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THE THIRD INTERNATIONAL FOOD CONVENTION AND FOOD EXPO
IFCON - 93

The Background

The Third International Food Convention - **IFCON-93** and Food Expo, organised by the Association of Food Scientists & Technologists (India) [AFST(I)] and Central Food Technological Research Institute (CFTRI), Mysore, India, will be held in Mysore from **7th to 12th September 1993.** The theme of the convention is **Food Technology for Health and Prosperity.**

The convention and Exposition will be held in the CFTRI Campus in Mysore, where adequate facilities are available for holding such international events. Mysore is a city of historical importance, being the erstwhile ruling centre of royal dynasty of Wodeyars, and has a population of about one million. It is the gateway to many interesting places of tourist attractions, like world famous Brindavan Garden; Bandipur and Mudumalai Wildlife Sanctuaries; renowned architectural monuments of Somanathpur, Belur, Halebid and gigantic statue of Gomateswara; Ranganathittu Bird Sanctuary; Coffee Plantations of Coorg and Tea Plantations of Nilgiris. Mysore is accessible from Bombay, New Delhi, Calcutta, Trivandrum and Madras by air, road and rail, via Bangalore. The weather will be pleasant, at the most, requiring some light and warm clothing. Arrangements will be made for accommodation of about 1500 participants in Mysore city and around, suiting their requirements. With a combination of serious technical programme and leisure as well as culture-oriented environment, **IFCON-93** will be an event worth cherishing for those opting for participation.

Technical Programme

A total of 35 separate symposia are being planned. There will be lead papers and keynote presentations by eminent persons with rich experience in respective areas, followed by discussions. International Union of Food Science and Technology (IUFoST) is likely to sponsor an exclusive workshop on post-harvest technology during **IFCON-93.** Based on these presentations and ensuing interactions, AFST(I) will strive to bring out the proceedings as a standard reference publication. The programme structure will have the following framework :

I. Inaugural Session

II. General

Sessions. Broad Topics Being Covered Under Each Session are as follows :

A. Policy

1. For Agro-Food Industry Development
2. For Research and Development
3. For Institutional Management
4. For Regional Co-operation

B. Research and Technological Development

1. Traditional Technologies
2. Emerging Technologies
3. Integration of Traditional and Emerging Technologies
4. Biotechnology, Development and Applications in Food Processing
5. Waste Utilisation, By-product Development and Environment Protection.
6. Energy input in Post-harvest system

C. Machinery and Equipment for Processing

1. Equipment available
2. Equipment Adaptation
3. New Developments and Designs
4. Packaging Equipment and Materials

D. Building Human Resource Capabilities

1. Basic Training
2. Advanced Training
3. Refresher Training
4. Retraining

E. Management

1. Research and Institutions
2. Technology Transfer
3. Industrial Development
4. Resources
5. Agro-Industries for Employment Generation and Rural Development

F. Future Institutional and Consumer Needs

1. Food for Institutional Needs
2. Convenience Foods
3. Speciality Foods
4. Food Safety and Consumer Protection

III. Technical Sessions : Recent Developments and Future Needs of Processed Foods

1. Processing of Foodgrains
2. Processing of Oilseeds
3. Animal Products, including Poultry
4. Dairy Products
5. Marine Products
6. Fruit and Vegetable Products
7. Plantation Products
8. Flavour and Chemical Additives

IV. Poster Sessions in Relation to the Above Subjects

V. Plenary Session

There will be four Conference Halls, with seating capacity varying from 200 to 2000 and all modern facilities of public address system and recording. The venue and various residential locations will be connected by coach service available for every 60 min. almost round the clock. Visual presentations can be done through 35 mm projectors, over-head projection system and epidiascope. 16 mm movie-projections and closed circuit television arrangement are also possible, if prior requisition is made.

Language

The communication medium for the Convention will be English. However, if translation facilities are required by any participant, prior intimation at least 60 days in advance, should be made to the Secretariat.

Poster Programme

Presentation of original work in any area of Food Science and Technology will be arranged during the Convention. (maximum 2 presentations by any registered participant).

Abstracts of papers to be presented will be grouped into topics or subject areas covered in the Convention. The abstracts will be listed in the Convention programme and consolidated for publication. Details about Poster presentation will be included in the programme, indicating time, poster-board number and location.

Poster should remain mounted for a minimum of 60 min. on the assigned board. Area available for poster pin-up is one sq. metre.

Affix on the top of the poster space a label showing the listed number of the abstract, its title and author(s). Minimum size of the lettering should be 2.5 cm. A typed copy of the abstract should be pasted at the left hand top corner of the board. Charts, drawings and illustrations should be readable from a distance of over 1 metre. Do not mount illustrations on a heavy board. Hand lettering should be bold and at least 1 cm. in size. Make functional use of colour. Please do not write on the poster boards. Poster assistants will help in the arrangement of the poster.

Abstract Submission Format

Prepare the abstract in a way suitable for direct reproduction in the Abstracts Volume, by following these instructions :

Use English only; type within a box measuring 13.5 x 12.0 cm; do not leave any margin inside the box; type out a short title in capital letters, names of authors with the presenter's name underlined; begin the abstract with a one-sentence research objective, make a brief statement of the actual results obtained and end with an inference.

Write out the names of chemical compounds in full, if they are mentioned for the first time followed by the abbreviation in parentheses. Do not use abbreviations as far as possible. The first letters of trade names should be in capitals. Do not erase or smudge the copy. If you retype the abstract, do so on a separate piece of white paper which should be in the precise size. Special symbols such as Greek letters, may be drawn by hand in black ink.

For mailing, use a large envelope and insert a similar sized loose cardboard backing to minimise shipping damage. Use the first class postage (International air mail, if sent from outside India). Abstracts, in duplicate, may be mailed before 30th June 1993 to IFCON-93 Secretariat.

Food Expo :

8th to 12th September 1993

Plans for the Exhibition to coincide with the Convention have been finalised. There will be about 200 covered stalls, each with a plinth area of 9.24 m^2, located at a strategic site in CFTRI grounds, with all required facilities. It will be a true exposition of the capabilities and reach of food processing sector world over.

The world-wide displays at the **FOOD EXPO** will cover :

* Processed Foods
* Ingredients and Additives
* Food Processing Machinery and Equipment
* Packaging Machinery and Materials
* Advances in Scientific Research and Development
* Technical Books and Periodicals.

Several leading research and development institutions in India will also be participating in the exhibition. The visitors to the **FOOD EXPO** will include over 1500 delegates to **IFCON-93,** who represent a prime audience for trade communication, besides users and consumers. A number of professional organizations, in related areas, will be holding meeting in Mysore at the same time as the Convention. This will facilitate the participation and attendance of a large number of professionals from food industry, in the **FOOD EXPO**, thereby maximising its effectiveness and impact.

Build up period : 1st to 7th Sept. 1993
Duration of Food Expo : 8th to 12th Sept. 1993
Dismantling period : 13th to 15th Sept. 1993

Exhibition space is offered as single/multiple units of size 3.3x2.8m. The tariff is Rs. 9,750/- per unit (US $500/-). Payments by Organizations outside India are to be made in US dollars only. On-the-spot services for Interior Decoration; Audio-visual Equipment;

Conference Rooms; Kitchen; Personnel for assistance in sales; Reception and Messenger Service; Security etc. will be available to **FOOD EXPO** participants on charge basis. Last date for receipt of application for space is 31st July 1993.

Publication

On the occasion of the Convention, a highly articulate publication is being brought out containing comprehensive information highlighting the latest developments in the area of Food Science and Technology. This will be in Demy-quarto size and the tariff for advertisement would be as under :

Outer Cover (Back : Rs. 15,000/- Inside Cover (each) : Rs. 10,000/-; Full page : Rs. 5,000/-; Half page: Rs. 3,000; Insertion: Rs. 7,000/-; Art paper : Rs. 7,500/-

Firm orders may be sent to the Secretariat along with the matter and payment in the form of Demand Draft on **IFCON-93,** AFST(I), Mysore, so as to reach by 30th June 1993.

Registration

For registration, separate composite registration form is available on request . The details of registration formalities are as under :

Normally, no registration fee will be accepted after 31st August 1993. Registration fee for spouses will be 50% of the prescribed rate. It is important that the Convention Secretariat receives the registration-cum-facilitation forms at the earliest in order to receive further information circulars. Cancellation is possible till 31st August 1993 and refund to the extent of 50% shall be considered. Registration fee is payable through Money Order, Demand Draft or Cheque. Payments may be sent in favour of "**IFCON-93,** AFST (INDIA)". Registration kits will be available to the registered participants between 8.00 a.m. and 6.00 p.m. every day during 6-12 September 1993 from the registration desk, located in Cheluvamba Mansion/ **IFCON-93** Secretariat.

Registration

Class of Registration	Registration Fee upto 15th May 93	Registration Fee with late fee
AFST(I) Members	Rs. 300	Rs. 500
Non-Members	Rs. 600	Rs. 800
International Participants	US $250	US $350
AFST(I) Student Members	Rs. 150	Rs. 250
Non-Member Students	Rs. 200	Rs. 300

General Arrangements

Accommodation and Food

There are a number of hotels offering transit accommodation facilities to visitors to Mysore. The tariff varies from Rs. 50/- to Rs. 2000/- per day depending on the standard of accommodation. Requests for accommodation may please be addressed to **IFCON-93** Secretariat at Mysore for prompt attention. Catering facilities will be available almost round the clock near the Conference Halls.

Reaching the venue

CFTRI campus is less than 1 km. from the Railway Station and 3.0 km. from the main Bus Stand. Regular buses and trains ply between Mysore and Bangalore. Prior intimation about arrival will help in providing local reception and transportation facilities to the participants, if possible. Three-wheeler scooters ply from railway terminal and bus station to any desired location in the city.

Travel Arrangements

The official Travel Agents to **IFCON-93** is M/s Triway Travels (Pvt.) Ltd., Parvathi Plaza, 1st Floor, 105, Richmond Road, Bangalore-560 025, India, who will be able to arrange for bookings and confirmation by rail as well as air within and outside India on full payment.

Bangalore Tel. : (080) 217587; (080) 217588
Mysore Tel. : (0821) 26321; (0821) 27548

Banking Service

A branch of State Bank of Mysore is located in the CFTRI campus within walking distance of all Conference Halls and a branch of Indian Overseas Bank at Yadavagiri, Mysore, about a kilometre away. The Banks offer foreign exchange service also including handling of Travellers Cheques and Cash.

Post Office

A separate Post Office with all facilities is already working within the campus and will be easily accessible to all the participants.

Visa for India

International participants may approach the respective Indian Embassies, High Commissions or Consulates located in their country/area for grant of Visa at least six weeks in advance of their travel.

Sight-Seeing

Elaborate arrangements are being made to organize sight-seeing tours on 3 days viz., 8th to 10th September 1993 to cover all places of tourist attraction in and around Mysore. Further details will be provided from time to time.

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

Affiliated to the Institute of Food Technologists, USA

The Association is a professional and educational organization of Food Scientists and Technologists

Objectives :

1. To stimulate research on various aspects of Food Science, Technology and Engineering.
2. To provide a forum for the exchange, discussion and dissemination of current developments in the field of Food Science, Technology and Engineering.
3. To promote the profession of Food Science, Technology and Engineering.

The ultimate object is to serve humanity through better food.

Major Activities :

1. Publication of Journal of Food Science and Technology (bi-monthly) and Indian Food Industry (bi-monthly).
2. Arranging lectures and seminars for the benefit of members.
3. Holding symposia on different aspects of Food Science, Technology and Engineering.

Membership :

Membership is open to graduates and diploma-holders in Food Science, Technology and Engineering and to those engaged in the profession. As per the option exercised, each member will receive a free copy of the Journal of Food Science and Technology or the Indian Food Industry. The Chapters of the Association are located at Bangalore, Bhopal, Bombay, Calcutta, Delhi, Hisar, Hyderabad, Jabalpur, Jaipur, Jammu, Kanpur, Karnal, Kharagpur, Ludhiana, Madras, Manipur, Nagpur, Pantnagar, Parbhani, Pune and Thiruvananthapuram.

	Membership Fee (Effective from 1, April 1992)	**Admission Fee**
Life Member	Rs. 600	Rs. 5
Life Member (Resident abroad)	US $ 400	US $ 1
Corporate Member	Rs.1000	Rs. 5
Full Member	Rs. 50	Rs. 5
Member (Resident abroad)	US $ 25	US $ 1
Affiliate Member	Rs. 80	Rs. 5
Student Member	Rs. 25	Rs. 5
Student Member (abroad)	US $ 15	US $ 1

Annual Subscription

Journal of Food Science and Technology (JFST)

Inland	Rs. 336
Foreign :	
Surface Mail	US $ 106
Air Mail	US $ 131

Indian Food Industry (IFI)

Inland	Rs. 216
Surface Mail	US $ 66
Air Mail	US $ 86

(The above rates include Registered Book Post Charges)

Additional Subscription for Members only

JFST	Rs. 70
IFI	Rs. 50

For membership and other particulars, kindly contact :

The Honorary Executive Secretary
Association of Food Scientists and Technologists (India)
Central Food Technological Research Institute Campus, Mysore-570 013, India.

JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

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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.

Manuscripts for publication, books for reviewing and 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 given in the January/February issue of the Journal.

New members of AFST(I) are entitled to receive 'Indian Food Industry' journal or Journal of Food Science and Technology, free of cost. Members opting for IFI can subscribe to Journal of Food Science and Technology at a concessional rate of Rs. 70/- per annum. Those members who were earlier getting or had opted for IFI, can now also opt for JFST (once in a year only), if they so desire. For others, the annual subscription rates are: Inland: Rs. 336/- Foreign: Surface Mail US$ 106/- Air Mail US$ 131 (inclusive of Reg. Book Post charges).

Advertisements from manufacturers and dealers of chemicals, glassware, instruments, machinery as well as publishers/distributors of book/periodical are accepted. The rates for appearance in six issues in a year are :

Back or inside Cover Page	: Rs. 5,000/-
Full Page	: Rs. 3,000/-
Half Page	: Rs. 2,000/-

Correspondence regarding subscription and advertisements should be addressed to the Executive Secretary, AFST(I), CFTRI Campus, Mysore-570 013, India. All payments shall be made by Demand Draft or Money Order in favour of the Executive Secretary, AFST(I), CFTRI Campus, Mysore-570 013. India.

