f}
% Spread factor	100.00^{a}	104.21^{b}	105.62^{c}	107.49^{d}	110.11^{e}	116.47^{f}
Hardness*, N	29.03^{a}	28.00^{b}	27.28^{c}	26.10^{d}	25.61^{e}	23.40^{f}
Sensory						
Appearance	7.9±0.83	6.8±0.68	8.0±0.55	7.9±0.77	8.1±0.64	8.1±0.29
Colour	7.8±0.67	7.8±0.82	7.7±0.77	7.6±0.58	7.7±0.37	7.8±0.46
Texture	5.0±0.90	5.2±0.88	6.3±0.62	6.4±0.77	7.2±0.54	7.3±0.22
Flavour	6.0±0.65	6.1±0.76	6.5±0.58	6.8±0.77	7.0±0.68	7.0±0.59
Overall acceptability*	5.6±0.96^{a}	5.7±1.23	6.3±0.95^{a,b}	6.8±1.23^{b,c}	7.2±0.56^{c}	7.4±0.59

Means followed by different letters in a row differ significantly at 5% level least significant difference

Spread ratio: 0.07; Hardness: 0.28; Overall acceptability: 0.85; Weight: 0.09; Diameter: 0.08; Thickness: 0.05; % sp. factor: 0.95

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Received 30 October 1995; revised 12 June 1997; accepted 24 June 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 532-533

A Rapid Test to Differentiate Hard Pressure Parboiled Rice from Other Parboiled Rices

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Consumers do not like pressure-parboiled rice produced under certain conditions. Since the colour of this rice and that produced after open-steaming the soaked paddy for longer duration or under adverse conditions look more or less alike, it is difficult to differentiate them as such or when mixed. To avoid this, a rapid test was developed to distinguish them. This test changed the translucent kernels of all parboiled rices other than those produced at high pressures to chalky white and the latter to transparent lumpy yellow gel. A similar observation was noticed in all the ten varieties used in this study.

Keywords: Pressure-parboiled rice, Normal parboiled rice, Rapid test for parboiled rice, Chalky white, Translucency, Lumpy yellow gel.

Rice samples produced from open-steamed paddy for longer duration or that from open-steamed paddy kept in a heap prior to drying or that from pressure-parboiled paddy look alike (yellowish brown). In general, the pressure-parboiled rice (Ppb) (Iengar et al. 1972), considering its longer cooking time and hard texture in the cooked kernel, is not liked by consumers (Ali and Bhattacharya 1982). Hence, a test for distinguishing Ppb from the customary open-steamed parboiled rice (OSpb) was developed (Pillaiyar et al. 1988). The applicability of this test to rices parboiled under different conditions are reported in this communication.

Ten varieties of 3-month old paddy representing super fine ('Adt 38', 'IR 50', 'IR 64' and 'White ponni'), fine ('Adt 36', 'IR 20') and bold (Adt 37', 'CR 1009', 'Co 37' and 'Tkm 9') (Dept of Food 1980) collected from the Tamil Nadu Rice Research Institute, Aduthurai were soaked by immersing in 85°C water in a vessel, covered with a cloth and left overnight in a cupboard (WS) (Bhattacharya and Indudhara Swamy 1967) and steamed at 0 kg/cm² (open-steaming-OS) for 10 to 30 min or under pressure. A portion of WS paddy, open-steamed for 20 min, was retained hot prior to drying. In another set, the raw paddy was soaked in water at room temperature (27°-32°C) for 10 or 120 min, water drained and subjected to different pressures (Table1). The above parboiled samples were air-dried in shade (27°-32°C), shelled in Satake Grain Testing Mill (Type THU, 35A Satake Engineering Co. Ltd., Japan) and milled in McGill miller No. 2 (McGill Inc, Houston TX, USA) to 5 ± 0.1% degree of bran removal. The parboiled rice produced at the Food Corporation of India, Thanjavur modern rice mill, adopting hot soaking (HS) at 65°C for 4 h and open-steaming for 20 min was also used in this test. Five whole milled rice kernels taken in a test tube (15 mm dia) were reacted with 1 ml of 5% KOH solution by keeping the test tube in a vigorously boiling water bath for 4 min. Just at the close of the period, excess alkali was discarded, the reacted kernels were transferred carefully to a glass plate with an aid of a thin wire and observed for the type of reaction.

In all the varieties used, the reaction was very severe in Ppb with the whole kernel becoming transparent lumpy yellow gel, whereas in OSpb samples, the kernels invariably became chalky

TABLE 1. REACTION OF DIFFERENT PARBOILED RICES IN 5% HOT KOH SOLUTION FOR 4 MIN

Conditions for Soaking	Steaming, kg/cm²-min	Number of kernels exhibiting Before treatment: Full translucency	Before treatment: Chalky white	After treatment: Yellow lumpy gel	After treatment: Chalky white
Raw rice	-	-	5	-	5
WS	0-10	5	-	-	5
WS	0-10	-	5	-	5
WS	0-30	5	-	-	5
WS	0-20+ heaped 60 min	5	-	-	5
WS	0.352-10	5	-	-	5
WS	0.703-10	5	-	-	5
RT-10 min	0-20+0.352-10+ 0.703-20+1.055-10	5	-	5	-
RT-10 min	-do-	-	5	-	5
RT-120 min	0-20+0.352-10+ 0.703-10	5	-	5	-
HS-4h#	0-20	5	-	-	5
HS-4h#	0-20	-	5	-	5

From FCI

Refer text for treatment details

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white (opaqueness) with a faint collar all round in spite of all kernels of Ppb and OSpb being fully translucent at the beginning of the reaction (Table 1). The rices produced from paddy held hot, that from modern rice mill and that after pressure-steaming upto 0.703 kg/cm^2 for 10 min also became chalky white (with a faint collar all round), though all these were translucent initially. Since the reaction was more or less identical in all types of parboiled rices produced from the varieties used in this study, details are not indicated. This indicates that though the above parboiled rices exhibited full transluceny, their starches did not undergo complete gelatinization. This is in good agreement with the observation of Priestley (1976) that 100% gelatinization in rice occurred, while steaming soaked paddy at 0.703 kg/cm^2 for 20 min, even though all parboiled rices exhibited full translucency. An X-ray diffraction study by Mahanta and Bhattacharya (1989) has indicated that except under fairly severe parboiling, the raw starch (opaqueness) did not disappear in normal parboiled rices. Other notable feature of this test has been that while the chalky centre of any pressure parboiled rice remained as such at the end of the reaction, the peripheral translucent portion became transparent lumpy yellow gel. But in the case of other rices, besides the existing chalky centre, the peripheral area, which otherwise was translucent also turned chalky and therefore this test clearly would help in distinguishing the above two classes of parboiled rices.

The financial support and supply of pressure-parboiled rice by the Food Corporation of India, New Delhi is gratefully acknowledged.

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Received 27 June 1995; revised 25 June 1997; accepted 26 June 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 534-536

Studies on Dehydration of Different Ber Cultivars for Making Ber *Chuharas*

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Fruits of four cultivars viz., 'Sanaur-2', 'Sanaur-3', 'Sanaur-4' and 'Nalagarh' were harvested at early ripe stage and were dried in a mechanical drier at 65 ± 2°C. After 31 h dehydration, 'Sanaur-3' and 'Nalagarh' were found to have maximum dry weight (26%), followed by 'Sanaur-2' (25%) and 'Sanaur-4' (23%), respectively. Organoleptically, all the varieties were acceptable on 6 months storage as ber *Chuharas*.

Keywords: Ber *chuharas*, Dehydration, Cultivars, Physico-chemical composition, Organoleptic quality.

The ber (*Zizyphus mauritiana* Lamk.) is an ancient and common fruit growing in wild, semi-wild and cultivated form throughout India (Pareek 1983). Now, it is getting great impetus as a commercial crop in the North Indian States of Punjab, Haryana and Rajasthan, because of its potential for high yields and excellent economic returns to the growers. India stands first with an area of 22,000 hectares under ber cultivation (Gupta and Kadam 1995). The peak season for harvesting ber in Punjab is mid-March to mid-April, being a slack season for other kind of fruits, ber sells readily at remunerative prices. Ber is eaten mostly fresh, but it can be processed into delicious products as well as dried forms for use in the off-season (Khurdiya 1980). Dried ber can be used in various products like *halwas, pinnies, laddoos*, ice creams, puddings, fruit chats and fruit salads. Fruit is easily digestible and acts as a mild laxative (Bal 1979).