Subscription through agents in India is not entertained.

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REVIEW *J. Food Sci. Technol., 1993, Vol 30, No.3, 155-162*

Methods for Peeling Fruits and Vegetables : A Critical Evaluation

G. RADHAKRISHNAIAH SETTY*, M.R. VIJAYALAKSHMI AND A. USHA DEVI
Fruit and Vegetable Technology Department,
Central Food Technological Research Institute, Mysore-570 013, India.

Various methods and machinery used for peeling fruits and vegetables, along with latest developments, have been critically discussed. Advantages of each system have been cited to allow the assessment of the overall effect of using a particular system in a given processing situation. The effect of peeling on the colour, appearance and composition of peeled material is also discussed.

Keywords : Fruit and vegetable peeling, Peeling methods, Machinery, Modifications, Advantages and limitations, Peel losses, Effluent quality.

Peeling is one of the most important preparatory steps in processing of some of the fruits and vegetables, meant for canning, freezing and dehydration. The selection of the proper peeling method is of importance, as the quality of the finished product depends, to a large extent, upon the method used. The amount of peel removed is important to the processor not only because it is a total loss and reduces product quantity, but also for the cost-intensive nature of peel disposal which, otherwise, causes environmental pollution. Reduction in peel weight also leads to increased product recovery and higher profits. The fruit and vegetable processing upto peeling stage also involves considerable operating cost as the raw material along with the peel gets cleaned, washed and processed for peeling. Hence, a need exists for judicious selection of the peeling method.

In the beginning of the fruit processing industry, only hand peeling was practised. Several methods/ machinery/equipments have been developed, since then. Effects of these methods on the raw material, in addition to peel removal, have also been studied to some extent. Literature pertaining to the above is widely scattered. It is worth mentioning that the peeling requirements for different products vary. Hence, goals of good peeling operation are (1) minimizing product losses, (2) peeling to the extent dictated by the products (e.g., potato products), (3) minimizing heat ring formation (e.g., apple, potato), (4) minimizing energy and chemical usage and (5) minimizing the pollution load. In this review, an attempt has been made to consolidate all the available literature and to pin-point the advantages and limitations of each peeling method. Peeling methods as applicable to individual fruits and vegetables and the effect of the various peeling treatments on the quality and composition of the product are also discussed.

* *Corresponding Author*

Hand peeling

Hand peeling, using stainless steel knives, is one of the earliest methods of peeling fruits and vegetables. The peeling knife with a curved blade and special guard to regulate the depth of peeling is of special interest, as it can be universally employed for any fruit or vegetable. The method has certain advantages such as minimum investment, as well as water requirement and no enzyme stimulation as in the case of heat and lye-peeling methods. The peels obtained can be further utilised, and the wash water is not contaminated with chemicals. Major disadvantages are high labour costs and chances of contamination with microorganisms. Though hand peeling has almost been replaced with modern methods of peeling, it is still practised for some fruits like mangoes.

Peeling by heat

Boiling water or steam loosens the peel of certain fruits and vegetables (e.g., tomatoes, peaches) and consequently, it can be easily slipped from the fruit by hand or with a scrubber. Main advantages of heat/steam peeling include (a) easier automation and precise temperature control to minimize peeling losses, (2) absence of chemical contamination of water, and (3) reduced pollution problems as compared to chemical peeling. In a steam peeler, the fruits are placed on a moving belt, one layer deep, and passed through a steam box equipped with a series of spray heads, from which the steam is sprayed directly on the material. Depending upon

the nature of material, 30-60 sec treatment is sufficient to loosen the peel which is removed by soft brushes after cooling in cold water.

In high pressure steam peelers, the liquid beneath the skin gets vapourized, when a vegetable is exposed to high pressure steam. As long as the surrounding pressure is same as the internal pressure, no reaction takes place. As soon as the chamber pressure is released, the surrounding pressure becomes lower than the internal pressure. This pressure differential results in forcing away the skin from the flesh, thereby facilitating easy removal. Thus, a physical phenomenon aids in the peeling process in high pressure steam peeler. Merkel (1970) developed a batch peeler with regulated pressure control to take advantage of the steam peeling. The system effectively separated peel from the flesh in a variety of fruits.

Recently, different high pressure continuous steam peelers have been introduced. Lopez (1987) has described one such peeler in which the material is exposed to steam under pressure in a fully insulated retort, which revolves slowly and mixes the vegetables. The material is discharged into the hopper below the retort, and conveyed over rubber-coated rollers running at different speeds. This causes the vegetables to gyrate as they are pushed along the rollers by means of mechanical fingers. Water at high pressure jets above the rollers and knocks the skins off, as the product passes along the rollers. The skins drop into a hopper below the roller, while the peeled product is discharged onto a conveyor for inspection and further processing.

Paul Kunz Company of Germany have designed larger capacity high pressure steam peeler (Anon 1978 a, b). The machine can be used to peel diverse variety of fruits and vegetables and hence, its use is not restricted to a particular harvest season. Products are peeled in a pressure tank at a pressure rating adapted to each product in the ranges 0.5-1.5, 3-6 and 6-15 bar. The low medium pressures are continuously variable. The operating sequences are automatically controlled and pre-programmed. The use of the pressure tank allows low steam consumption. Outputs vary with the type of material peeled e.g., tomatoes : 9 T/h, potatoes: 15 T/h, baby carrots : 8 T/h and large carrots: 9-12 T/h. Roma variety of tomatoes gave a product yield of 93%. Smith et al. (1980) have modified the high pressure steam peeler so that the material, after steam treatment, is flash-cooled by injecting cold water in the peeling chamber. They have claimed that the treatment facilitates trimming and handling with a better yield and improved appearance for sweet potatoes.

Mechanical peelers

Batch type abrasive mechanical peeler consists of an upright cylinder, provided in the bottom, with rapidly revolving disk, which undergoes an undulatory movement. The inner walls of the cylinder and the upper surface of the disk are coated with abrasive carborundum. As the disk revolves, water is sprayed into the peeler for washing away the grated peelings and facilitating the peeling process. Apples, carrots and potatoes can be peeled in this way (Cruess 1958).

Continuous abrasive peeler has been described (Anon 1978) which can peel 2.5 to 8 T/h potatoes or root vegetables. The material passes over 103 m long carborundum-coated rollers, which are equipped with oscillatory rings. The inlet and outlet openings are 2400 and 1200 mm, respectively, above the floor. Advantages claimed include simple construction, easy maintenance, allowing initial use of only 6-8 rollers and efficient peeling with minimum losses. Most abrasive peelers are sensitive to loading. Too low loading results in incomplete peeling, while overloading causes excessive peeling for some and insufficient peeling for others in the same batch. Some machines provide controls to regulate abrasive action and exposure time for varying potato conditions. Machines are generally available with varying grit rings. Coarse grits peel faster and leave rough surface, while fine grits peel more slowly and smoothly (Huxsoll and Smith 1975).

Three types of non-abrasive mechanical peelers are available for high speed and micro-thin peeling of apples and pears. Atlas-pacific pear peeler can handle upto 66 fruits per min (6 at a time). The blades fixed in vertical position are used for peeling and coring of the fruit. In the Fox mechanical peeler, safety razor-like blades are employed to remove skin to uniform depth. Edward peeler holds the fruit in clamshell-like cup and the peel is removed in uniform size and shape by knives (Woodroof and Luh 1975; Downing 1989). Recently, Heimerdinger (1970) has been granted a patent for a potato peeling machine which consists of square container, with a cutter disc at the base and rectilinear knives. Circular peeling knives are attached to the corners. Potatoes are turned without mechanical aid due to the angular container shape. Peeled potatoes are discharged through a chute in a side wall.

Lye peeling (chemical peeling)

It is, by far, the method of choice for removing peel of many fruits and vegetables because of the ease of mechanisation; continuous operation; and uniformity, quality as well as high yield of the product. Lye (sodium hydroxide solution) dissolves the fruit and vegetable peels and the rate of dissolution depends on lye concentration, temperature and period of immersion. The surface tissues of most fruits consist of three layers, namely, epidermis, middle lamella and parenchyma. The middle lamella is composed of pectinous substances that are highly soluble in the lye. The parenchyma cells are large and more resistant to the lye. Hence, epidermis layer is removed along with the middle lamella without affecting the parenchyma cells in the normal lye peeling process. It has been found that wetting agents, tergitol (sodium 2-ethyl hexyl sulphate) and Faspeel (sodium mono and dimethyl naphthalene sulphonate), uses of which have been approved by FDA in the lye, increase peeling efficiency by reducing the time of disintegrating the peel to about half. Major advantages of lye peeling include (a) lower cost, (b) rapid handling, (c) reduced loss of fruit as compared to hand peeling, (d) amenability to large scale operation, and (e) suitability to all shapes, sizes and varieties (Cruess 1958). Consequently, guava, peaches, pears, apricot, orange segment, etc., are generally lye-peeled.

A simple method of lye-peeling is to dip the fruits into the heated lye for a definite period, followed by thorough water washing of the peeled fruit. Residual lye may be neutralized by further dipping in dilute citric acid solution. Generally, 1.5-2.0 kg of sodium hydroxide is required to peel 1000 bu peaches. The quantity of sodium hydroxide required for peeling pears and tomatoes is about 2 and 5 times of that for peaches (Cyr 1971; Willard 1971).

Commercial peelers consist essentially of a heated temperature controlled tank for holding the lye, with facility for passing the material through the tank at a controlled rate. Two early industrial lye peelers, such as Dunkley lye peeler and Kyle lye peeler, have been described by Cruess (1958). The former consists of a rectangular sheet metal box through which the material is carried on to a wire conveyor. The material is first sprayed with hot water, followed by sprays of hot lye. The Kyle peeling machine makes use of agitation of the lye-treated fruit in water to remove the lye and skins.

Three types of lye peelers i.e. draper type scalder, lye spray scalder and mill-wheel scalder are in common use at present (Woodroof and Luh 1975; Huxsoll and Smith 1975). In the draper type, one of the most commonly used scalders, the material is carried over the belt first in a prewetting bath and then through a lye scalder. The latter is equipped with adjustable speed control, thermostat, lye concentration indicator, closed steam heating coils and V-bottom for the drainage of sediment. However, it requires a large amount of floor space. The lye spray scalder is used exclusively for mechanically pitted clingstone and freestone peach halves, which are spread on a metal mesh with the peel side up and passed for a desired length of time under sprays of hot lye, pumped from coil heated vat. Thus, the shapes of the peaches are well maintained as they are not tumbled and the system can be modified so as to use any concentration of the lye. In the mill wheel scalder, the peach halves are immersed on a vertical wheel, the lower half of which turns in a bath of lye. The time of treatment depends upon the size and speed of the wheel. The equipment requires less space, as well as power and holds less solution.

Recently, two more lye peelers, i.e., rotary or Ferris wheel type and rotoscrew peeler have come into use (Lopez 1987). In the first one, perforated drums with angular vanes are used to hold the raw material in between the vanes. These rotate through the hot lye in the tank, which is heated by steam coils. The rotor-screw type peeler has a narrow vat-like tank and a continuous link belt conveyor, to which cross members are fixed. The movement of these propels the material through the lye bath. After the lye treatment, the material requires thorough water wash to remove not only the lye disintegrated peel, but also the residual lye on the surface of the peeled material. This step forms a critical part of the lye-peeling process. In some cases, peeled and washed material is dipped in or sprayed with dilute citric acid solution to ensure the neutralization of residual alkali.

Main advantage is the requirement of smaller floor space. The disadvantages include high peeling losses, loss of damaged fruits and pollution of large volumes (2600 gal/ton fruit peeled) of water (Woodroof and Luh 1975).

Dry caustic peeling system

It constitutes a modification of the lye-peeling process developed to overcome some of the serious pollution and waste disposal problems inherent in

the ordinary lye-peeling process (Graham et al. 1969a, 1969b). The process uses infra-red energy at a very high temperature to condition the surface of fruit and vegetable treated with strong lye, while the rolling of the conveyor turns the material so as to expose all the material to the infra-red energy. This accelerates the chemical peeling activity and the process makes use of the lye more completely, thereby reducing caustic consumption. The dry soft rubber tipped scrubbers remove about 90% of the loosened peel from the treated material, while the remaining peel is removed by the brush washers. Water requirement is reduced by 90% and hence, it is called as dry-peeling process. The method can be applied for tomatoes, carrots, sweet potatoes, peaches and apricots. According to Huxsoll and Smith (1975), the advantages include reduced processing costs, lower volume of plant effluent, increased product yield and the use of the sludge as a cattle feed.

Freeze peeling (cryogenic peeling)

Peaches and tomatoes are frozen quickly in liquid nitrogen, Freon-12 or liquid air, to a depth slightly below the skin, and thawed rapidly in tap water. The flesh is not frozen and therefore, the skin is released easily. Peel losses are reduced to half as compared to conventional processes and pollution problems are avoided to a great extent (Woodroof and Luh 1975; Gould 1983).

Flame peeling

It utilises high temperatures (650-2000°F) of spent combustion gases. The material is passed through a flame for very short period for blistering the skin and pulling away from the flesh by high pressure spray of water (Gould 1983; Huxsoll and Smith 1975). The process is specially applicable to tomato, pepper, onion and garlic.

Vacuum peeling

A Bulgarian vacuum method for peeling of tomatoes consists of scalding the vegetables at 96°C and applying vacuum at 600-700 mm Hg for tearing off the peel. It has a high peeling efficiency, retention of high fruit quality and low energy consumption as well as costs (Kliamow et al. 1977).

Acid peeling

Peach peel is soluble in hot solution of 0.1% HCl, 0.05% oxalic acid, 0.1% citric acid or 0.1% tartaric acid. It disintegrates the peel rather than loosening it (Woodroof and Luh 1975).

Calcium chloride peeling

Dipping tomatoes in boiling $CaCl_2$ solution loosens the skin for easy removal. Major disadvantage of the method is the difficulty in controlling the absorption of calcium by the fruit (Stephens et al. 1973).

Peeling with ammonium salts

Fruits and vegetables, when treated with 0.5 to 15% aqueous solution of mono-, di- or tri-ammonium ortho phosphate (preferably diammonium) at 80-95°C for 3-10 min (pH 7.0-9.5), produces astonishing skinning effect without destroying the tissue. The effectiveness can be improved by adding surface active agents (ammonium alkyl benzene sulfonates) preferably at 0.02 to 0.2% level (Soler 1975).