The information about dehydration of various ber cultivars is limited. The present investigation, therefore, was undertaken to study the rate of dehydration of various ber cultivars in cabinet drier and their stability during storage as ber *chuharas*.

Fresh lots of (8-10 kg) ber varieties namely 'Sanaur-2', 'Sanaur-3' 'Sanaur-4' and 'Nalagarh' were procured from the New Orchard of Department of Horticulture, Punjab Agricultural University, Ludhiana during March, 1984. Lots of 4 kg were made from each of the variety and washed thoroughly under running water. All the samples were evenly placed on perforated trays, containing 0.7 kg/sq. ft load. These trays were kept in a cabinet drier at 65 ± 2°C to analyze the drying rate of these varieties after every one hour, till the moisture content of the samples reached about 14 to 18%. The dehydrated samples were packed in small lots of 100 g each in the double polythelene bags of 200 gauge thickness and kept at room temperature (10-32°C) for physico-chemical and organoleptic analysis.

Physico-chemical and organoleptic analysis: Weights of the fruit and stone were taken and percent edible portion was calculated. Fruit colour was noted with the help of Horticultural chart (Wilson 1938). Moisture, TSS, acidity, vitamin C, reducing and total sugars were analyzed as per methods described by Ranganna (1994). Ber varieties were analyzed organoleptically immediately after dehydration and during storage by a trained panel of 10 judges, using a 9-point Hedonic scale. Data were analyzed statistically on analysis of variance. Samples of dried ber were rehydrated and analyzed following the methods given by Ranganna 1994.

Physico-chemical composition: 'Nalagarh' was found to have maximum of edible portion (93.6%), whereas by weight 'Sanaur-2' is the heaviest (23.2 g/fruit) with lowest specific gravity. All the varieties were yellow in colour except 'Sanaur-4', which was found to have red patches on one side over the light yellow colour. 'Sanaur-4' contained highest moisture content (82.5%) among four cultivars. 'Sanaur-2' and 'Nalagarh' were found to have maximum TSS i.e., 19.4°B and 18.9°B. 'Sanaur-3' had more acid content (0.56%) than other cultivars. Ascorbic acid content ranged between 92.5 mg/100 g in 'Sanaur-4' and 123.1 mg/100 g in 'Nalagarh', (Table 1).

Rate of dehydration of ber varieties: During dehydration, the weight decreased 1 to 2% every h upto 8 h. The rate of dehydration increased to 3-5% upto 19 h and further decreased from 1 to 0.5% upto 31 h (Fig. 1). 'Sanaur-3' showed

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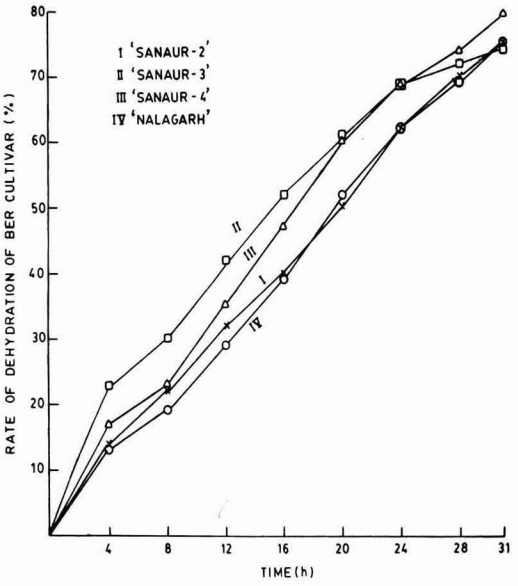

Fig. 1. Rate of dehydration of ber varieties

maximum rate of dehydration among all the cultivars.

Sensory evaluation and physico-chemical characteristics of dehydrated ber: Appearance-wise 'Sanaur-2' and 'Nalagarh' were found to have maximum scores (8) followed by 'Sanaur-3' (7.4) and 'Sanaur-4' (7.2), respectively (Table 2). In other characteristics like flavour and chewability, 'Sanaur-3' was rated the highest, having scored 8 and 8.4 by the judges. 'Sanaur-3' was preferred for flavour due to high acid and sugar contents. 'Nalagarh' was found more fleshy and sweet in taste. Overall sensory quality of dehydrated ber at zero time was: 'Sanaur-3' > 'Nalagarh' = 'Sanaur-2' > 'Sanaur-4', whereas during storage, 'Sanaur-3' and 'Nalagarh' were found at par followed by 'Sanaur-2' and 'Sanaur-4'. No significant difference was noticed in the quality of ber *chuharas* from different cultivars (Table 2). 'Sanaur-3' showed the highest moisture %, but the lowest rehydration ratio and co-efficient of rehydration. Total soluble solids were maximum

TABLE 1. PHYSICO-CHEMICAL CHARACTERISTICS OF FRESH BER* CULTIVARS

Cultivar	Edible portion, %	Fruit size, cm Length/breadth	Weight, g	Shape	Specific gravity	Moisture, %	TSS, %	Acidity, %	Vitamin C, mg/100g	Sugars, % Reducing	Sugars, % Total
'Sanaur-2'	91.6	4.48/3.12	23.2	Oval-oblong	0.97	81.6	19.4	0.44	117.8	4.4	11.5
'Sanaur-3'	88.2	3.9 /3.12	15.2	Beaked	0.98	80.7	16.0	0.56	108.3	3.6	6.9
'Sanaur-4'	91.6	4.24/2.95	18.0	Beaked	0.99	82.5	15.6	0.38	92.5	3.5	12.5
'Nalagarh'	93.6	3.63/2.97	17.4	Obovate	0.98	81.1	18.9	0.23	123.1	3.9	12.4

*Average of 20 fruits on fresh weight basis

TABLE 2. SENSORY CHARACTERISTICS OF DEHYDRATED BER FROM DIFFERENT CULTIVARS

Cultivar	Appearance		Flavour		Chewability		Overall acceptance	
	0	6	0	6	0	6	0	6
'Sanaur-2'	8.0	7.6	7.2	7.0	7.6	6.8	8.0	7.0
'Sanaur-3'	7.4	7.2	8.0	7.3	8.4	7.8	8.2	7.3
Sanaur-4'	7.2	7.0	7.0	6.7	7.4	6.8	7.0	6.6
'Nalagarh'	8.0	7.4	7.8	7.4	8.2	7.8	8.0	7.3
CD 5%	NS	ND	NS	ND	NS	ND	NS	ND

TABLE 3. PHYSICO-CHEMICAL CHARACTERISTICS* OF DEHYDRATED AND REHYDRATED BER CULTIVARS

Cultivar	Dehydrated ber		Rehydrated ber					
	Moisture, %	Colour	Moisture, %	TSS, °B	Rehydration ratio	Co-efficient of rehydration	Colour	Shrivellage
'Sanaur-2'	15.87	Golden brown	56.8	18.0	1:1.9	0.43	Light golden brown	Moderate
'Sanaur-3'	18.08	Brown	51.3	32.5	1:1.7	0.39	Redish brown	more
'Sanaur-4'	14.84	Golden brown	57.3	23.4	1:1.9	0.41	Light golden brown	minimum
'Nalagarh'	17.38	Dark brown	51.9	34.0	1:1.7	0.40	Light brown	more

*Average of 3 values

in 'Nalagarh' (34°B) and minimum in 'Sanaur-2' (18°B), (Table 3).

In conclusion, the ber varieties were found acceptable for making into *chuharas*, which can be produced on commercial as well as on domestic levels.

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Received 2 May 1995; revised 30 June 1997; accepted 2 July 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 537-539

Physical and Mechanical Properties of Tomato Fruits as Related to Pulping

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The physical properties like size, density, content of seed and pulp, moisture content of pulp and skin and the mechanical properties like cutting force and crushing strength were determined for 'PKM-I', 'Marutham', 'Pusarubi' and 'Phillippines' varieties of tomato fruits. The shape of the fruits can be regarded as oblate. The 'Marutham' variety was larger in size than the other varieties. The seed content was 44.2 % in 'PKM-I' variety and higher than the other varieties. The percent seed, pulp and skin content in the fruit varied with the variety. The cutting force required varied from 0.65 kg to 1.47 kg and crushing force from 1.25 kg to 5.6 kg, depending upon the axis of loading.

Keywords: Tomato, Physical properties, Pulping, Seed, Pulp, Size and Density, Cutting strength, Crushing strength.

Pulping of tomato fruits is an important unit operation in food industry for the extraction and production of both seed and pulp/juice. The extraction of seed from tomato fruits is presently carried out by manual pulping, which is time-consuming, cumbersome and unhygienic (Kachru and Sherief 1992). It often leads to injuries to the hands and feet of the workers. The use of pulpers for the seed extraction from fruits and vegetables is becoming popular now-a-days. Fridley and Adrian (1966) studied the stress-deformation behaviour of apples, peaches, pears and potatoes and concluded that maturity had an important effect on these properties. The sphericity of guava fruit was found as 0.92 (Wasiri and Mittal 1983). A study on the physical properties of tomato fruits is important to generate some essential engineering data for the development of the pulpers. The various properties of tomato fruits like, size, shape, density, seed-pulp ratio and cutting force for 4 different varieties have been determined and the results are reported in this communication.

Raw materials: Fully matured and ripened tomato fruits of 'Marutham', 'PKM-I', 'Pusarubi' and 'Phillippines' varieties, obtained from the University farm on the day of the experiments were used.

Size : The size of the fruits was determined using a dial type vernier caliper with a least count of 0.01 mm. The diameters were measured along the longitudinal and cross-sectional axis. Twenty five fruits from each variety were randomly selected for measurement and the mean value was reported. The diameters of the 4 varieties of tomato fruits measured along the longitudinal axis and cross section are presented in Table 1.

In all the varieties, the diameter along the cross-section is greater than the longitudinal diameter. The mean values for diameters ranged from 27.18 to 36.84 mm and 32.42 to 47.74 mm along longitudinal and cross section, respectively. As the fruits of all varieties studied were flattened at the stem end and apex, the diameter along this direction is less than the cross sectional diameter. This exhibits the shape of these varieties as oblate (Mohsenin 1980).

Density: The densities of the tomato fruits were determined by using the platform-scale method (Mohsenin 1980). The variation in the density inrespect of the varieties is given in Table 1. The densities varied from 0.94-0.99 g/cc with standard deviation of 0.12. The 'PKM-I' variety had the minimum density of 0.944 g/cc, while 'Marutham' and 'Pusarubi' had the maximum densities (0.995g/cc and 0.994g/cc) and the 'Phillippines' variety had the moderate density of 0.963 g/cc.

Seed-pulp-skin content: The individual weights of seed, pulp (juice) and skin present in the tomato fruits of these 4 varieties were determined by separating them manually. The mean of 10 samples was reported. Table 1 shows the percent content of seed and others (pulp and skin) in all the 4 varieties. The seed contents varied from 30.7 to 44.2% with the maximum content in the 'PKM-I' variety. The pulp and skin contents were the highest (69.3%) in the 'Phillippines' variety. The other two varieties 'Pusarubi' and 'Marutham' contained only 57.3 and 58.8% of pulp and skin, though these varieties had the densities nearing unity.

Moisture content: The moisture contents of the seed, pulp and the skin were determined by keeping

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TABLE 1. PHYSICAL AND MECHANICAL PROPERTIES OF TOMATO FRUITS

Properties	Varieties			
	'Marutham'	'PKM-I'	'Pusarubi'	'Phillippines'
Physical				
Diameter, mm				
longitudinal axis	36.84 (4.95)	32.75 (3.91)	27.18 (3.82)	26.65 (4.36)
cross section	47.74 (8.18)	38.95 (3.54)	37.18 (4.85)	32.42 (4.96)
Density, g/cc	0.995 (0.12)	0.944 (0.11)	0.994 (0.13)	0.963 (0.13)
Seed content, %	41.22	44.23	42.75	30.68
Pulp content, %	58.78	55.77	57.25	69.32
moisture content, % w.b.				
seed	92.65	90.17	91.89	93.47
pulp	64.32	59.64	54.70	53.61
Mechanical				
Cutting force, kg				
along longitudinal axis	0.63 (0.08)	0.89 (0.06)	0.96 (0.04)	0.73 (0.07)
along cross section	0.68 (0.04)	0.78 (0.15)	1.45 (0.11)	0.98 (0.16)
Crushing strength, kg				
along longitudinal axis	2.80 (0.32)	2.10 (0.43)	1.25 (0.28)	2.15 (0.38)
along cross section	3.15 (0.45)	5.60 (0.36)	2.70 (0.10)	3.10 (0.02)

The figures given in the parentheses are the standard deviation

the samples in a thermostatically controlled electric oven at 130 ± 1°C for one hour (AOAC 1976). The moisture contents of the seed and pulp (including skin) for these varieties are given in Table 1. The moisture contents of tomato seeds varied as 90.17 to 93.47% wb. Among the varieties, 'PKM-I', had the least moisture content (90.17% wb). The moisture contents of the pulp and skin varied from 53.61 to 64.32% wb.

Cutting force: The cutting force required to cut and split the tomato fruits into two halves was determined, using the apparatus shown in Fig. 1 In this apparatus, a knife made of 1.5 mm thick high carbon steel and sharpened to 45° bevel angle was hinged to a vertical frame. A loading pan was provided on the other end of the knife to apply dead weight. The fruit was placed on the base, below the knife. By adding incremental weight in the pan, which was suspended by a thread from the knife, cutting force was applied, till the fruit was cut into two halves. The dead weight added in the pan was taken as the cutting force in kg.

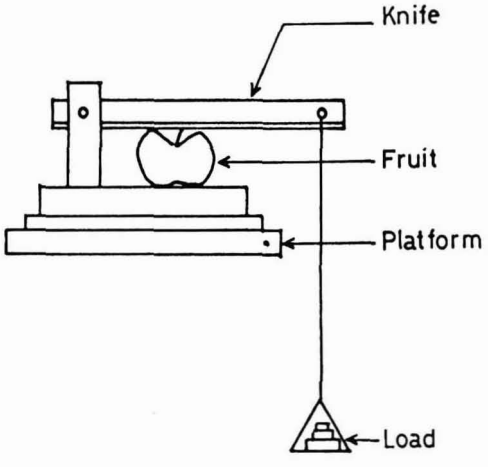

Fig. 1. Experimental set up for the determination of cutting force on tomato

The experiment was repeated with 10 new fruits and the mean values are reported with standard deviation. For these varieties, the cutting force (kg) varied from 0.68 to 0.96 and 0.68 to 1.45 along the longitudinal and cross-sectional directions respectively. Both along the longitudinal and cross-sectional directions, 'Pusarubi' variety exhibited the maximum cutting force (0.96 kg). 'Marutham' exhibited the minimum cutting force of 0.65 and 0.68 kg along the longitudinal and cross sectional directions, respectively.

Crushing strength: Crushing strength is the force required to crush the tomato fruit to take out the seed and pulp from the fruits. The crushing strength was determined for the tomato fruits by using a grain hardness meter. The loading was done using a 6 mm diameter flat type loading pointer by keeping the fruit between two pieces of metal plates placed parallel. Incremental load was applied to the fruit by lowering the loading pointer by rotating the hand wheel. The crushing strength in kg was noted from the dial as indicated by the

pointer. The crushing strength for four varieties of tomato fruits were determined by selecting 10 fruits in random from each variety. Measurements were carried out in the longitudinal and cross-sectional directions.

The 'Marutham' variety, which exhibited the least cutting force, had pronounced the highest force along longitudinal axis (2.8 kg) with a crushing force of 3.15 kg along the cross-sectional direction. The least force along the longitudinal axis of 1.25 kg was shown by 'Pusarubi' variety, which exhibited a maximum cutting force (0.96kg) among the varieties. Along the cross sectional direction, 'PKM-I' has shown the highest crushing force of 5.6 kg, followed by 'Marutham' (3.15 kg), 'Phillippines' (3.1 kg) and 'Pusarubi' (2.7 kg).