Efficacy of peeling methods

It is worth mentioning that the choice of the peeling method to the individual material is determined to a large extent by the volume of the material to be handled and the cost of equipment. The data on the various process parameters that are used in the application of the individual method to different fruits and vegetables, along with their efficacy, are presented in Tables 1 and 2.

Effect of peeling on colour and quality

Depending upon the peeling method used and the nature of the fruit or vegetable peeled, the material may undergo some changes in their colour, appearance and constituents. Consequently, the selection of peeling method assumes vital importance with respect to the economy. The aspects on colour, appearance and composition of the peeled material with respect to peeling method are, therefore, discussed below:

Major problem in steam-peeling or hot lye-peeling is the formation of brown ring (heat ring) below the surface of the fruit due to the tissue damage and polyphenol enzyme activity. (Downing 1989). Smith et al. (1981) found that the width of heat ring was minimum (0.1 mm or less) in steam-peeled apples as compared to 1.4 and 2.3 mm for lye-peeled and abrasive pre-wash peeled apples, respectively, thereby indicating minimum damage to the tissues in steam-peeled apples. Colour and appearance of steam-peeled apples were rated excellent, as against less brilliant, but still highly acceptable lye-peeled products. The abrasion-peeled apples darkened more rapidly and lacked smoother surface. Water uptake, which resulted in lowering

TABLE 1. DESCRIPTION OF VARIOUS PROCESS PARAMETERS FOR DIFFERENT METHODS OF PEELING FRUITS

Commodity	Peeling method	Parameters	Remarks	Reference
Orange segments (Mandarin)	Lye 1. Japan	0.6-0.7% HCl, 30-35°C, 40 min, washing, dip 0.4-0.5% lye, 35°C, 15 min.	Maintenance of temperature required	Itoo (1977)
	2. Indian	Boiling 1-2% NaOH, 20-30 sec, rinsing and dip 0.8-1.0% HCl, washing	More breakage	Girdharilal et al. (1986)
	3. Modified	1.5% HCl, RT (25-28°C) washing, dip 1% NaOH, RT, 25 min and wash.	Less breakage, Superior quality segments	Kalyanmoynath (1976)
Sweet orange segments	Lye	0.25 % HCl, 1h, wash, dip 0.75% NaOH RT, 30 min, wash dip 0.1% CA and wash.	-----	Rao et al. (1969)
Apple	Lye - Machine	FMC-automatic apple preparation system. 10-15% NaOH or KOH 60-90°C, 4-5 min.	Peel loss 10-12%	Harrington and Hill (1968)
	High pressure steam	100 psig 20 sec. lowering to 25 psig and flash cooling with water at 65 psig 15 sec.	Peel loss 2.5%	Smith et al. (1981)
	Machine	Atlas-Pacific peeling machine, 130 F/min.	High peel loss	Downing (1989)
Pears				
Bartlette	Machine 1. Atlas-Pacific	Micro-thin peeling, 66 F/min.	Size grading required	Woodroof and Luh (1975)
	2. FMC C8 Trushape	Can peel at random	Size grading not required. High yields	Woodroof and Luh (1975)
Kiefer	Hand peeling	Blanch 20-30 sec, boiling water or steam and peel	-----	Woodroof and Luh (1975)
Peaches	1. Lye	a. Spray 10% lye, 145 °F, 4 min.	For freezing and drying	Woodroof and Luh (1975)
		b. 2% boiling lye spray, 38 sec.		Chung and Luh (1972)
	2. Diammonium phosphate	4%, 93 ± 2°C, 1 min.	Peel loss 10-15%	Soler (1975)
	3. Lye	20%, 93 ± 2°C, 1 min.	Peel loss 25-30&	Soler (1975)
Clingstone	Lye spray scalder	Cup down peaches, 5-11% lye, 215-220°C, 30-60 sec.	-----	Lopez (1981)
Freestone (Green)	Lye	3-4% boiling lye, 45-60 sec.	-----	Lopez (1981)
Freestone (Ripe)	Steam	$1^1/_2$-2 min	-----	Lopez (1981)
Guava	Lye	2.0-2.5% boiling lye, 60-90 sec.	-----	Girdharilal (1986)
Mango	Hand	Cutting the cheeks, quartering and scooping the slice with curved knife	-----	Girdharilal (1986)
	Machine	Can peel and cut the cheeks	-----	Franklin (1988)

the total solids, was more in lye-peeled apples than that in steam-peeled product.

Discolouration of the cambial region due to the polyphenol oxidase activity occurs when sweet potatoes are peeled by dipping in 10% boiling lye for 6 min and results in unattractive finished product (Scott and Kattan 1957). The discolouration can be prevented either by 15 min lye-peeling or by pre-soaking in water at 80°C for 30 min, followed by 6 min lye-peeling. Both these treatments inactivate the enzyme system, while the carotenes in the root remain unaffected (Walter and Giesbrecht 1982). Light and scanning electron microscopy showed heat-mediated starch gelatinization, cell wall separation, chromoplast disruption and enzyme discolouration in the treatments (a) 15 min lye-

TABLE 2. DESCRIPTION OF VARIOUS PROCESS PARAMETERS FOR DIFFERENT METHODS OF PEELING FRUITS

Commodity	Peeling method	Parameters	Remarks	Reference
Tomatoes	Hot water	a. Boiling water, 15-60 sec cooling and pulling of the peel by hand:	--	Cruess (1958)
		b. Jamoon variety - Boiling water - 15 sec 90°C - 20 sec	Peel loss, 4.05% Peel loss, 4.7%	Jyothi and Radhakrishnaiah Setty (1988)
	Steam	a. Steam, 30-60 sec	Peel loss, 7-8%	Gould (1983)
		b. Jamoon variety - Steam 10 sec	Peel loss, 6.9%	Jyothi and Radhakrishnaiah Setty (1988)
	Lye	18% NaOH, 190-200°F, 25 sec and hold for 45-60 sec	Peel loss 7.5%	Schulte (1965)
	Infra-red	1500-1800°F, 4-20 sec	Peel loss 5.3%	Gould (1983); Shulte (1965)
	Vacuum	Hot water 96°C, 30-40 sec, vacuum 600-700 mm Hg	Peeling efficiency, 98%	Kliamow et al. (1977)
	$CaCl_2$ 42%	Scalding 121°C	Peel loss, 3.78%	Stephen et al. (1973)
			firmer	Jyothi and Radhakrishnaiah Setty (1988)
Potatoes	Mechanical (abrasion)	a. Fine grits - freshly harvested b. Course grits - cured tough skinned	No heat ring High peel loss upto 20%	Huxsoll and Smith (1975)
	Lye	5-20% NaOH, 170-210°F, 1 to 6 min depending on variety, age, storage conditions	Peel loss, 8-18%, considerable heat ring formation	Huxsoll and Smith (1975)
	Dry caustic	Dip 6-10% NaOH, 190-210°C, 30-80 sec, hold for 3-5 min, expose to infra-red radiation, 1650°F 60-90 sec	Peel loss, 6-10%, negligible heat ring formation	Huxsoll and Smith (1975)
	High pressure steam	100 psi, 30-90 sec batch type 35-45 sec continuous type	--------	Huxsoll and Smith (1975)
	Flame	Expose, 2000°F, 15-30 sec	Peel loss, 10%	Huxsoll and Smith (1975)
Sweet potatoes	Lye	10% lye, 200°F, 8-10 min	Peel loss, 22.5-40.8%	Edmond and Ammerman (1971)
	Steam with flash cooling	100 psig for 75 sec, lowering to 25 psig and injecting cold water at 65 psig for 15 sec	Peel loss, 19%	Smith et al. (1980)
Carrots	Mechanical (abrasion)	Blanch at 185-190°F, short period, Machine peeling	--------	Cruess (1958)
	Lye	3-10% boiling lye spray	--------	Cruess (1958)
	High pressure steam	Expose at 300 °F, short period	Minimum peel loss	Cruess (1958)
Onions	Flame	Heat onions in air at 90-100°F, expose to flame, brush spray washing	--------	Cruess (1958)
	Gas	Jets of gas under pressure, penetrate and strip off peel	--------	Menou (1989)
	Lye abrasion White onions	9% lye, 210°F, 3-3$^1/_2$ min roller peel, pressure spray water wash	--------	Lopez (1981)
	Yellow onions	6$^1/_2$% lye, 210°F, 3 min roller peel, pressure spray water wash	--------	Lopez (1981)

peeling (b) 30 min pre-soak (water at 78-80°C) followed by 6 min lye-peeling and (c) 6 min lye-peeling. The treatment (b) was found to provide the most attractive finished products in the decreasing

order (Walter and Schadel 1982).

Retention of ascorbic acid was 77.6% in apricots, 71% in clingstone peaches and 65% in Elberta peaches after lye-peeling. Ascorbic acid loss increased with the increase in peeling time in a given strength of the lye (Lamb et al. 1947). Dhopeswarker and Magar (1954) reported 70-72% retention of ascorbic acid in the lye-peeled guava. Gothwal (1992) reported 75.2, 79.2, 79.0, 92.0, 93.0 and 92.5% retention of sugars, total carotenes, ascorbic acid, calcium, iron and phosphorus, respectively. Gorun (1978) and Gorun et al. (1973, 1974) have compared the effect of three peeling methods (mechanical, lye-steam combination and steam) on potato composition and found lowest losses of carbohydrates, vitamin C (2.9%) and B-vitamins (thiamin 18-20%, riboflavin 15-16% and niacin 5.0-5.5%) with steam-peeling, while the losses were highest with lye-steam combination in case of B-vitamins (thiamin 32-35%, riboflavin 25-26% and niacin 20-23%). The losses were highest in the case of carbohydrates and vitamin C (10.3%) in mechanical peeling. However, total sugars, reducing sugars and glucose increased after lye steam-peeling and steam-peeling. Freeze-peeled (liquid nitrogen) tomatoes had attractive red colour due to high lycopene content in the initial layer of cells just beneath the skin, as this layer was not removed during peeling and the lack of exposure of the underlying vascular bundles (Brown et al. 1970). Scanning electron microscopy showed superior cellular integrity for liquid nitrogen and carbon dioxide freeze-peeled tomatoes (Thomas et al. 1978). Severe cellular disruption and chromoplast destruction lead to poorer colour with lye steam and calcium chloride brine-freeze heat-peeled tomatoes (Thomas et al. 1976).

No significant changes in the important constituents such as °Brix, acidity, pH, lycopene and calcium have been reported in tomatoes peeled by hot water, steam or calcium chloride peeling method, except for rapid absorption of calcium in the calcium chloride method (Jyothi Kiran and Radhakrishnaiah Setty 1988). The latter leads to bitter taste of the product. The titrable acidities in the lye-peeled and niacin in water-peeled tomatoes were found to get decreased (Saldana et al. 1978). Acidity and °Brix were higher, while pH of broken fruits were lower in the canned tomatoes peeled by liquid nitrogen, as compared to hot calcium chloride or water-peeled tomatoes (Saldana et al. 1978). Nitrogen-peeled tomatoes also scored higher capacity to absorb added calcium (Brown et al. 1970). The salad pastes, prepared from hot calcium chloride peeled tomatoes, were firmer than those with the product peeled with hot water or liquid nitrogen, with added calcium (Saldana et al. 1971). Lycopene content of peels and trimmings of water-peeled tomatoes were significantly higher than in liquid nitrogen-peeled product, while the carotene content was not significantly affected (Brown et al. 1970). No significant losses in total sugars, total carotenes, calcium, phosphorus and iron were noticed in peeled and trimmed (machine-peeled) carrot as well as hand-peeled drumstick (Gothwal 1992).

Overviews

In addition to conventional methods (heat, lye and abrasion peeling), several new methods (high pressure steam-peeling, flame-peeling, vacuum-peeling, acid-peeling, freeze-peeling, calcium chloride peeling and peeling with ammonium salts) have been developed recently. Modifications have also been effected in the recent methods, viz., high pressure steam-peeling with flash-cooling, dry caustic peeling, freeze-heat peeling, lye steam peeling and use of wetting agents. Major emphasis in all these efforts has been to (a) minimize the peel loss, (b) improve the quality of the peeled material, (c) reduce the pollution and waste water disposal problems and (d) lower the cost of peeling. Selection of the proper method is of critical importance and is governed by the nature of the fruit or vegetable, its maturity, time lapsed after harvesting, volume of the material to be handled, cost of peeling and availability of the machinery.

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Moisture Diffusivity and Thermal Expansion of Gorgon Nut

S.N. JHA[1] AND SURESH PRASAD*
Post-harvest Technology Centre,
Indian Institute of Technology, Kharagpur-721 302, India.

Moisture diffusivity of gorgon nut seed and its kernel, during roasting in an open pan at different moisture contents and pan temperatures was, determined. The coefficient of cubical thermal expansion of the kernel and the shell at various moisture levels was determined by a dilatometer. Moisture diffusivities of kernel and nut increased with increase in moisture content and temperature and have been correlated with the same. Cubical thermal expansion of the shell and kernel increased with increase of moisture content.

Keywords : Gorgon nut, Moisture diffusivity, Dilatometer, Cubical expansion, Kernel, Shell, Moisture ratio

Gorgon nut (*Eurvale ferox*), commonly known as *Makhana* in India, is a seed of an aquatic herb. It is the main aquatic crop in Darbhanga, Kosi, and Purnea divisions of Mithila, North Bihar, India and is grown in large number of stagnant fresh water pools with not more than 1-1.5 m depth. Its present natural forms can be observed in the pools of North-Eastern and Central India, while it grows wild in China, Japan, USSR, and North America (Jha et al. 1991). The gorgon nut is characterized by its hard seed coat (shell), black colour and spherical shape, with diameter ranging from 4.5 to 14.5 mm. Edible part of the nut is its starchy kernel, which cannot be separated easily from the raw nut due to close adherance of the shell to the kernel at high moisture content. It is, therefore, necessary to give thermal treatments for mechanical separation of the popped (expanded) kernel. Expanded kernels contain (g/100 g) 12.8 moisture, 76.9 carbohydrates, 9.7 proteins, 0.1 fat, 0.5 total minerals, 0.02 calcium, 0.9 phosphorous and 0.0014 iron (Gopalan et al. 1987). *Makhana* is used for milk-based food preparations, like *kheer*, puddings and curry, due to its rich nutritive value. Fried *makhana* with salt or sugar is widely used as a snack food. *Makhana* has medicinal value and is used as an ingredient in the preparation of indigenous tonics. It also serves as a source of starch for textile industries (Lakhmani 1978), and its amino acid composition has also been determined (Nath and Chakraborthy 1985).