From the study it may be concluded that properties, viz., size, density, moisture and force varied with the variety of the tomato fruits. Among the varieties studied, 'Marutham' was large in size. The density was nearing to that of water for 'Marutham' and 'Pusarubi'. The variety 'PKM-I', contained more seed than the other varieties. The variety requiring least force for cutting, required a higher crushing force along the same axis of loading.

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Received 15 November 1995; revised 7 July 1997; accepted 8 July 1997

J. Food Sci. Technol., 1997, Vol. 34, No. 6, 540-542

Chemical Composition of *Potadoma freethi* and *Coclicella acuta*

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The proximate, antinutrient substances, mineral elements and amino acids composition of cooked *Potadoma freethi* and *Coclicella acuta* were determined. The moisture contents of the samples were 73.47 and 70.16, respectively. Crude proteins, crude fat, and ash contents were 36.33 and 56.40; 2.50 and 4.40; 11.27 and 9.86% of dry matter, respectively. Both samples were found to be rich in sodium, potassium, magnesium and calcium, while iron, manganese, zinc and copper were present in small quantities. Also, both samples were richer in most of the essential amino acids than hen's egg, the limiting amino acid being methionine with a chemical score of 71.9 in *P. freethi* and 52.0% in *C. acuta*.

Keywords: *Potadoma freethi*, *Coclicella acuta*, Chemical composition, Proximate composition, Mineral elements, Antinutrients, Amino acids.

It is becoming increasingly difficult to obtain adequate supply of proteins from traditional sources such as beef, pork, goat etc., because of economic recession. It has become imperative to explore alternative sources, which are cheap and readily available. In this context, *Littorina littorea* (Umoh and Bassir 1977), *Egreria radiata* (Ifon and Umoh 1987), *Thais cattifera* (Udoh et al. 1995a) and *Limicolaria aurora* (Udoh et al. 1995b) have been shown to be good supplements.

P. freethi is a species of perewinkle, which is found in smooth shells and is available in the creeks of the rain forest, extending from Akamkpa in the Cross River State of Nigeria upto Ghana along the West African coast. *C acuta* is a mollusc, which is found in moist places. They are available all the year round, but more commonly between April and August. Both animals are presently used as cheap protein sources only by a small population, perhaps due to lack of information on their nutritive value. This communication reports the chemical composition of *P. freethi* and *C. acuta* and highlights the need for their wider and increased usage.

Live samples of *P. freethi* were bought from the Watt market, Calabar, Cross River State of Nigeria, while *C. acuta* were picked from an open farm in Abak, Akwa Ibom State of Nigeria. The animals were thoroughly washed with distilled water before removal from the shell (after soaking in hot water in the case of *P. freethi*). The samples were fried to a constant weight (*C. acuta* after cooking) in an oven at 60°C. The dry samples were milled into fine powder for analysis.

The proximate composition was determined, using standard methods of AOAC (1980). Carbohydrate value was obtained by difference. The ash produced at 600°C from a known mass of the powder was dissolved in 6M HCl solution (AOAC 1980) and the resulting solution was made to a definite volume and used for the determination of mineral elements. Phosphorus was determined by the molybdovanadate colorimetric method (Vogel 1969). Sodium and potassium contents were determined with a flame photometer (Jenway PF 7, Essex, England), while those of other elements were determined, using an atomic absorption spectrophotometer (Unicam Analytical System, Model 919, Canbridge, UK). Amino acids were determined, using an automatic amino acid analyzer on the principles of Moore (1963) and Spackman et al (1958). Cystine and tryptophan were not determined. The procedure involves hydrolysis, which does not permit the determination of tryptophan. The chemical scores were calculated on the first limiting amino acid compared to reference pattern of amino acids (Paul et al. 1976). Total oxalates were determined by the method of Dye (1956) and hydrocyanic acid was determined by the alkaline titration method (AOAC 1980), while tannic acid was determined by the colorimetric method of Burns (1971). Except for amino acids, all analyses were done in triplicate and the mean values have been reported and bracketed by their standard deviation, SD. All chemicals were of analytical reagent grade and double distilled water was used.

Table 1 shows that the crude protein content (on dry weight basis) of *P. freethi* is lower than that of *C. acuta* and those reported for *T. cattifera*, 56, 440g/100g (Udoh et al. 1995a); *L. aurora*,

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TABLE 1. PROXIMATE, MINERAL, AMINO ACID ND ANTINUTRIENT COMPOSITION OF *P. FREETHII* AND *C. ACUTA*

Constituent	Content	
	P. freethi	*C. acuta*
Proximate values, g/100g dry matter		
Moisture (wet weight)	73.47±0.19	70.16±0.88
Crude fibre	nil	1.38±0.22
Crude proteins	36.33±2.30	56.40±0.62
Crude fat	2.50±0.30	4.40±0.24
Carbohydtrates	49.90±0.97	27.96±1.58
Calorific value, Kcal/100g	367.42	33.40±1.24
Ash	11.27±0.31	99.86±0.50
Minerals, mg/100g		
Sodium	111.66±4.46	196.00±0.08
Potassium	182.00±0.86	480.00±1.40
Magnesium	746.50±5.21	610.00±1.08
Calcium	3,825.00±1.15	960.00±0.11
Zinc	13.40±0.44	198.00±1.18
Iron	26.21±0.18	0.54±0.22
Manganese	15.89±0.56	1.52±0.03
Copper	13.28±0.34	2.60±0.05
Phosphorus	ND	560.00±0.70
Amino acids, g/16gN		
Isoleucine	5.8 (103.6)a	7.6 (136.0)a
Leucine	7.6 (91.6)	10.6 (120.0)
Lysine	8.1 (130.7)	7.8 (113.0)
Methionine	2.3 (71.9)	1.8 (52.0)
Phenylalanine	5.7 (111.8)	1.8 (56.0)
Tyrosine	5.8 (145.0)	6.2 (122.0)
Threonine	4.4 (110.8)	5.3 (133.0)
Valine	5.8 (77.8)	4.1 (80.0)
Arginine	8.1 (132.8)	0.7 (12.0)
Histidine	2.9 (120.8)	3.8 (158.0)
Alanine	6.1 (113.8)	6.7 (124.0)
Aspartic acid	10.4 (97.2)	7.5 (70.0)
Glutamic acid	15.8 (131.7)	14.8 (117.0)
Glycine	6.5 (216.7)	6.8 (227.0)
Proline	5.9 (155.3)	5.2 (137.0)
Serine	3.7 (46.8)	4.1 (52.0)
Antinutrients, mg/100g		
Total oxalates	ND	204.00±0.12
Hydrocyanic acid	16.20±1.53	399.00±0.08
Tannic acid	40.0±0.07	399.00±0.24

Figures in parentheses indicate anino acid score as compared with whole hen's egg. a: Paul et al (1976) ND: not determined.

51.40g/100g (Udoh et al. 1995b); *Vivapara guadrata*, 63.36 g/100g, *Paramonetes varians*, 69.70 g/100g; *Pachymelana byronensis*, 55.03 g/100g (Mba 1980); *E. radiata*, 61.00 g/100g (Ifon and Umoh 1987) and whole hen's egg, 50.00 g/100g (Paul et al. 1976). *C. Acuta* however, has protein content, which compares well with the above alternatives. Both these animals can contribute significantly to the recommended human daily protein requirement of 23-56 g (NRC 1974).

C. acuta has low fibre content (on dry basis) and this compares well to that reported for *P. varians*, 4.72 g/100g (Mba 1980), but is higher than those reported for *V. quadrata*, 0.14 g/100g, *P. byronensis*, 0.21 g/100g and smoked fish, 0.21 g/100g (Mba 1980). The absence or low dietary fibre in foods is associated with colon diseases (Robson 1972), while high contents reduce the rates of glucose and fat absorption (Mottram 1979).