Processing of gorgon involves various operations such as drying, size grading, pre-heating, tempering, roasting and popping. Roasting of nuts is normally carried out in an open iron pan at about 300°C surface temperature (Jha and Suresh Prasad 1990). It is expected that high internal pressure will develop within the seed at this temperature, due to vapourization of water from kernel. But, the shell of the nut being strong, does not break in spite of possible high internal pressure. Sudden impulsive mechanical impact is needed to crack the shell. As soon as cracks develop, water vapour comes out with an explosion and the kernel gets popped out.

As the nut comprises of the kernel and hard shell, it is expected that the major moisture transfer during roasting will be from the kernel alone, while the cubical thennal expansion of the shell and the kernel may be different. Studies on these properties of the nut are not reported in the literature. Such studies are required for mathematical simulation of the roasting and popping processes and the knowledge would be useful in designing an efficient roaster for gorgon nut processing. The present investigation was, thus, aimed at determining the moisture diffusivity of whole nut, and the kernel, as well as the coefficient of cubical thermal expansion of the kernel and the shell of the nut.

Materials and Methods

Sample preparation : Samples of fresh gorgon nut of 60.2% moisture content (db) were procured from the market of Madhubani, Bihar. Medium-sized nuts (8-10 mm dia) were dried, preheated and roasted to bring down the moisture contents of nuts to about 33.7, 25.9 and 11.5%, respectively, as per procedure of Jha and Suresh Prasad (1990). The kernel was obtained from the preheated and roasted nut by manual decortication. Moisture contents in all the cases were determined by vacuum oven method (Hall 1970). The moisture contents of shell obtained from dried, preheated and roasted nuts

* Corresponding Author, [1]Present address : Banana Research Station, Hajipur, Vaishali-844 101, Bihar.

were about 15, 5, and 2%, respectively, and those of the preheated and roasted kernels were about 33.4 and 15.3%, respectively. To increase the moisture content of the preheated kernel to about 48.6%, it was soaked in water at ambient temperature of about 30°C for 10 min. Conditioned samples were kept in different desiccators partly filled with saturated salt solutions to equilibrate and maintain the moisture content.

Moisture diffusivity : Conditioned samples were roasted in an open iron pan with continuous stirring. The heat source was 1.5 kW electric heater. Temperature of the pan surface was measured with an iron-constant (J-type) thermo-couple attached to the millivoltmeter having the least count of 0.01 mV. For the corresponding millivolt, the temperature was noted from the standard chart of the thennocouple. For maintaining a particular temperature of the pan surface, input voltage of the heater was regulated by an auto-transformer, connected to power source. When a preset temperature of the pan surface was obtained, the sample was put into the pan and the time of roasting was noted. Sample was agitated continuously and the representative samples at 0.5, 1, 2, 3, 4 and 5 min intervals were taken out and kept quickly in pre-weighed moisture box. Radii of the individual nuts and kernels of the sample were measured before roasting with the help of a vernier caliper. Equilibrium moisture content of the sample at roasting temperature was assumed to be negligible because of very high roasting temperature. Five equations, viz., quadratic, linear, logarithmic, power and exponential were tested for best fit of the data of moisture ratio (MR) and roasting time. Among these equations, correlation coefficients of the following exponential equation was found maximum, (>0.992).

$$MR = \frac{M}{M_0} = C_1 \exp(-C_2\theta) \quad \ldots\ldots (1)$$

Where, M is moisture content of the sample at any time θ (% db), M_0 is initial moisture content of the sample (% db), C_1 is constant (dimensionless), C_2 is constant (min^{-1}) and θ is roasting time (min).

The values of C_1 and C_2 were obtained from the exponential equations, best fitted to the data of moisture content ratio and roasting time and the constant C_2 of equation (1) was interpreted, considering the mass transfer from the porous bodies as follows (Luikov 1966) :

$$\text{i.e.,} \quad C_2 = \frac{D\pi^2}{r_0^2} \quad \text{or,} \quad D = \frac{C_2 r_0^2}{\pi^2} \quad \ldots\ldots (2)$$

Where D is moisture diffusivity (m^2min^{-1}) and r_0 is the average radius of the kernel or nut (m).

When $D\pi^2/r_0^2$ is greater than 1.2, the equation (2) gives satisfactory results (Luikov 1966). From Equation (2), the moisture diffusivities of the samples at 60.2, 33.7 and 25.9% moisture content (db) of gorgon nut, at 48.6, 33.4, 15.3% moisture contents of kernels and 200, 300 and 400°C pan surface temperature, were calculated using the average radius of the individual kernel and the nut. Each experiment was replicated thrice. To determine the relationships among moisture diffusivity, moisture content and roasting temperature, randomized design experiments were chosen. Levels of the moisture content of the samples were selected which were obtained after drying, preheating and roasting of the nut. The results were analysed according to the multiple regression method (Snedecor and Cochran 1967). Coefficients of each term of the regression equations were subjected to F-test at 5% level of significance.

Coefficient of cubical thermal expansion : The method to determine the coefficient of cubical thermal expansion of gorgon nut kernel and shell was based on the standard ASTM test D864-52 for plastics (ASTM 1968).

Results and Discussion

Moisture diffusivity : The results of the moisture diffusivity of gorgon nut and kernel are presented in Table 1. It is evident that the moisture diffusivities

TABLE 1. MOISTURE DIFFUSIVITY OF GORGON NUT AND ITS KERNEL

Treat-ment No.	Tempe-rature	Gorgon nuts		Kernels	
		Moisture content	Moisture diffusivity	Moisture content	Moisture diffusivity
	°C	%, db	$m^2/min \times 10^{-7}$	%, db	$m^2/min \times 10^{-7}$
1	200	60.2	5.11	48.6	4.87
2.	200	33.7	4.08	33.5	4.28
3	200	25.9	3.88	15.3	3.59
4	300	60.2	5.66	48.6	5.72
5	300	33.7	4.78	33.4	5.20
6	300	25.9	4.39	15.3	4.29
7	400	60.2	6.28	48.6	6.57
8	400	33.7	5.29	33.4	6.11
9	400	25.9	4.78	15.3	4.83

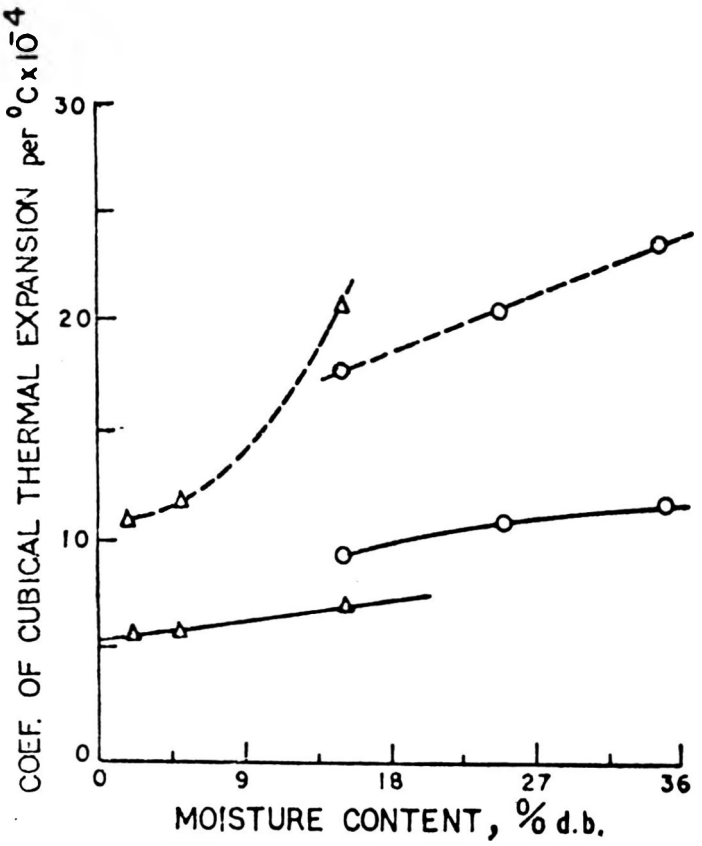

Fig. 1. Effect of moisture content and temperature on coefficient of cubical thermal expansion of gorgon nut kernel and shell, O—O kernel; Δ——Δ shell; —— 31-66°C; - - - - 66-96°C

of the nut and the kernel increase with increase in moisture content and temperature. The multiple regression analysis of results showed that the coefficients containing all the moisture and quadratic terms in the equation for nut, and the coefficients of second order terms for moisture as well as temperature of the equation in case of kernel, were not found significant at 5% level and thus, those terms were omitted from the final equations. The final regression equations for the nut and the kernel with best fit having the correlation coefficients of 0.997 for both the cases were :

$$D_n = 1.22 \times 10^{-7} + 6.77 \times 10^{-10} T \quad \ldots (3)$$

$$D_k = 1.22 \times 10^{-7} + 5.88 \times 10^{-9} M + 7.32 \times 10^{-10} T \quad \ldots (4)$$

Where, D_n and D_k are moisture diffusivity of the gorgon nut and the kernel, respectively ($m^2 min^{-1}$), M is moisture content of the sample (% db), and T is the temperature of the sample (°C).

Coefficient of cubical thermal expansion : Coefficient of cubical thermal expansion of the kernel and shell are plotted with moisture content in Fig 1. Coefficients of cubical thermal expansion of both kernel and shell are much higher beyond a transition temperature of 66°C. The coefficient of cubical thermal expansion of the shell increases rapidly above 5% moisture content and 66 to 96°C temperature range and exceeds the value of the kernel at about 15% moisture content. But, in actual roasting operation of the gorgon nut, moisture content of the shell would never exceed beyond 5% and that of the kernel in the range of 15 to 33%. In the above range of moisture content, the coefficient of cubical thermal expansion of the kernel is much higher than that of the shell. This indicates that the nut is subjected to not only the internal pressure build up within the nut due to thermal processing, but also to the mechanical pressure exerted by the kernel on the shell due to higher rate of cubical thermal expansion.

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Large Scale Production of Iron Fortified Salt

S. RANGANATHAN*[1], P.K. DILLIKUMAR[2], P RAMAMOORTHY[2] AND VINODINI REDDY[1]

[1]National Institute of Nutrition, Hyderabad-500 007, India.

[2]Mariyur Valinokkam Salt Complex, Tamil Nadu Salt Corporation Ltd., Valinokkam-623 528, India.

A new process that can produce iron fortified salt (IFS) on a large scale (3-4 metric tons/h) has been developed for the first time in India in a salt factory at Ramanathapuram, Tamil Nadu State. In this process, common salt is mixed with 0.5% each of ferrous sulphate and sodium hexametaphosphate in a ribbon blender. The dry mixing is superior to the other method based on spraying of a solution of ferrous sulphate, monosodium orthophosphate and sodium acid sulphate over common salt. The spray-mixing method encountered operational problems on account of stickiness of the components and it also requires additional equipment such as dryer. The need for this is eliminated in the dry mixing process. Also, the product obtained by the spray-mixing process developed yellow colour on storage. IFS obtained by the dry-mixing process remained colourless during prolonged storage at ambient temperatures. Iron distribution in the IFS was also found to be uniform. Various food items prepared using the IFS of dry-mixing process were indistinguishable from those containing unfortified salt in colour, taste, flavour or texture. The IFS conforms to the standards of the PFA Rules.

Keywords : Iron fortified salt, Large scale production, Dry mixing of salts, Acceptability, Analytical aspects, Production cost.

Iron deficiency anaemia (IDA), the most prevalent nutritional problem in the country, is, particularly, high among pregnant women and young children. Severe anaemia in pregnancy is associated with increased risk of maternal mortality, premature delivery and low birth weight (Menon 1968). Anaemia, in its milder form, may manifest itself in the symptoms like fatigue and lethargy, thereby affecting the individual's ability to work. There is evidence to show that even moderate reduction in haemoglobin can impair work capacity, mental performance and immune response (Anderson and Barkve 1970; Srikantia et al. 1976). Anaemia is caused by insufficient iron intake, its poor absorption and increased iron losses. Administration of therapeutic doses of iron is a short-term measure to quickly restore haemoglobin levels. In this context, fortification of foods with iron is considered to be a more practical approach to supplement iron and thus minimise the incidence of anaemia in the population (INACG 1977; RWGFSI 1982; Cook and Reusser 1983).

Common salt presents itself as an ideal carrier of iron for several reasons. It is consumed in all regions of the country, irrespective of the dietary patterns, by all normal children and adults (urban/rural, poor/rich, vegetarian/non-vegetarian) each day consistently throughout the year. Salt is well dispersed in all food preparations. Most of the salt consumed in the country is produced from sea water, the consumption by an adult being 10-15 g per day (Pasricha 1966). The usefulness of iron fortified salt (IFS) in the prevention and control of IDA has been clearly demonstrated in extensive studies conducted in India (Nadiger et al. 1980; RWGFSI 1982). The standards for IFS have been notified in the year 1985 in the Prevention of Food Adulteration Rules of the PFA Act (PFAR 1955). Though there are some small scale ventures in the private sector, information on large scale manufacture of IFS is scanty in the country. In view of this, attempts were made to manufacture IFS on a large scale (3-4 metric tons/h which leads to 500 metric tons/month in a single shift) in a public sector factory for the first time in India. The studies on the stability and acceptability of IFS, and on economics of its production on a large scale, have led to the commissioning of two other plants in Madras and Jaipur, India, in public sector.

Materials and Methods

The trials were carried out at Ramanathapuram plant of the Tamil Nadu Salt Corporation, a public sector undertaking of the Government of Tamil Nadu. The plant has an installed capacity of 15,000 metric tons/annum. Common salt (NaCl 97-98%, water 2-3%) from the Mariyur-Valinokkam Salt Complex was used. Ferrous sulphate ($FeSO_4$. $7H_2O$) monosodium orthophosphate (NaH_2PO_4. $2H_2O$) and sodium acid sulphate ($NaHSO_4.2H_2O$) were supplied by UNICEF. Sodium hexametaphosphate (SHMP) was obtained from M/s. Abhyudaya Chemical and Scientific Corporation, Hyderabad. All the chemicals used were of food grade quality. Standard methods

* Corresponding Author

were used for the analysis of IFS as per PFA Rules (PFAR 1955).