P. freethi and *C. acuta* have crude fat contents that favourably compare with reported values for *V. quadrata*, 2.68 g/100g and *P. byronensis*, 1.37 g/100g (Mba 1980). The carbohydrate and calorific values of *P. freethi* are higher than those of *C. acuta*, although in the case of the latter, the values compare well with that reported for *L. aurora* (Udoh et al. 1995b). The ash content is a reflection of the amount of minerals in the sample. The ash contents (on dry basis) of both *P. freethi* and *C. acuta* compare well with those reported for *P. varians*, 11.79 g/100g (Mba 1980,; *T. cattifera*, 12.60 g/100g (Udoh et al. 1995a) and *L. aurora*, 11.76 g/100g (Udoh et al. 1995b), but higher than values reported for *V. quadrata*, 8.43 g/100g, *P. byronensis*, 4.68 g/100g and *P. varians*, 4.68 g/100g (Mba 1980).

The mineral composition indicates that the animals are rich in sodium, potassium, calcium and magnesium and in the case of *C. acuta*, zinc. The values are higher than those reported for *L. littorea* (Umoh and Bassir 1977), *V. quadrata*, *P. byronensis*, *P. varians* (Mba 1980) and *E. radiata* (Ifon and Umoh 1987), although the values for *C. acuta* are lower than the ones reported for *L. aurora* (Udoh et al. 1995b). Both animals can act as good sources of mineral elements, if properly collected and processed. The heavy metals nickel, chromium, cobalt and lead were not detected.

The amino acid patterns of *P. freethi* and *C. acuta* on comparison with that of hen's egg (Paul et al. 1976) showed that both contain all the amino acids naturally present in proteins. Their amino acid contents compare well with the values reported for *E. cattifera* (Udoh et al. 1995a) and *L. aurora* (Udoh et al. 1995b). For both animals, the most limiting essential amino acid was methionine having a chemical score of 71.9 and 52.0 for *P. freethi* and *C. acuta*, respectively. The levels of the other essential amino acids are higher than in the egg and for *P. freethi*, the chemical score is not too low.

Both animals are rich in lysine, which is the most limiting in a predominantly cereal diet common in Nigeria. Hence, both can contribute significantly to the protein quality of a diet.

C. acuta has higher antinutrient contents than *P. freethi.* However, *C. acuta* has lower total oxalate content than *T. cattifera*, 1686.07 ± 0.05 g/100g (Udoh et al. 1995a) and *L. aurora*, 381.00 ± 0.06 g/100g (Udoh et al. 1995b). Also, the hydrocyanic acid and tannic acid contents of *C. acuta* are lower than those of *L. aurora*, 112.00 ± 0.15 and 592.00 ± 0.12 mg/100g, respectively (Udoh et al. 1995b). Soluble oxalates are known to precipitate calcium salts. Although tannins have adverse effect on the protein value of plant foods (Ford and Hewitt 1979), some therapeutic effects of tannins have also been reported (Ekabua and Eka 1978). Further, although the values of some of these antinutrients in *C. acura* are high, no health effects have yet been reported. Therefore, consumption in adequate quantities would help alleviate nutrient deficiency now prevalent in Nigeria and other developing countries to a great extent.

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Received 18 October 1995; revised 25 July 1997; accepted 28 July 1997

COMPUTERIZED CONTROL SYSTEMS IN THE FOOD INDUSTRY - Food Science and Technology Series/78, Edited by Gauri S. Mittal, Published by Marcel Dekker Inc., 270, Madison Avenue, New York, pp 616, 1997, Price $ 195

The availability of powerful, reliable and low cost computers and developments in sensor, process control and communication technologies, have made computer-based process control essential and more attractive for quality control and to increase productivity, efficiency and profitability. The basic concepts, application techniques and advances in computerized control systems in food industry to derive these benefits form the subject matter of the book on "Computerised control systems in the food industry", edited by Gouri S. Mittal. The book is divided into 4 parts, containing 20 chapters contributed by leading experts in the field. The book covers the fundamentals and advances in computerized automation and process control, process modelling, sensors, instruments, control of critical unit operations and applications in a few process food industries. Part I introduces the subject, discusses the issues involved, instrumentation process modelling and simulation. Part II includes basics of fuzzy controls and image processing. Computerized control in unit operations and food manufacturing are the subject matter of parts III and IV, respectively.

Chapter 1 introduces the subject of process control in food industries, describes the needs, limitations, problems, possible solutions and its future. Chapter 2 describes the various sensors, including biosensors and special sensors used and hardware and software required. Chapter 3 describes modelling and simulation of food processes required for reliable prediction of process behaviour and on-line optimization. Knowledge-based data driven and behaviour-based modelling and simulation methods, followed by identification and estimation of parameters are described. Chapter 4 describes the basics of process controls, different types of controllers, tuning of controllers, digital control implementation and multivariable controls. Chapter 5 presents basic of fuzzy logic and neural network in process control and implementation of neuro fuzzy technology in process model, controls, sensors and pattern classification. In chapter 6, these concepts are further developed and specific applications of fuzzy control to drying and fermentation processes are discussed. Machine vision systems including digital image processing, image analysis and feature extraction are described in chapter 7. The application of image processing in raw material, processed food and packaging inspection in food industries are included.

Chapters 8-14 describe applications of computers in important unit operations. Chapter 8 discusses the control of fermentation processes. Sensors, on-line measurement techniques, automatic monitoring and control of bioreactors and process modelling are included and applications in alcoholic fermentation, fermented milk and dairy products and production of bakers yeast and vinegar are presented. Chpater 9 details the applications of computerized control of thermal processing. Feed forward control of bacterial inactivation, feedback control of retort temperature, prediction of temperature of food and cumulative lethality are included. Chapter 10 on "Automatic control of drying processes", presents different control strategies including predictive control models. Control of food freezing operations is presented in chapter 11. After introducing the nature of the freezing operation and thermo-physical properties required, methods for estimating freezing time, different freezing equipments are described.

Chapter 12 describes models for effective control of separation processes. Widely used separation operations such as filtration, leaching/ extraction and membrane process models are presented so that these may be integrated with the control equipment. Chapter 13 on "Computerized automation of food warehouse", describes the information required and computer use in warehouse management systems, automated material handling, warehouse design and distribution optimization along with system architecture and applications. Chapter 14 deals with computer-based control systems in food packaging. Metal detectors, checkweighers, machine vision, leak testing equipment, PLCs and microprocessors are described.

Chapter 15 - 20, included in part IV, describe automation and computerized control systems in major food industries. Computerized controls in dairy processing giving details of essential elements of a dairy processing plant, process controllers and control of other dairy products such as yoghurt, cheese and condensed milk are described in chapter 15. Automation and control of meat processing is the subject matter of chapter 16. Slaughter and dressing technologies for bovines, ovines and porcines, computer simulation of slaughter floor,

carcass classification, inspection and grading and refrigeration are presented. Computerized process control in industrial cooking operations is described in chapter 17. Development in computerized control systems, on-line systems including flexible manufacturing systems, food plant automation and off-line systems dealing with process simulators, quality control and planning are discussed. Chapter 18 presents, computerized process control for the bakery and cereal industries. Sensors for oven control and control of baking ovens are described. Chapter 19 describes controls in fish harvesting and fish processing. Integrated manufacturing in the food industry is presented in chapter 20. Basic concepts of data and knowledge bases, computer-aided design techniques, product planning and control and computer-aided manufacturing systems, implementation issues and applications of CIM in food industries are presented in this chapter.

The book is amply illustrated with a number of diagrams, photographs, flow diagrams and tables, which make the subject matter easy to understand. The book is useful as an important source of information for food processors, process control, instrumentation, agricultural and food engineers to understand, select appropriate tools, instruments and control strategies. The publication will be of great use to all concerned with computer control of processes and operations in food and fermentation industries.

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EVALUATION OF CERTAIN VETERINARY DRUG RESIDUES IN FOOD - Forty-fifth Report of the Joint FAO/WHO Expert Committee on Food Additives, Technical Report Series Nr. 864, 1996, vi + 60 pages, WHO Publication, Geneva, Price Sw. fr 12/-(developed countries), Sw. fr 8.40/- (developing countries)

Veterinary drugs used in food animals promote their health and productivity. However, the drug residues in muscle and milk may cause health risk for human consumers of these products. As a result of the recommendations of the first joint FAO/WHO conference on "Food additives" held in 1955 (FAO Nutrition Meeting Report Series, Nr. 11, 1956; WHO Technical Report Series, Nr. 107, 1956), there have been 44 previous meetings of the joint FAO/WHO Expert Committee on "Food additives". The purpose of the 45th meeting of the committee was to provide guidance to FAO and WHO member States and to the Codex Alimentarius Commission on public health issues, pertaining to residues of veterinary drugs in foods of animal origin. The specific tasks before the committee were:

- to elaborate principles of evaluating the safety of residues of veterinary drugs in food and for establishing Acceptable Daily Intakes (ADIs) and Maximum Residue Limits (MRLs) for drug residues, when such drugs are administered to food producing animals.
- To evaluate the safety of residues of certain veterinary drugs.

The committee consisting of 18 expert members drawn from 13 countries held its 45th meeting in Geneva during 6-15 June 1995 and this book presents the deliberations and recommendations of the committee for 3 types of veterinary drugs, including six antihelminthic agents (abamectin, doramectin, moxidectin, febantel, fenbendazole and oxfenbendazole), four antimicrobial agents (ceftiofur, chlortetracycline, tetracycline and oxytetracycline) and one antiprotozoal agent (diclazuril).

Of the total 11 drugs, the committee reviewed 5 new drugs (abamectin, doramectin, moxidectin, ceftiofur and diclazuril) for the first time. Further toxicological and other information provided by the sponsors for the remaining 6 drugs were also reviewed by this committee. The committee evaluated rigorously the toxicological, metabolism, pharmacokinetic and residue data made available for these drugs as also the analytical methodologies such as gas chromatography, HPLC, radio-labelled drug residues etc., used to monitor the drug residues, inter-laboratory validation of methodologies, sampling procedures, detection limits etc. No - observed - effect levels (NOEL), LD_{50} values, and Minimum Inhibitary Concentration (MIC) data provided were also reviewed by the committee. In calculating ADI, based on antimicrobial activity, the committee used the formula developed at its 38th meeting, which is reproduced on page 28 of this book. On the basis of such a detailed and in-depth review, the committee recommended ADI and MRL for each drug administered either through feed, water or intramuscular/subcutaneous injections.

The following interesting points may be noted:

- Abamectin is a fermentation product of *Streptomyces avermitilis*. It is used both as a pesticide and as an antihelminthic drug in animals.

- Biotransformation of abamectin and doramectin follows a similar metabolic pathway due to close structural similarities between the compounds.
- Ceftiofur exhibits antibiotic activity against both Gram positive and Gram negative bacteria, including ß-lactamase-producing bacterial strains. It is used in the treatment of respiratory injection in cattle and pigs.
- Oxytetracycline can be given to prawns through formulated medicated diet to control variety of Gram negative bacterial infections with a temporary MRL of 100 mg/kg edible tissue. Microbiological assays for quantification of oxytetracycline were not recommended by the committee, because the detection limit in prawns of 1 mg/kg is not adequate for residue analysis.

Apart from the above, several other critical factors in assessing the safety of drugs are discussed lucidly. Annexure 1 lists the reports and other documents (118 numbers), resulting from previous meetings of Joint FAO/WHO Expert Committee on food additives. The recommended ADI and MRL values for the 11 drugs reviewed by this committee are listed in Annexure 2 for ready reference. During the course of the review of the experimental evidences, the present committee felt the need for further toxicological studies and other information on certain drugs and these are listed in Annexure 3. The committee intends to review these data on antimicrobial agents in 1996 and on antihelminthic and antiprotozoal agents in 1998. Also, listed are the WHO Technical Report Series Nrs. 819-863 published during 1992-1996 and other selected WHO publications (9 numbers) of related interest.

The book is a very valuable guide for all those working on veterinary drugs, food safety, public health issues and regulatory agencies and the information provided is very useful for better understanding for the production of safe muscle foods. This facilitates the harmonisation of international trade in animal products.

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AFST (I) ANNOUNCEMENT

ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS (INDIA)

Central Food Technological Research Institute Campus, Mysore - 570 013, India.

Invites Nominations for Fellows of AFST (I) for the year 1997

The Association has pleasure in inviting nominations from persons to be conferred as "Fellow of Association of Food Scientists and Technologists (India)" (FAFST) to honour those who have contributed significantly to the progress of Food Science and Technology.

General

1. The awardee will be called as Fellow of Association of Food Scientists and Technologists (India) and in an abbreviated form as FAFST.
2. The total number of Fellows of the Association will not exceed 5% of the total membership, including regular and life members of the Association, in any given year or 100, whichever is lower.
3. The title of Fellow has so far been awarded to 36 AFST(I) members and 6 non-members who have contributed to the progress of Food Science and Technology.

Eligibility

1. The aim is to honour persons of outstanding merit who have contributed significantly in the field of Food Science and Technology including R & D, Product/Project Development, Industry, Transfer of Technology and Marketing. The merit of contribution should be the main criterion.
2. Among the Fellows to be nominated every year, 70% will be from AFST(I) and remaining 30% may be from non-members who have contributed significantly for the development of Food Science and Technology.

Nominations

1. The nomination for Fellow should be proposed by 5 AFST(I) members of good standing for a minimum of 5 years or by 2 Fellows of the Association. This is applicable to AFST(I) members as well as non-members.
2. Any regular or life member of AFST(I), who has been continuously a member of the Association can sponsor the nomination for only one Fellow in a particular year.
3. The nomination shall be accompanied by acceptance of the person proposed.
4. The nomination shall be in the format given on the following page. A brief bio-data of the nominee, highlighting the Scientific or Technological achievements in the area of Food Science and Technology, supported by a list of publications not exceeding 10 important research papers or other supporting documents not **exceeding 20 pages,** must accompany the nominations.
5. Central Executive Committee Members of AFST(I) are not eligible to be nominated as Fellows.
6. The nomination duly proposed and agreed by the nominee shall be sent to the Hon. Executive Secretary, AFST(I) by **31st March 1998.**

Selection of Fellows

The nominations received will be placed before an Expert Committee, appointed by the CEC for suitable recommendations to CEC each year. CEC by majority decision will finalise the names of Fellows for each year. **The decision of CEC in this matter will be final.**

Privilege of a Fellow

The Fellow shall be entitled to the following rights:

1. The awardee will be entitled to add FAFST after his/her name as short title.
2. To be present and vote at all general body meetings.
3. To propose and recommend the candidates for Fellow of the Association.
4. To receive *gratis* copies of one of the publications of AFST(I).
5. To fill any office of AFST(I) duly elected.
6. To be nominated to any committee of AFST(I).
7. To offer papers and communications to be presented before the meeting of the Association.
8. The title will remain for life time of the member.

Cessation of Fellow

1. Any Fellow may withdraw his/her title of the Association by signifying his/her wish to do so by a letter addressed to the Hon. Executive Secretary, AFST(I), which will be placed before the CEC for acceptance.
2. If the Association comes to know of any activity prejudicial to the interest and well being of the Association, the CEC will have the right to withdraw the title.

Conferring as Fellows

The Fellow will be conferred with a Citation at the time of AGBM or at any other suitable function of the Association.

The Association may invite some Fellows, nominated each year, to deliver special lectures in the area of their specialization either at the AGBM or any other function arranged by the AFST(I).

Please forward your nominations duly filled as per the format given on the following page and mail it by Registered Post to the Hon. Executive Secretary, AFST(I), CFTRI Campus, Mysore-570 013, before **31st March 1998.**

The envelope containing the nomination along with the bio-data and contributions (6 copies) should be superscribed 'Nomination for Fellow AFST(I)'.

RAJESH S. MATCHE
HON. EXECUTIVE SECRETARY

ASSSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS (INDIA) CFTRI CAMPUS, MYSORE - 570 013

Nomination Form For Fellows

We, the following members of AFST(I) wish to propose

Full name and academic distinction

FULL NAME

DATE OF BIRTH

AREAS OF SPECIALIZATION

ACADEMIC QUALIFICATIONS

---

for election as the Fellow of AFST(I). We append below the statement of his/her claims for election as Fellow and certify that in our opinion he/she is fully qualified for that distinction. We also certify that he/she has been informed of the obligations attached to the fellowship of the AFST(I) and is agreeable to abide by them, if elected.

Statement of the proposer (not to exceed 100 words) setting out the discovery, invention or other contribution to newer or processes/products or the industrial development of the knowledge made by the nominee.

.....