In the spray-mixing process, a solution of ferrous sulphate, monosodium orthophosphate, and sodium acid sulphate (old formula, Table 1) in

TABLE 1. COMPOSITION OF IRON FORTIFIED SALT

Ingredient	Quantity
Old formula	
Common salt, kg	25
Ferrous sulphate, g	125
Monosodium orthophosphate, g	87.5
Sodium acid sulphate, g	125
New formula	
Common salt, kg	25
Ferrous sulphate, g	125
Sodium hexametaphosphate, g	125

water was sprayed over common salt and mixed in a ribbon blender, till iron distribution was uniform. In the dry-mixing process, both the old formula (Narasinga Rao and Vijayasarathy 1978) and the new formula (Ranganathan 1992) were used (Table 1). A schematic diagram of the system is shown in Fig.1. The chemicals were thoroughly

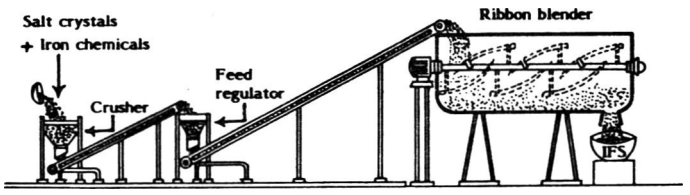

Fig.1. Salt fortification - Dry mixing plant

mixed in a small blender (50 kg capacity) and the mixture along with common salt was introduced into the crusher for the first stage of mixing. The second stage of mixing took place in the feed regulator. The third and final stages of mixing were carried out in a ribbon blender. Acceptability of IFS incorporated in various foods (Table 2), in place of common salt, was studied in the factory itself. Foods prepared using the unfortified salt served as the control. Cooked foods were served to fifty volunteers (IFS factory staff and visitors) in a double-blind mode i.e. they were ignorant about the presence or absence of IFS in the food items being tasted by them. The scores given by them to the food items with respect to organoleptic properties were recorded.

Results and Discussion

In the spray-mixing process, IFS became wet and sticky in the ribbon blender and this hampered

TABLE 2. FOODS USED IN THE ACCEPTABILITY TRIAL OF IRON FORTIFIED SALT

A. VEGETARIAN
(1) Cooked preparation:
Curry - Bittergourd, brinjal, potato, green banana and snakegourd.
Sambar - Lady's finger, onion and tomato.
Rasam - Tomato, coriander leaves.
(2) Raw vegetables : Tomato, green banana, potato, mango
(3) Fruit : Apple
(4) Pickle : Mango

B. NON-VEGETARIAN
Egg omelette, boiled egg, prawn fry, sea fish curry and fry, fish and mutton.
Sambar : Cooked redgram and vegetables suspension.
Rasam : Vegetarian soup made with tamarind and seasoned with pepper/spices/tomato

continuous production of the salt. The removal of excess moisture necessitated the use of an expensive and sophisticated fluid-bed dryer. The IFS developed yellow colour within a few days of production. Incorporation of additional monosodium orthophosphate or orthophosphoric acid, followed by blending could decolourize the IFS. However, the IFS turned yellow again after 3-4 weeks of storage. Though the old formula was shown to be satisfactory in the laboratory trials (Narasinga Rao and Vijayasarathy 1978), it was found unsuitable for the production of IFS on an industrial scale. Similar observations have also been reported in other factories in Hyderabad and Madras (Ranganathan 1992). Due to the operational problems and higher cost of production, the spray-mixing was found unsuitable for continuous production of IFS. Satisfactory results were obtained in the dry mixing process. No problems were encountered in the continuous production of IFS i.e. uninterrupted production. The raw materials were fed continuously. The blender was not stopped to collect the IFS, unlike in case of batch mixing where the blender had to be switched off to collect the IFS. The normal production capacity of the plant (3-4 metric tons/h) was unaltered. Uniform iron distribution (1000±50) could be achieved. The old formula was found unsatisfactory in this process also, since the IFS turned yellow within a few days of production. On the other hand, the new formula did not pose any problem. The IFS retained the colour of the unfortified salt. No discolouration was observed even after one year of storage. Analysis of several hundred samples showed that iron distribution was uniform and the IFS conformed to the standards of the Prevention of Food Adulteration Rules of the PFA Act for iron fortified common salt (Table 3). The results of different production techniques

TABLE 3. ANALYSIS OF UNFORTIFIED AND IRON FORTIFIED SALT

Attribute	Unfortified salt	Iron fortified salt
Colour and appearance	White crystalline solid	White crystalline solid
NaCl, % (dry weight)	98.9	98
Moisture, % (dry weight)	2	2
Iron, ppm	Traces	950-1050
Phosphorus ppm	Nil	1500-1600
pH of 5% aqueous solution	6.7	3.4
Magnesium (water soluble), % (dry weight)	0.04	0.04
Sulphate, % (dry weight)	0.13	0.3
Water insoluble matter, % (dry weight)	0.4	0.4
Matter insoluble in dilute hydrochloric acid, % (dry weight)	0.3	0.3
Matter soluble in water-other than NaCl - % (dry weight)	0.4	1.1

showed that except for dry-mixing, using the new formula, the quality of IFS by other techniques was unsuitable.

The results of the acceptability trial showed that IFS is acceptable in day-to-day cooking. There was no alteration in the organoleptic properties of foods prepared by using IFS in place of unfortified salt, as ascertained by the scores given by volunteers in respect of colour, taste, flavour and texture of foods containing either unfortified salt or IFS. This observation is in line with the earlier experience with the new formula (Ranganathan 1992).

The IFS produced in the plant is packed in 1 kg HDPE packs and supplied to the centres of the 'Nutritious Noon Meal Scheme' of the Tamil Nadu Government, through the Social Welfare Department. Monthly supply has been 400-500 metric tons. The feed-back on IFS from the noon meal centres is satisfactory and confirms the acceptability trial. The cost of 1 kg IFS is Rs. 2.50 and it depends upon the quality of raw salt and the type of HDPE pack. The cost of investment to set up an IFS plant depends upon the land, building, machinery and manpower. The costs of 100 kg batch mixer and the crusher are Rs. 1 lakh and Rs. 0.90 lakh, respectively. These machines are available in the country (RSGCPPISS 1984). Using a 100 kg batch mixer, 4-6 metric tons of IFS can be produced in one shift of 8 h (Ranganathan 1992).

The important step in salt fortification is the choice of an iron compound and an appropriate stabiliser so that the IFS will be free from discolouration. Acceptability, stability and bioavailability of iron should be satisfactory. The new formula of dry-mixing appears to satisfy all these criteria (Ranganathan 1992). The present study shows that commercial production of IFS in a factory is smooth and economical.

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Storage Stability and Sensory Quality of Washed Ground Buffalo Meat and Meat *Patties* During Refrigerated Storage

V.V. KULKARNI[1]*, B.N. KOWALE[2], V. KESAVA RAO[2] AND T.R.K. MURTHY[2]

[1]Animal Products Technology, Department of Animal Breeding and Genetics, College of Veterinary and Animal Sciences, HPKV, Palampur-176 062, India.

[2]Division of Livestock Products Technology, Indian Veterinary Research Institute, Izatnagar - 243 122, India.

Effect of washing with water and EDTA solution (2%, pH 4.5) on the keeping and sensory qualities of ground buffalo meat and meat *patties* during refrigerated storage of 20 days at 4±1°C was studied. Myofibrillar fragmentation index (MFI) of raw and EDTA-washed meat did not differ significantly, but exhibited pronounced increase in water-washed samples during storage and was accompanied by higher microbial counts. Tyrosine contents in all the samples increased significantly ($P<0.01$) during later days of storage. Washing generally reduced thiobarbituric acid (TBA) value and EDTA-washed meat had lowest TBA value. Microbial counts of EDTA-washed meat were significantly ($P<0.01$) lower than those of unwashed. EDTA-washed meat *patties* had poor binding and juiciness. *Patties* prepared from EDTA-washed meat and stored for 20 days at 4±1°C were rated as slightly acceptable. Water-washed meat *patties* were comparable to raw meat patties.

Keywords : Buffalo meat, Water and EDTA washing, Meat *patties*, Refrigerated storage, Sensory quality.

In buffalo meat products, colour and mouth coating are two major problems which need to be solved successfully (Padda et al. 1968; Kondiah et al. 1986). In spite of initial improvement in the quality of washed meat, its keeping quality during refrigerated storage has not been studied so far. The refrigerated shelf-life of washed-meat, overall acceptability of meat *patties* (pancake-like traditional preparation) prepared from washed-meat and effect of EDTA-washing to extend the shelf-life of buffalo meat were studied.

Materials and Methods

Four adult (around 6 years old) healthy male buffaloes (*Murrah* type) of uniform body conformation were selected and slaughtered by *halal* method at the local slaughterhouse. Meat sample from one buffalo was used for conducting experiment at a time. Muscles comprising medial round cut (*Mukkadam*, a common wholesale cut in India) were collected within 6 h of slaughter; brought to the laboratory in chilled condition, trimmed-off fat, fascia and excess of connective tissue; and cut into approximately 2.5 cm^2 cubes. The cubes were minced through 8 mm, followed by 4 mm plates.

Minced meat was divided into 3 groups-one served as control and the other two were subjected to washing. For washing, minced meat samples were soaked separately in chilled distilled water or 2% EDTA (disodium) solutions (pH 4.5) in a ratio of 1:2 (w/v) in sterilized stainless steel vessels with frequent stirring for 10 min. The meat was squeezed in double layered sterilized muslin cloth by applying hand pressure to the extent that no continuous drip was evident from the meat. In all, two washings were given to each group of meat samples. About 100 g and 25 g of samples were packed separately in 150 gauge polyethylene bags and were stored at 4±1°C for 20 days. Samples drawn on 0, 5, 10, 15 and 20th day of storage, were analysed for myofibrillar fragmentation index (MFI), tyrosine content, thiobarbituric acid (TBA) value, aerobic plate count (APC), psychrotrophic plate count (PPC) and sensory quality.

In order to evaluate the effect of washing on the sensory quality, *patties* were prepared from a) raw, water washed raw + water washed (1:1) and b) raw, EDTA-washed, raw + EDTA-washed, raw + EDTA-washed (1:1) meats. Recipe for spice mix and *patties* preparation was as reported elsewhere (Anjaneyulu 1988; Pati et al. 1992).

Analytical methods : MFI was determined by the method of Olson et al. (1976), as modified by Cullar et al. (1978), tyrosine content by the procedure of Strange et al. (1977) and the TBA value by the extraction method of Witte et al. (1970). APC and PPC were determined according to the procedure of ICMSF (1978). Sensory evaluation was conducted adopting a 8 point Hedonic scale with at least 6 semi-trained taste panelists. The statistical analysis of the data was done by using analysis of variance technique and LSD. The significance of the

* Corresponding Author

correlation coefficients was tested by using students' 't' test (Snedecor and Cochran 1967).

Results and Discussion

MFI of raw, water and EDTA-washed meat samples increased during storage of 20 days at 4±1°C (Table 1). A similar increase was observed in MFI during post-mortem storage of bovine meat tissue, as a result of enzymatic and microbial breakdown of myofibrillar proteins (Olson and Parrish 1977; Olson et al. 1970). A significant ($p<0.05$) correlation ($r=0.50$) in water-washed samples with length of storage period was observed. After 10 days storage, MFI in EDTA-washed meat was lower as compared to water-washed meat. This may be due to chelation of heavy metal ions by EDTA, which, in turn, might have reduced the activity of calcium activated sarcoplasmic factor (CASF) on myofibrillar proteins during early stages of storage (Olson and Parrish 1977). However, difference between MFI of raw and EDTA-washed meat during the entire storage period was not significant ($P>0.05$).

washed samples suggested that the increase in the former samples was mainly due to microbial action and in the latter, due to autolytic enzymes. Morrisey et al. (1980) also observed increased tyrosine contents in both sterile and inoculated beef samples during refrigerated storage.

TBA value observed in fresh raw meat (Table 1) was higher than that recorded by others (Anjaneyulu 1988; Agnihotri 1988; Kesava Rao 1988). This could be attributed to mincing of meat prior to estimation as against the chunks used by others. Washing of meat reduced the TBA value due to removal of components formed during oxidative reactions and partial removal of catalyst iron, as observed in water-washed pork (Colmenero and Matamoros 1981). During storage, TBA values in all the samples increased significantly ($P<0.01$). There were no significant differences in TBA values of washed and unwashed samples upto 10th day. During the entire storage period, TBA values in EDTA-washed samples were within the range of threshold value of 1-2 mg/kg as reported by Watts

TABLE 1. EFFECT OF WATER AND EDTA TREATMENT ON THE MFI, TYROSINE (mg/100 g) AND TBA (mg MALONALDEHYDE/kg) VALUE OF MINCED BUFFALO MEAT DURING REFRIGERATED STORAGE (4±1°C)

Storage period, days	MFI[1]			Tyrosine			TBA[2]		
	R	W	E	R	W	E	R	W	E
0	87.5 ±19.0	65.0 ±8.6	88.2 ±17.8	19.4^{aA} ±4.3	8.1^{aA} ±1.4	18.3^{aA} ±8.6	0.7^{aA} ±0.1	0.6^{aA} ±0.1	0.6^{aA} ±0.3
5	72.5 ±13.3	89.2 ±25.8	89.2 ±27.9	21.4^{aAB} ±3.1	19.9^{bB} ±3.2	23.4^{aA} ±7.1	1.4^{aA} ±0.3	1.0^{aA} ±0.2	0.6^{aA} ±0.2
10	74.5 ±15.3	93.3 ±18.5	80.0 ±7.2	32.2^{bBC} ±3.4	26.3^{bcBC} ±3.9	31.1^{aABC} ±10.3	1.5^{aA} ±0.1	1.5^{aA} ±0.4	0.7^{aAB} ±0.2
15	105.5 ±8.3	138.3 ±22.6	80.1 ±22.9	50.0^{bCD} ±12.1	38.6^{bBC} ±7.6	32.1^{aBC} ±5.8	3.9^{aB} ±0.7	2.8^{bB} ±0.3	1.7^{cB} ±0.5
20	89.0 ±10.2	114.5 ±16.3	91.5 ±22.7	62.4^{bD} ±14.4	69.2^{bC} ±18.9	41.0^{aC} ±8.8	2.1^{aC} ±0.1	3.6^{aC} ±0.9	1.1^{bAB} ±0.01

Means with at least one similar superscript in the same row (a, b, c) and column (A, B, C) do not differ significantly ($P<0.05$), R=Raw, W=Water, E= EDTA; n=4 for each mean±S.E. value; 1. Myofibrillar Fragmentation Index; no effect of either treatment or storage was noticed. 2. Thiobarbituric Acid Value.

Tyrosine content of fresh raw meat (Table 1) was comparable to that reported for buffalo meat (Agnihotri 1988). Washing did not affect the tyrosine content. However, it increased significantly ($P<0.01$) during storage in all the samples and a significant correlation with length of storage period was observed in raw ($r=0.71$), water-washed ($r=0.75$) and EDTA-washed ($r=0.54$) samples. Similar increase was reported in buffalo meat (Olson et al. 1976). A significant ($P<0.01$) correlation of tyrosine content between microbial counts (APCs and PPCs) in raw ($r=0.60$, 0.60) and water-washed ($r=0.67$, 0.72) samples and insignificant correlation in EDTA-

(1962) for rancidity in meats. This confirmed the anti-oxidant effect of EDTA as observed by Roozen (1987). TBA values in raw and water-washed samples crossed the threshold limit after 10th day of storage.

APC and PPC in fresh raw meat (Table 2) were comparable to those reported for buffalo meat (Agnihotri 1988). During storage, APC and PPC increased significantly ($P<0.01$). The microbial counts in EDTA-washed samples were lower than those for raw and water-washed meat samples during entire storage period. Both APC and PPC in water-washed samples exceeded log 7/g, the maximum limit of

TABLE 2. EFFECT OF WATER AND EDTA TREATMENT ON THE APC (10g/g) AND PPC (10g/g) OF MINCED BUFFALO MEAT DURING REFRIGERATED STORAGE (4±1°C)

Storage period, days	APC[1]			PPC[2]		
	R	W	E	R	W	E
0	5.4^{aA}±0.1	4.9^{aA}±0.2	4.6^{aA}±0.3	3.0^{aA}±0.1	3.3^{aA}±0.5	2.5^{aA}±0.2
5	5.8^{aA}±0.3	5.6^{aA}±0.5	4.5^{aA}±0.2	5.1^{aAB}±1.0	6.4^{bB}±0.9	3.0^{aAB}±0.4
10	6.6^{abA}±0.8	7.0^{bB}±1.0	5.0^{aA}±0.7	5.5^{bBC}±0.7	7.2^{bcBC}±0.5	3.8^{aABC}±0.9
15	7.7^{bAB}±0.8	7.9^{bBC}±0.7	5.0^{aA}±0.4	7.4^{bCD}±1.1	8.5^{bBC}±0.3	5.1^{aBC}±0.9
20	8.8^{abB}±0.4	9.1^{bC}±0.3	7.3^{aB}±0.8	8.2bD±0.4	9.0^{bC}±0.6	6.0^{aC}±1.5

Means with at least one similar superscript in the same row (a, b, c) and column (A, B, C) do not differ significantly ($P<0.05$) R=Raw; W=Water; E=EDTA, n=4 for each mean ±SE value 1-Acrobic Plate Count; 2-Psychrotrophic Plate Count.

standard plate count (Mallya 1983) on 10th day of storage. The EDTA-washed samples were better with counts (lower than log 7/g up to 15th day) than raw and water-washed samples.

Washing of meat reduced the meat colour appreciably. Water-washed meat had pink red colour and pleasant meaty odour, whereas EDTA-washed meat was near white dull in colour with little sour odour. Texture of washed meat samples was near to the rubbery texture of water-washed pork (Colmenero and Matamoros 1981). In general, acceptability scores of fresh raw meat were higher than water-washed meat. Insignificant changes were recorded in colour, odour and overall acceptability scores in EDTA-washed samples during entire storage period. This was indicative of the lesser microbial and oxidative changes in these samples. The slight sour odour in these samples was not expressed as unpleasant which would render it unacceptable by the taste panelists. Water-washed samples developed greening, browning and off-odour on 15th day. Agnihotri (1988) also observed a slight off-odour in buffalo meat on 9th day of refrigerated storage with total microbial counts above log 7/g.

Meat *patties* prepared from water-washed meat alone were comparable to *patties* prepared from raw meat and addition of raw meat did not improve the sensory qualities of these *patties*. EDTA-washed meat *patties* had poor binding, juiciness and slight sour odour and these were rated as slightly acceptable. This may be due to lower pH and low extractability of meat proteins. Addition of raw meat to EDTA-washed meat improved the overall sensory quality to a moderately acceptable level. No deterioration of sensory quality of these *patties* was observed even after 20 days of refrigerated (4±1°C) storage of meat.

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Utilization of Butter Milk in Manufacture of Buffalo Milk Cheddar Cheese : Changes During Ripening

N.S. JOSHI* AND P.N. THAKAR
Dairy Science College, Gujarat Agricultural University, Anand-388 110, India.

Buffalo milk was standardized to casein : fat ratio of 0.7, using skim milk and various proportions of sweet cream butter milk for preparing Cheddar cheese. Incorporation of butter milk in cheese significantly increased the moisture, acidity, maturity index and total volatile fatty acid contents compared to control cheeses, whereas the pH was reduced. Sensory evaluation of the cheeses revealed that the cheese made by substituting 25% casein of skim milk by butter milk was at par with that of control. Further addition of butter milk in buffalo milk brought deterioration in the cheeses.

Keywords : Butter milk, Cheddar cheese, Ripening, Sensory evaluation.

Many varieties of cheeses are manufactured utilizing butter milk Some examples are Edam (El-Sadek et al. 1969), Brick (Reisfield and Harper 1954), Soft (De et al. 1974), Kachkaval (Prodanski and Simov 1973), Low fat (Nikolaev and Fremina 1974), Kareish (Ibrahim et al. 1990) and Danbo cheese (Bagger and Forsingal 1989). Inclusion of sweet cream butter milk in cheese milk for baby Edam cheese (El-Sadek et al. 1969), Litowski cheese (Nikolaev and Fremina 1974), Kachkaval cheese (Prodanski and Simov 1973) and Kareish cheese (Ibrahim et al. 1990) has resulted in faster proteolysis of resultant cheese and improvement in flavour of the cheeses. Kulkarni et al. (1975) studied the quality of dried cheese from buffalo milk, while Kanawjia and Singh (1990) reported the effect of proteases on flavour development and other biochemical changes in buffalo milk cheddar cheese. But so far, no work has been reported on the utilization of butter milk for manufacturing Cheddar cheese, except for a very early report (Yamamoto et al. 1962); wherein skim milk along with 6% butter milk was used. The present paper reports the results of studies on the use of butter milk in producing Cheddar cheese, along with the ripening changes and sensory quality.

Materials and Methods

Different levels of substitution of casein from skim milk, by butter milk used to standardize buffalo milk, were in the proportions of 75:25 (T_1), 50:50 (T_2), 25:75 (T_3) and 0:100 (T_4). The fat, casein and total solid contents of buffalo, skim and butter milks were 8.2, 3.1, 16.8; 0.1, 3.3, 10.6; and 0.2, 2.8, 10.0, respectively. Standardized and pasteurized (72°C for 16 sec) milk (90 kg) was used for cheese making by a standard method (Van Slyke and Price 1952) with modifications such as use of 2% of starter (Wiesby-1488), 33°C setting temperature and cooking at 37°C. Fromase, the enzyme preparation from *Mucor miehei* (Gist Brocades, France) was used as a coagulant at a rate of 4.5 g/100 kg milk. The cheese curd was milled at the acidity level of 0.45% lactic acid, followed by salting (2.5%) and pressing for 16 h. All the cheeses were ripened at 8±1°C and 80-88% relative humidity (RH) for a total period of 180 days. The cheese samples were subjected to analysis when fresh and after 45, 90, 135 and 180 days of ripening.

Chemical analysis : Moisture and total nitrogen of the cheese were determined according to the procedures outlined by MIF (1959) and Menefee and Overman (1940), except that instead of using mercury oxide as a digestion catalyst, a mixture of copper sulphate and potassium sulphate was used. Acidity was determined as per the method of AOAC (1972). The pH of the cheese was measured at 25°C in a slurry of 1:1 grated cheese with distilled water. The degree of proteolysis was determined by the level of maturity index (Kosikowski 1970), whereas, the total volatile fatty acids (TVFA) were determined by direct distillation method (Kosikowski and Dahlberg 1946) and expressed as 0.1 N acid/100 g cheese.

Sensory and statistical evaluation: A panel of 8 judges scored cheese samples on the basis of flavour, body and texture, using Cheddar cheese score card (Nelson and Trout 1964). The mean values of each attribute, obtained from duplicate samples for 3 replicates of the experiment, were

* Corresponding Author

subjected to statistical analysis as per the method described for split plot design (Steel and Torrie 1980).

Results and Discussion

Fig. 1 represents the changes in moisture content of cheese during ripening. Control cheese exhibited the lowest moisture content ($p<0.01$) initially and

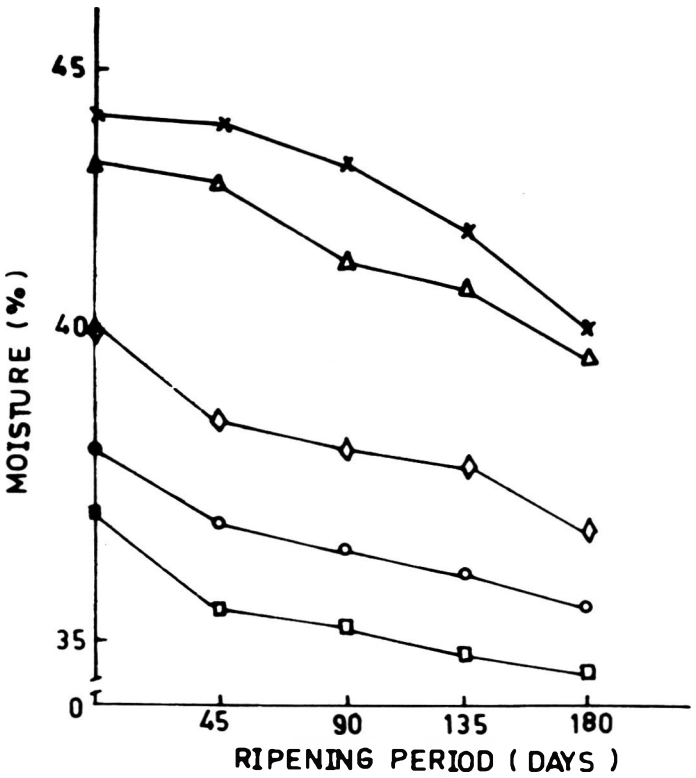

Fig. 1. Changes of moisture during ripening
□—□ Control, ○—○ T_1, ◇—◇ T_2, Δ—Δ T_3, x—x T_4

throughout the ripening period. The level of butter milk was also found to affect the moisture content significantly ($p<0.01$), while the product made with higher butter milk showed higher moisture and the difference persisted throughout ripening. A gradual reduction in moisture of all the cheeses was observed as the ripening progressed, probably due to evaporation (Scott 1954).

The biochemical changes in cheese are presented in Fig. 2. The acidity of all the experimental cheeses was significantly higher ($p<0.01$) than the control, initially and also throughout the ripening period. A higher rate of increase in acidity of cheese, made from the milk containing higher proportion of butter milk, was observed, and this may be due to higher retention of moisture and relatively increased activity of microorganisms in the product. With the progress of cheese ripening, the acidity was found to increase significantly ($p<0.01$) in all the cheeses.

Control cheese showed significantly ($p<0.01$) higher pH throughout the ripening period, as compared to all the experimental cheeses, except T_1. Similarly, T_2 and T_3 also had pH values at par upto 90 days of ripening, beyond which the difference in pH was significant ($p<0.05$). A gradual rise in pH was observed in all the cheeses till 135 days, beyond which control cheese showed rather sharp increase in pH, as the ripening progressed upto 180 days. The rise in pH may be attributed to degradation of lactic acid, formation of non-acidic decomposition products and weaker or less highly dissociated acids, and liberation of protein decomposition products (Lawrence et al. 1987).

The minimum value of maturity index was 10.38 in fresh control cheese, whereas the maximum value was 56.95 in T_4 cheese ripened upto 180 days. The maturity indices of experimental cheeses were significantly ($p<0.01$) higher than the control and the difference persisted throughout the ripening period. The total replacement of skim milk casein by butter milk, in standardizing the milk, resulted in significantly higher maturity index throughout the ripening, as compared to all other treatments. Relatively higher values of maturity index in fresh cheeses might be due to use of fromase (Pahkala and Antila 1981). Significantly higher proteolysis in experimental cheeses may be attributed to higher acidity of cheese milk, presence of soluble protein in cheese milk (available from butter milk), thereby enhancing the growth of lactobacilli and higher moisture and coagulant retention in the cheese. These factors have been shown to be responsible for increased proteolysis in cheese (Ibrahim et al. 1990; Lawrence et al. 1987; Pahkala and Antila 1981). Inclusion of butter milk in cheese milk have also been shown to result in faster proteolysis of the resultant product (Ibrahim et al. 1990; Nikolaev and Fremina 1974; Prodanski and Simov 1973).