Seconder's name & signature

Date :

Station :

Proposer's name & signature

Date :

Station :

(Signature of supporters from their personal/general knowledge)

(1)

(2)

(3)

I agree for the above nomination

(Name & Signature)

.....

Note : (1) Six copies of the candidate's bio-data and list of important scientific publications not exceeding 10 pages and one set of reprints or supporting documents not exceeding 20 pages shall be attached to this form.

(2) Additional information that would be of assistance in considering the nomination may be supplied on separate sheet.

(3) Last date for receipt of nomination at the office is **31st March 1998.**

ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS (INDIA) CFTRI CAMPUS, MYSORE - 570 013, INDIA

Nominations for AFST (I) Awards for 1997

Nominations for the following awards of the AFST(I) for the year 1996 are invited. All nominations should be sent by Registered Post, so as to reach Honorary Executive Secretary, Association of Food Scientists and Technologists (India), CFTRI Campus, Mysore-570 013, **before 31st March 1998.**

PROF. V. SUBRAHMANYAN INDUSTRIAL ACHIEVEMENT AWARD

The guidelines for the award are :

(i) Only Indian nationals with outstanding achievement in the field of Food Science and Technology will be considered for the award.

(ii) The nominee should have contributed significantly to the enrichment of Food Science and Technology and the development of agro-based food and allied industries in India.

(iii) The nominations duly proposed by a member of the Association must be accompanied by the bio-data of the nominee, highlighting the work done by him/her for which he/she is to be considered for the award.

(iv) The awardee will be selected by an expert panel constituted by the Central Executive Committee of the Association.

(v) Central Executive Committee Members of AFST(I) are not eligible to apply for the award during their tenure.

The envelope containing the nominations, along with bio-data and contributions (six copies) should be superscribed **"Nominations for Prof. V. Subrahmanyan Industrial Achievement Award-1997".**

LALJEE GODHOO SMARAK NIDHI AWARD

The guidelines for the award are :

(i) The R & D group/person eligible for the award should have contributed significantly in the area of Food Science and Technology in recent years, with a good standing in his/her field of specialization.

(ii) The nominee(s) should be duly sponsored by the Head of the respective Scientific Institution and the application for this award should highlight complete details of the contributions made by the nominees and their significance.

(iii) The nomination duly proposed by a Member of the Association must be accompanied by the bio-data of the nominee.

(iv) Central Executive Committee Members of AFST(I) are not eligible to apply for the award during their tenure.

The envelope containing the nominations along with bio-data and contributions (six copies) should be superscribed **"Nominations for Laljee Godhoo Smarak Nidhi Award 1997".**

BEST STUDENT AWARD

The award is to be given to a student having a distinguished academic record and undergoing the final year course in Food Science and Technology in any recognised University in India. The aim of the award is to recognize the best talent in the field and to encourage excellence amongst the student community.

The guidelines for the award are :

(i) The applicant must be an Indian national.

(ii) He/she must be a student of one of the following courses:

(a) M.Sc. (Food Sciences/Food Technology).

(b) B.Tech., B.Sc. (Tech), B.Sc. (Chem. Tech) with Food Technology specialization.

(iii) He/she should not have completed 25 years of age on 31st December 1997.

Heads of the Department of Food and Science and Technology in various Universities may sponsor the name of one student from each institution, supported by the candidate's bio-data, details starting from high school onwards, including date of birth and post-graduate performance to date (six copies).

The envelope containing the nomination should be superscribed **"Nomination for Best Student Award 1997".**

YOUNG SCIENTIST AWARD

The award is aimed at stimulating distinguished scientific and technological research in the field of Food Science and Technology amongst young scientists in their early life.

The guidelines for the award are :

(i) The candidate should be an Indian national below the age of 35 years on 31st December, 1997, working in the area of Food Science and Technology.

(ii) The candidate should furnish evidence of either.

(a) Original scientific research of high quality, primarily by way of published research papers and (especially if the papers are under joint authorship) the candidate's own contribution to the work.

OR

(b) Technological contributions of a high order, as reflected by accomplishments in process design etc., substantiated with documentary evidence.

The application along with details of contributions and boi-data (six copies) may be sent by registered post with the envelope superscribed **"Nomination for Young Scientist Award 1997".**

BEST PAPER AWARD AND BEST FEATURE ARTICLE AWARD

These awards are to be given by the AFST(I) Educational and Publication Trust to the author(s), who have contributed the best paper to the *Journal of Food Science and Technology* and best feature article to *Indian Food Industry* published in 1997. A panel of experts, constituted by the Central Executive Committee will scrutinize the issues and select the best paper/feature article for the award.

RAJESH S. MATCHE
HON. EXECUTIVE SECRETARY

ICFoST-97 AND ANNUAL GENERAL BODY MEETING 1997

The Association of Food Scientists and Technologists (India), Mumbai Chapter organised the Indian Convention of Food Scientists and Technologists (ICFoST-97) jointly with the Food Technology Division, Bhabha Atomic Research Centre (BARC), Mumbai during September 25-26, 1997 at the Multipurpose Hall, BARC Guest House, Anusakthinagar, Mumbai-400 094. The focal theme of the Convention was "Emerging Trends in Indian Food Industry in the 21st Century".

INAUGURAL SESSION

It was held under the Presidentship of Mr. Anil Kakodkar, Director, BARC. Over 500 delegates participated in the Convention. Dr. H.R. Adhikari Vice-President, (Mumbai Chapter) welcomed the delegates. Dr. C.L. Nagarsekar, President, AFST(I) briefed the delegates on the theme of the ICFoST-97.

The function was inaugurated by Dr. V. Prakash, Director, CFTRI, Mysore. Mr. Ramesh Chauhan, Chairman, Parle Exports was the Chief Guest and he gave away the various awards and conferred the title "FELLOW" AFST on 4 distinguished persons.

AFST(I) AWARDS

The main event of the inaugural session was the presentation of AFST(I) Annual Awards by the Chief Guest, Mr. Ramesh Chauhan. Dr. M.S. Krishnaprakash, Hon. Secretary, AFST(I) briefed the distinguished gathering about the various awards instituted by AFST(I) and read the citation of the recipients. The following 4 distinguished persons were conferred the title "FELLOW" AFST on this occasion. i) Dr. G.A. Ravishankar, Head, Plant Cell Biotechnology CFTRI, Mysore: ii) Dr. J.S. Pai, UDCT, Mumbai; iii) Dr. B.K. Mital, G.B. Pant University of Agriculture and Technology, Pantnagar and iv) Dr. Rugmini Sankaran, Former Director DFRL, Mysore.

The following persons received the various awards of AFST(I) for the year 1996.

1. Prof. V. Subrahmanyan Industrial Achievement Award

Dr. M. Mahadeviah, Head, Food Packaging Department, CFTRI, Mysore.

2. Laljee Godhoo Smarak Nidhi Award

Dr. (Mrs.) Indirani Karunasagar, College of Fisheries, Mangalore.

3. Young Scientist Award

Dr. Sudhakar Johnson, Dabur Research Foundation, Ghaziabad, Haryana.

4. Best Student Award

Mr. Jagadeep Singh Marahar, CFTRI, Mysore.

5. Best Paper Award

Journal of Food Science and Technology– 1996

A research paper entitled *"In vitro* Interaction of Groundnut Proteins with Aflatoxin B_1" published in the *Journal of Food Science and Technology* Vol. 33, No. 1, 27-31 by Dr. P. Vincent Monteiro, Dr. K. Sudhindra Rao and Dr. V. Prakash was adjudged the Best Paper.

6. Best Feature Article Award

Indian Food Industry–1996

The best feature article award instituted by the AFST(I) from the year 1996 was won by Dr. Raghunandan, Dr. P. Purkayastha and Dr. Vinay Dharmadhikari for their article entitled "Application of Electronics and Computers for Small Scale Food Processing Industry" published in *Indian Food Industry* Vol. 15, No. 1. pp 18-28.