The mean values of TVFA were 5.87 for T_1, when fresh, and 48.08 for T_4 cheese ripened upto 180 days. Except the T_4 cheese, all the fresh cheeses including control showed statistically similar values of TVFA. When fresh, T_4 cheese had significantly ($p<0.01$) higher TVFA content than control and T_1 as well as T_3 cheeses. At 45 days, all the experimental cheeses differed significantly ($p<0.01$) in their TVFA contents from those of control, the difference being highly significant within the treatments also. At 90 days, the difference in TVFA content between control and T_1 was significant ($p<0.05$), whereas,

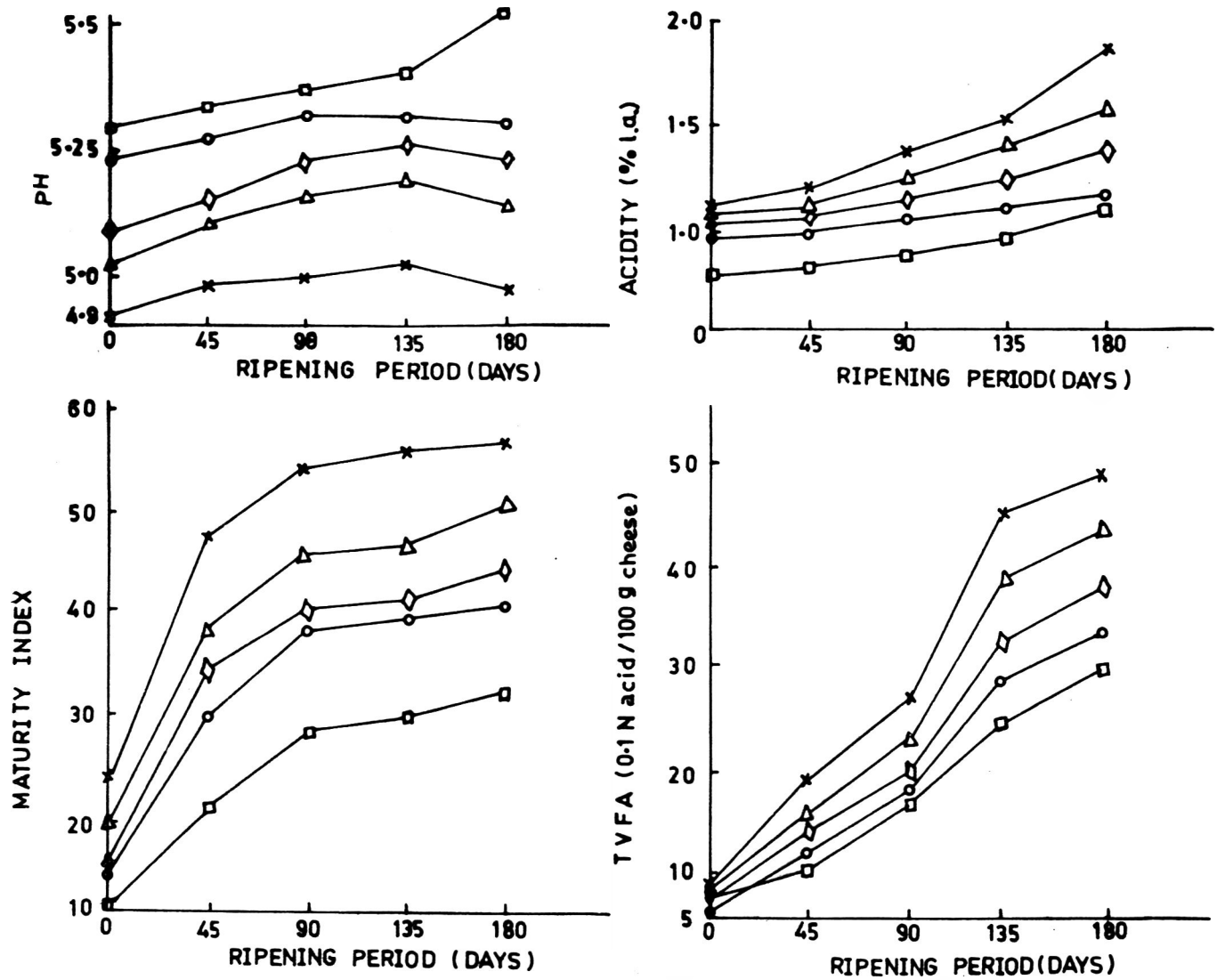

Fig.2. Biochemical changes in cheese during ripening at 8°±1°C □—□ Control, ○—○ T_1 ◇–◇ T_2, Δ—Δ T_3, X—X T_4

these two cheeses had significantly ($p<0.01$) lower TVFA values than all other experimental cheeses. The highly significant difference in TVFA between the control and experimental cheese as well as within the experimental cheeses persisted at 135 and 180 days of ripening. Higher TVFA content was always obtained in the cheese made from the milk containing more proportion of butter milk. Prodanski and Simov (1973) observed an increase in some volatile fatty acids of Kachkaval cheese made by addition of 0.5% protein from butter milk. The increase in TVFA content was highly significant in all the cheeses as the ripening progressed from one stage to another.

The flavour scores of control and T_1 cheese remained statistically at par throughout the ripening period and the same were significantly higher ($p<0.01$) than rest of the cheeses (Table 1). There

TABLE 1. SENSORY SCORES OF CHEDDAR CHEESE MADE FROM BUFFALO MILK, ADDED WITH DIFFERENT LEVELS OF SKIM MILK AND BUTTER MILK.

Treatment	Ripening period (days) 45	90	135	180
Flavour (Maximum 45)				
Control	38.0	41.3	41.1	41.4
T_1	38.6	40.6	40.4	41.5
T_2	37.0	38.5	38.5	38.5
T_3	35.6	36.5	35.7	36.8
T_4	33.4	33.9	•	•
Body and texture (Maximum 30)				
Control	27.2	28.1	28.4	28.8
T_1	27.2	27.9	28.1	28.6
T_2	26.1	26.3	26.8	27.1
T_3	25.1	25.1	25.6	25.5
T_4	23.1	22.7	•	•

• Samples not acceptable sensorily

were increases in flavour scores of all cheeses upto 90 days; after that the changes were non-significant. Mouldy, unclean, acidic and rancid flavours in T_3 and T_4 cheeses were noticeable such that the cheeses became organoleptically unacceptable after 135 days of ripening. Cheddar cheese containing high moisture (about 40%) has been shown to exhibit fermented and whey taint flavours, in addition to bitter and unclean flavour during ripening (Najim and White 1990). The body and texture score increased throughout the ripening period in all the cheeses, except T_3 and T_4. These cheeses had pasty, coarse and crumbly body defects, making them unacceptable after 135 days.

From the results of the present investigation, it is concluded that even though it is possible to make resultant buffalo milk Cheddar cheese with increased proteolysis and lipolysis, substitution at 25% casein of skim milk by butter milk is of practical use, as it gives a product of acceptable organoleptic quality, as compared to control.

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Recovery of Proteins from Ovine Lungs and Rumen for Their Incorporation in Meat *Patties*

SERU GANESH BABU*, V. KESAVA RAO AND B.N. KOWALE
Division of Livestock Products Technology,
Indian Veterinary Research Institute, Izatnagar-243 122, India.

Alkaline extraction method gave a better recovery of proteins from ovine lungs and rumen. The method is simple and lowered microbial load in protein isolates, thereby rendering the proteins microbiologically safe. The protein isolates could be incorporated in the mutton *patties* upto 20% level, replacing high cost lean, without any loss of quality characteristics and sensory attributes. The mutton *patties* incorporated with protein isolates could be stored safely at refrigerated temperature (4±1°C) for 15 days, without any deteriorative changes in quality and acceptability.

Keywords : Lung protein isolate, Rumen protein isolate, Mutton *patties*, Refrigerated storage, Microbiology.

Utilization of edible proteins from slaughter-house byproducts as human food has become necessary to overcome the severe shortage of proteins of higher biological value. Methods for protein isolation are well known in developed countries (Swingler and Lawrie 1979). Paradoxically, the animal protein present in the byproducts is mostly un-utilized or wasted in the developing countries, where there is an increasing demand for such proteins. The method of extraction for recovery of proteins from ovine lungs and rumen as well as the acceptable levels of incorporation in mutton *patties* (without affecting quality, acceptability and shelf-life) are reported in this paper.

Materials and Methods

'Muzaffarnagari' sheep, 1.5 years old, were procured and slaughtered after a thorough ante-mortem examination.

Recovery of proteins : Lungs and rumen were collected and washed thoroughly under running tap water, followed by distilled water. These were cut into small pieces and minced through 4 mm grinder plate in a Electrolux Food Mincer (Model No. 1986 R20, Sweden). Five hundred g each of minced lungs and rumen were suspended in 5 l water. Soluble proteins were extracted for 2 h at pH 10 (adjusted with 10 M sodium hydroxide). The resulting protein solution was filtered through muslin cloth. The protein was recovered by isoelectric precipitation at pH 4.5 using 1 M HCl, followed by centrifugation at 5000 rpm for 20 min. The yields of lung protein isolate (LPI) and rumen protein isolate (RPI) were recorded.

Analysis : The raw lungs, rumen and protein isolates were analysed for moisture, protein and ether extract content (AOAC 1980). The collagen content was determined by estimating hydroxyproline (Nueman and Logan 1950). The microbiological quality of raw lungs, rumen and protein isolates was evaluated by estimating mesophilic (SPC) and psychrotrophic microbial counts (PPC), using the standard methods (ICMSF 1978).

Preparation of mutton patties *incorporating protein isolates :* Entire carcass from 'Muzaffarnagari' female sheep was used as meat source for *patties* preparation. The carcasses, chilled overnight, were hand-deboned. Mutton sample for each trial was pooled from deboned meat of carcasses. Seven recipes were formulated containing 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, and 30.0% of LPI and RPI, with 15% fat in each recipe. The remaining was lean, salt 2%, dry spice mix 1.50%, green curry stuff (onion, garlic and ginger in the ratio of 3:1:1) 3%, phosphate (tetrasodium pyrophosphate) 0.3% and crushed ice 10% were added extra. Meat emulsions were prepared in a bowl chopper (Model 8418 D, Hobart, USA). Sixty g of meat emulsion was moulded in an aluminium circular mould (75 mm diam x 15 mm ht) and cooked to an internal temperature of 75±1°C on perforated trays in a preheated oven at 180°C±5°C. The *patties* were packed in low density polyethylene (LDPE) bags of 150 gauge.

Analysis of mutton patties : The pH of the emulsion and *patties* was measured (Elico pH meter, Model L_1-120) by homogenizing 10 g sample with 100 ml distilled water. Moisture, protein, ether extract and total ash contents of the *patties* were determined (AOAC 1980). Cooking loss was estimated by cooking mutton *patties* samples (25 g) in LDPE bags at 80°C in a water bath for 20 min and weighing samples before and after cooking (Baliga and Madaiah 1970).

* Corresponding Author

Sensory evaluation : The hot cooked *patties* having different levels of LPI and RPI were subjected to the sensory evaluation by semi-trained panel (Soman et al. 1987) for appearance, flavour, juiciness, texture and overall acceptability. A 7 point descriptive scale (7:very acceptable and 1:extremely unacceptable) was used.

Storage studies : Four batches of *patties* were prepared and packed in LDPE bags (150 gauge) and stored in a refrigerator (4±1°C) for a period of 15 days. The stored *patties* were analysed for pH, thiobarbituric acid (TBA) value (Taraladgis et al. 1960), mesophilic and psychrotrophic microbial counts and sensory attributes (Soman et al. 1987) at intervals of 0, 5, 10 and 15 days. The data were subjected to statistical analysis by standard procedures viz. t-test and ANOVA (Snedecor and Cochran 1968).

Results and Discussion

The yield of proteins was 38.2% for lungs and 31.0% for rumen (Table 1) and was in accordance with the findings of Swingler and Lawrie (1978). However, on dry matter basis, there was no difference in the protein yields (lungs 30.35 g/kg and rumen 30.30 g/kg). The proximate compositions of LPI and RPI were similar to those reported for protein isolates obtained from bovine lungs and rumen (Swingler and Lawrie 1978).

TABLE 1. YIELD AND PROXIMATE COMPOSITION OF PROTEIN ISOLATES FROM OVINE LUNGS AND RUMEN

	Lung protein isolate	Rumen protein isolate
Protein recovery, %	38.20±0.46	31.00±0.52
Protein, %	12.81±0.27	19.33±0.16
Moisture, %	84.11±0.20	80.45±0.18
Fat, %	1.00±0.01	0.52±0.02
Total ash, %	0.55±0.02	0.56±0.01
Collagen, %	0.22±0.04	0.12±0.04

Microbial quality of isolates : The mesophilic (SPC) and psychrotrophic microbial counts (PPC) of LPI (4.12±0.25 and 2.35±0.25 log units/g) and RPI (4.66±0.16 and 2.78±0.2 log units/g) were significantly lower (P∠0.01) than the values for raw lung (5.16±0.17 and 3.56±0.25 log units/g) and raw rumen (6.43±0.28 and 4.81±0.3 log units/g). The SPC and PPC of raw lungs were significantly lower (P∠0.05) than those of rumen, in accordance with the findings of Swingler et al. (1979).

Quality characteristic of mutton patties *incorporated with protein isolates* : There was a marginal decrease (P∠0.05) in pH of raw emulsion with increase in incorporation levels of protein isolates from 0 to 30% (Table 2). This decrease was due to low pH of protein isolates. On cooking, the pH of all *patties* increased by 0.5 to 0.9 units, with or without incorporation of protein isolates. The increase in pH of cooked *patties* has also been reported by other workers (Bouton et al. 1971; Kesava Rao and Kowale 1989). This was attributed to a change in protein charge as well as cooking loss (Bouton et al. 1971). There was a marginal decrease (P∠0.05) in cooking loss with increase in levels of protein isolates incorporated. As the decrease in pH was accompanied with higher incorporation level of isolates in raw emulsion, there should have been a simultaneous increase in the cooking loss. But, it was not so, because the protein isolates might be having some role in improving the water binding/hydration or imparting emulsion stability to the meat on cooking (Perera and Anglemer 1980).

The moisture content of *patties* gradually increased, while protein and ether extract contents decreased, with increase in incorporation levels of protein isolates, the change being significant (P∠0.01 for moisture and P∠0.05 for ether extract) with 25% and 30% incorporation levels of LPI and RPI (Table 2). The increase in moisture content and decrease in ether extract content were in close agreement with the findings of Krokha and Shtulboi (1979), who incorporated offal protein isolates in salt sausages, upto 40%.

Sensory evaluation of patties *incorporated with protein isolates* : The general appearance scores for *patties* with 25% and 30% levels of LPI (4.66±0.50 and 4.33±0.36) were significantly (P∠0.01) lower as compared to those for RPI (5.16±0.23 and 4.83±0.20). When LPI and RPI were incorporated upto 20% levels, marginal decreases in scores for all sensory attributes were recorded. The *patties* with 25% and 30% incorporation levels of LPI and RPI recorded significantly lower scores (overall acceptability of 4.33±0.29, 4.16±0.43 and 4.50±0.27, 4.33±0.44, respectively), as compared to those with 20% level (6.00±0.20, 6.00±0.17). It was obvious that panelists preferred *patties* with incorporation of upto 20% levels of protein isolates. However, *patties* with higher levels i.e. 25% and 30% LPI have received lower scores than *patties* with RPI at same levels. This may be attributed to the higher amount of residual heme pigment of LPI in these *patties* which result

TABLE 2. MEAN OF QUALITY CHARACTERISTICS VIZ., PROXIMATE COMPOSITION, pH AND COOKING LOSS (%) OF MUTTON *PATTIES* INCORPORATING LPI AND RPI AT DIFFERENT LEVELS.