Technical Sessions

There were 6 sessions. The Technical Session I on "Emerging Trends in Indian Food Industry in the 21st Century" was chaired by Prof. D.V. Rege, Ex-Director, UDCT, Mumbai. Dr. D.H. Pai Panandikar spoke on "Emerging Trends in Indian Food Industry, while Dr. S.S. Arya, Director, DFRL, Mysore presented a paper on "Traditional Foods-Emerging Trends"

The Technical Session II on "Marketing Strategies" was held under the Chairmanship of Mr. Ashish Mitra, Managing Director, ITC Agro-Tech. Ltd. The first speaker was Mr. Jagdeep Kapoor on the topic "Marketing of Food Products to Indian World Class Customers" followed by Mr. Rama Bijapurkar, Marketing Consultant who spoke on "Marketing Strategies".

The Technical Session III on "Impact of Globalisation of Food Industry" was chaired by

Mr. R.K. Bansal, Director, FPO, Ministry of Food Industries, New Delhi. There were 3 papers in this session. Ms. Ireena Vittal, McKinley & Co. Inc., presented a paper on "FAIDA-Modemising the Food Chain". Mr. Shrikant Gupta, Marico Industries, presented a paper on "Impact of Globalisation - Perspective of Indian Food Industry", while Mr. F.J. Dastoor, Chairman, Acumun Management Services spoke on "Challenges and Opportunities in the Food Industry Over the Next 10 years".

The Technical Session IV on "Food Laws" was held on September 26, 1997, under the Chairmanship of Prof. J.S. Pai, UDCT, Mumbai. There were 3 main speakers. Mrs. Debi Mukherjee, Asst. Director General, PFA, spoke on "Food Safety and Food Quality Control in India". Dr. A.S. Aiyar, Director, Centre for Processed Foods, Bangalore dealt with "Impact of Legal, Technical, Economic and Societal Factors on Food safety" and Dr. Huaying Zhang, Coca-Cola Ltd., presented paper on "Risk Assessment and Food Safety Control".

The Technical Session V was on "New Technologies/New Ingredients". The first part dealt with "Food Irradiation". It was chaired by Dr. P.C. Kesavan, Director, Bio-Sciences Group, BARC, Mumbai. Two speakers presented their papers. Dr. Paul Thomas, Head, Food Technology Division, BARC, spoke on "Food Irradiation - a Technology for 21st century" and Dr. V.K. Iya, Former Director, Isotope Group, BARC dealt with "Radiation Technology - the Emerging Science". The second part was on "Functional Food Ingredients". This was conducted under the Chairmanship of Dr. V.H. Potty, Chairman, Diversified Food Technologies (India), Mysore. There were 4 speakers. Mr. Abbott Chong, FMC read a paper on "Development of Texture in Foods - Scope of Additives". Mr. V.P. Iyer, Bums Phillips India Ltd., spoke on "Additives for Bread", Dr. Charley Ponti, Global Food Innovation, Switzerland spoke on "Micromilled Soya Powder - a Functional Food". Mr. Ketan Trivedi presented a paper on "Balancing the Indianisation and Globalisation of Functional Food Ingredients".

The session VI was "Panel Discussion", which was chaired by Dr. C.L. Nagarsekar, President, AFST(I). The sessions ended with a valedictory function.

General Body Meeting

The Annual General Body Meeting of AFST(I) was held on 26, September 1997 at 5-30 p.m. The President, Dr. C.L. Nagarsekar welcomed the members.

Dr. M.S. Krishnaprakash read the Secretary's report. In his report, he presented the various activities, progress and achievements of the AFST(I) and various chapters during the year 1996-97.

Sri Baldev Raj, Hon. Treasurer, AFST(I) presented the audited statements of accounts. He also presented the budget proposal of AFST(I) and AFST(I) Education and Publication Trust for the year 1997-98. The General Body approved both the reports and the budgetary proposals.

Announcement of Election Result

The Secretary announced the result of the election held for the post of President-Designate. The others were elected without contest. The following are the office-bearers of the Association for the year 1997-98.

1. President-Designate	: Prof. G.S. Chauhan (Pantnagar)
2. Vice-President (Head Quarters)	: Mr. N. Keshava
3. Vice-Presidents (Chapters)	: Dr. H.R. Adhikari (Mumbai)
	: Dr. S.B. Maini (New Delhi)
	: Mr. N.P. Kawale (Hyderabad)
	: Dr. Dheer Singh (Pantnagar)
4. Joint Secretary	: Dr. A.D. Semwal (Mysore)
5. Hony. Treasurer	: Mr. N. Manjunath (Mysore)

In addition to the above, the President Dr. S.S. Arya, Immediate Past President Dr. C.L. Nagarsekar, Hony. Executive Secretary Shri Rajesh S. Matche, Immediate Past Secretary Dr. M.S. Krishnaprakash, Editor-in-Chief JFST Dr. B.K. Lonsane, and Chief Editor IFI Dr. Richard Joseph will form the members of the Central Executive Committee for the year 1997-98.

The outgoing President Dr. C.L. Nagarsekar welcomed the members of the new CEC and inducted Dr. S.S. Arya to the chair of President of AFST(I). Dr. Arya acknowledged with gratitude the confidence reposed on him by the members of the Association. He promised to do his best to further enhance the reputation of the Association during his tenure. Dr. A.S. Gholap, President, Mumbai chapter, AFST(I) proposed a vote of thanks.

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ACKNOWLEDGEMENTS

The Editor-in-Chief expresses gratitude to the following referees for their valuable help in the evaluation of papers published in the Journal during 1997. The figures in bracket indicate the number of papers evaluated.

Abichandani, H. (1)
Abraham, K.O. (2)
Achaya, K.T. (1)
Appu Rao, A.G. (3)
Aravinda Prasad (1)
Arya, S.S. (5)
Azeemoddin, G. (1)

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Bawa, A.S. (6)
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Chauhan, G.S. (1)

Damodaran Namboodri, D. (3)
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Jamuna Prakash (4)
Jawahar Abraham (1)
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Prabhakar, J.V. (1)
Prakash, V. (1)
Prasad, C. (1)
Pratima N. Sastri (2)

Radhakrishnaiah Setty, G. (1)
Raghava Rao, K.S.M.S. (2)
Rajalakshmi, D. (1)
Rajni Modgil (1)
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Ramana, K.V.R. (1)
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Rudra Setty, T.M. (1)

Sarva Mangala (1)
Satish Kulkarni (3)
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Shankar, P.A. (1)
Shantha Krishnamurthy (1)
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Susanta K. Roy (1)
Suvendu Bhattacharya (1)

Tara Gopaldas (1)
Tharanathan, R.N. (1)

Umaid Singh (1)
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Vijay Sethi (3)
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Vijaya Rao, D. (4)
Vijayanand, P. (1)

Yella Reddy, S. (1)

Zakiuddin Ali, S. (1)

The Editor-in-Chief expresses gratitude to the following experts for their valuable help in reviewing the books during 1997. The figures in bracket indicate the number of books reviewed.

Appaiah, K.M. (1)
Haridas Rao, P. (1)
Lokesh, B.R. (1)
Mahendrakar, N.S. (1)
Misra, M.C. (1)
Nagarsekar, C.L. (1)
Neelam Khetarpaul (1)
Rajalakshmi, D. (1)
Ramesh V. Bhat (1)
Ranganath, K.A. (1)
Sattigeri, V.D. (1)
Shekar Shetty, H. (1)
Vijaya Rao, D. (2)

The Editor-in-Chief expresses gratitude to the following publishers for submitting books to the JOURNAL for reviewing during 1997. Figures in brackets indicate the books received.

Chapman & Hall, London, U.K. (2)
Information Directorate, New Delhi, (1)
Marcel Dekker Inc. New York, U.S.A. (7)
Plenum Press, New York and London (1)
T.R. Publications (P) Limited, Chennai (1)
Tata McGraw Hill Publishing Co. Ltd. New Delhi (1)
VCH Publications, Federal Republic of Germany (1)
World Health Organisation, Geneva, Switzerland (1)

INDIAN FOOD INDUSTRY

A Publication of Association of
Food Scientists and Technologists (India)
Contents of May-June 1997 Issue

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FEATURE ARTICLES

DEPARTMENTS

INDIAN FOOD INDUSTRY

A Publication of Association of Food Scientists and Technologists (India)

Contents of July-August 1997 Issue

Published by the Secretary AFST (India) CFTRI, Mysore-570 013 and Printed at M/s. Jwalamukhi Job Press, 44/1, K.R. Road, Bangalore-560 004, India.