	Levels of incorporation (%)						
	0	5	10	15	20	25	30
			Moisture, %				
LPI	62.41	62.54	62.65	62.80	62.90	63.40**	63.90**
RPI		62.55	62.67	62.83	62.94	63.41**	63.92**
			Protein, %				
LPI	18.82	18.76	18.70	18.65	18.55	18.00**	17.88**
RPI		18.75	18.70	18.67	18.57	18.03**	17.80**
			Ether extract, %				
LPI	13.60	13.58	13.51	13.45	13.40	13.05*	12.85*
RPI		13.68	13.50	13.45	13.38	13.04*	12.83*
			Total ash, %				
LPI	2.14	2.11	2.08	2.04	2.00	1.98	1.90
RPI		2.09	2.07	2.03	2.01	1.99	1.90
			pH of emulsion				
LPI	5.73	5.71	5.69	5.67	5.66	5.63	5.56
RPI		5.70	5.68	5.67	5.64	5.61	5.58
			pH of cooked *patties****				
LPI	6.31	6.29	6.27	6.25	6.24	6.11	6.09
RPI		6.29	6.27	6.25	6.25	6.20	6.14
			Cooking loss, %				
LPI	12.54	12.51	12.45	12.90	12.38	12.35	12.32
RPI		12.52	12.48	12.44	12.40	12.37	12.38

* Significant ($P<0.05$) from that of control

** Significant ($P<0.01$) from that of control

LPI = Lung protein isolate, RPI = Rumen protein isolate

*** The mean pH values for cooked *patties* were significantly higher than those for emulsion at all the incorporation levels. Overall range of SE values : 0.01 - 0.43.

in dark brown colour and simultaneous lower sensory scores.

Storage studies: The pH of all the three groups of *patties* (control, LPI and RPI) gradually increased (6.31-6.38 in control; 6.24 to 6.30 in LPI and 6.25 - 6.31 in RPI) during refrigerated storage from 0 to 15 days. This may be possibly due to the prevention of the chemical changes and bacterial action under the refrigerated storage in all the three groups of *patties* (Keeton 1983). The TBA values (mg malonaldehyde per 1000 g) of *patties* increased significantly ($P<0.01$) upto 10th day of storage (0.156 to 0.234 in control, 0.160 to 0.234 in LPI and 0.159 to 0.236 in RPI). These values, however, decreased on 15th day (0.226, 0.225 and 0.226 mg malonaldehyde/1000 g, respectively for control, LPI and RPI). All the 3 groups of *patties* showed similar behaviour which may be due to the influence of other factors, such as reaction of malonaldehyde with amino acids, proteins, amino acids containing phospholipids and malonaldehyde itself to form fluorescent compounds, thereby resulting in reduced extraction of malonaldehyde (Melton 1983). In all the three groups of *patties*, SPC (log units/g) and PPC (log units/g) showed no significant differences from 0 to 15 days of storage (SPC: 3.71 to 3.91 in control, 3.68 to 3.91 in LPI and 3.69 to 3.92 in RPI and PPC: 2.44 to 2.88 in control, 2.42 to 2.84 in LPI and 2.41 to 2.83 in RPI).

The taste panel scores of all the three groups of *patties* gradually decreased (overall acceptability: control 6.16 to 6.04, LPI 6.00 to 5.91 and RPI 6.00 to 5.87) on storage from 0 to 15 days. There was no significant difference in the sensory scores of three groups of *patties* on 10th and 15th day of storage. Such storage stability of meat products for about 10 to 15 days under refrigeration has also been reported by other researchers (Padda et al. 1985; Anjaneyulu 1988).

The study indicated that protein isolates from lungs and rumen could be incorporated upto 20% levels in mutton *patties* without affecting their quality characteristics and the products could be stored at refrigerated temperature (4±1°C) for 15 days.

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Studies on the Suitability of Used Tinplate Container for Packing Groundnut Oil

R.V. GOWRAMMA, M. MAHADEVIAH* AND R. NARESH
Centre for Food Packaging,
Central Food Technological Research Institute, Mysore-570 013, India.

Storage quality of groundnut oil, packed in used tin containers, has been studied over a period of 13 months and compared with that of the oil packed in fresh tin containers. The data on the profiles of free fatty acids, peroxide value, Kries test and sensory evaluation indicated that the fresh tin containers were safe for long storage of 12 months at 37°C, in contrast to the short shelf-life of 3-4 months at 37°C in case of used tin containers.

Keywords : Used tinplate containers, Packing of groundnut oil, Shelf-life, Sensory evaluation, Rust spots, Rancidity.

Normally, tinplate container is the major packaging material for storage and transportation of edible oils. Of late, plastic packaging materials such as flexible pouches and rigid bottles, have been introduced as unit packs and also bag-in-box for 5 kg capacity. However, used tin containers are being used by some of the small scale manufacturers for packing their products. There is an apprehension by tinplate manufacturers that packing of edible oils in used cans may pose health hazards and also provide scope for adulteration. As per the Indian Standards (BIS 1982), the specifications for tin containers include 0.3 mm thickness of tinplate for body, ends and closure, electrolytic 5.6/5.6 g/m^2 tin coating and 18 litres (15 kg) capacity.

Scanty information is available in the literature on the packaging of edible oils in used tinplate containers. Some preliminary studies have been carried out at Agmark laboratory, Nagpur, on the effect of used cans on the quality of edible oils. The results indicated that the reduction in shelf-life of oil, packed in once used containers, was upto 4 months (Grover et al. 1982). The present communication reports long storage studies on the extent of deterioration of groundnut oil packed in used tin containers, as compared to fresh tin containers.

Materials and Methods

Used tin containers : Tin containers (18 litre capacity), used once for packing same type of oil, were used in these experiments. These were washed with caustic soda, rinsed thoroughly in running water and sun-dried before use for packing. The number of rust spots on the tins seen visually were recorded. These cans were stored under ambient conditions (23-32°C; RH; 70-80%) at Bombay, before using for repacking of oil.

Packed oil : Virgin groundnut oil was packed under commercial conditions in fresh and used tin containers of 18 litres capacity at the oil extraction and packing unit, Bombay.

Shelf-life studies : The shelf-life studies were carried out upto 13 months at ambient temperature (25-30°C) and 12 months at 37°C plus one month at ambient temperature. The cut-out analysis was carried out on the product and the condition of the containers.

Methods of analysis : Moisture content was determined by drying 10 g of sample in an oven at 105°±1°C for 1 h (BIS 1968). Free fatty acids (FFA) and peroxide value (PV) were determined by AOCS (1960) method and the method of Wheeler (1932), respectively. Kries test was carried out by the method of Poole and Prater (1945).

Sensory evaluation : This was carried out to determine freshness of oil, identification of rancidity and also of possible incipient rancidity by a 10-member panel. Four stage quality parameters i.e. 1. fresh and typical, 2. indicative of incipient rancidity, 3. slight rancid and 4. clearly rancid (Shanthi Narasimhan et al. 1986) were used in evaluation of overall quality of oil. The mean score on the four point scale was taken into consideration to assess the overall quality of the oil.

Results and Discussion

The results of the periodical shelf-life studies are discussed below.

Storage period upto 3 months : Initially, the moisture contents were 0.008 and 0.093% in case of control and used cans, respectively. There was no significant difference in free fatty acids, peroxide value and Kries value between the oil packed in fresh and

* Corresponding Author

used tin containers. The quality of oil was good and acceptable. On an average, 2-3 rust spots were noticed in the used containers (Table 1).

decomposition of peroxide as a result of secondary reaction, which is accelerated at 37°C. These facts provide possible explanation for the erratic changes

TABLE 1. SHELF-LIFE STUDIES OF OIL IN TIN CONTAINERS

Storage Temperature and period	FFA, % oleic acid		Peroxide value, m.eq. per kg of oil		Kries value, OD/g oil		Quality of oil flavour*	
	Control	Used	Control	Used	Control	Used	Control	Used
1 month at ambient temperature	0.17	0.21	7.0	8.7	0.25	0.39	1	1
3 months at ambient temperature	0.17	0.21	8.3	8.4	0.41	0.41	1	1
2 months at 37°C and 1 month at ambient temperature	0.18	0.25	8.0	12.7	0.42	0.57	1	1
5 months at ambient temperature	0.17	0.21	7.7	9.6	0.63	0.62	1	1
4 months at 37°C and 1 month at ambient temperature	0.20	0.23	10.9	12.3	0.84	0.61	1	3
7 months at ambient temperature	0.17	0.22	34.1	36.1	0.46	0.56	1	3
6 months at 37°C and 1 month at ambient temperature	0.21	0.26	27.6	38.5	0.60	0.57	1	4
9 months at ambient temperature	0.19	0.22	10.9	11.6	0.55	0.56	1	3
8 months at 37°C and 1 month at ambient temperature	0.26	0.38	9.4	7.4	0.63	0.54	1	4
13 months at ambient temperature	0.20	0.29	6.9	4.2	1.40	1.23	1	4
12 months at 37°C and 1 month at ambient temperature	0.28	0.33	4.7	4.6	1.47	1.55	2	4

Ambient temperature was 25-30°C. * Mean score on a 4 point scale.
1 = Typical and fresh, 2 = Incipient rancidity, 3 = Just noticeable rancidity, 4 = Clearly noticeable rancidity

Storage period upto 7 months : After 5 months storage at ambient temperature, the oil packed in control and used tin containers at ambient temperature and the control cans at 37°C was acceptable with respect to all the characteristics. However, oil packed in used cans, stored at 37°C, showed slight rancidity. There was no significant difference in moisture, FFA, PV and Kries test between control and recycled cans (Table 1).

After 6 months storage at 37°C, plus one month at ambient temperature, the oil packed in used cans showed clear rancidity and it was not acceptable. The oil packed in fresh cans, both at ambient temperature and at 37°C, was free from rancidity, without affecting the quality, and it was acceptable by the panelists.

Oil samples in both the containers were free from moisture as against 0.008% and 0.093% at 3 months' storage period in fresh and used tin containers. FFA values were 24% more in used cans. There were steep increases in the peroxide values in both fresh and used cans. The evaluation of peroxide value is helpful in the earlier stages of oxidation. As the oxidation proceeds, the peroxide value increases and reaches a maximum value and thereafter, the peroxide value decreases due to in peroxide values. There was no significant difference in the Kries value between the fresh and the used cans.

Storage period upto 13 months : After 9 months storage at ambient temperature, oil packed in used cans had slight rancidity and change in flavour, whereas, the oil showed clear rancidity at 37°C (Table 1). A few rust spots were also noticed in the interior of used cans. Oil packed in fresh cans was acceptable upto a storage period of 9 months at ambient temperature and 37°C. The can interior of fresh cans was normal and free from rust spots. The final analysis after 13 months storage at ambient temperature and 12 months at 37°C plus one month at ambient temperature indicated that oil packed in fresh cans was acceptable. Can interior was also found to be normal.

In the case of oil packed in used cans, clear rancidity was noticed with off-flavour, thereby making the oil unacceptable. At 37°C, strong obnoxious off-flavour was noticed. A few rust spots were also noticed in the can interior. The results, thus, show that the presence of iron in the form of rust spots accelerates not only oxidation, but also the appearance of reversion flavours. It is apparent that the flavour and stability of the

product cannot be guaranteed because of the lack of control on re-using of tin containers. While cleaning the cans for packing edible oil, stringent precautionary measures have to be taken to maintain the quality of the product.

The results of these studies clearly indicated that groundnut oil could be safely packed in fresh tinplate cans for a long shelf-life of about 12 months at 37°C. Used tinplate cans are suitable for packing groundnut oil for storage upto 4 months at 37°C. Beyond 4 months storage, the oil becomes rancid and on long storage, unacceptable odour develops in the oil which makes it unfit for consumption.

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Influence of Dietary Protein on Aminotransferases and Phosphatases in Rat Tissues

M.R. DORE RAJU, K. VIJAYALAKSHMI AND M. KARUNA KUMAR*
Department of Studies in Biochemistry,
University of Mysore, Manasagangotri, Mysore-570 006, India.

In albino rats, fed *ad libitum* with diets containing 5, 16, 32 and 48% dietary protein for 45 days, the liver mitochondrial and supernatant alanine aminotransferase activities increased at higher levels of protein, but the activities showed a decline in serum. The aspartate aminotransferase levels in mitochondria increased at higher protein levels, whereas the supernatant enzyme was enhanced only in the case of 32 and 48% dietary protein-fed groups. The activities of these enzymes in kidney and heart cell fractions were not influenced by the level of protein. The alkaline phosphatase activities in serum and liver were lower in rats fed on high protein diets, whereas the acid phosphatase activities were not affected.

Keywords : Aminotransferases, Phosphatases, Dietary protein, Rat tissues.

L-alanine-2-oxoglutarate aminotransferase (ALA, E.C. 2.6.1.2) activities, both in mitochondrial and supernatant fractions of rat liver, have been reported (Hopper and Segal 1964; Swick et al. 1965). The enzyme activities in liver homogenates were found to change markedly in response to protein levels in the diet (Woldorf et al. 1963; Rosen et al. 1958), but the significance of isoenzyme forms was not considered. Very little information is available about the aminotransferase activities in kidney and heart tissues of rats fed with different levels of dietary protein. Hence, the influence of dietary protein at optimum and also at high and low levels on the activities of ALA was studied in rat tissues under severe protein stress conditions. The results are presented in this communication. In addition, data have also been presented for L-aspartate-2-oxoglutarate amino-transferase (ASA, E.C. 2.6.1.1) and phosphatases.

Materials and Methods

Young male' Wistar' strain albino rats, weighing 60-70 g, were grouped (8 rats per group) according to randomized block design. The rats were housed individually in wire cages and given experimental diets *ad libitum* with free access to water. The experimental diets were prepared as described by Lalitha and Radhakrishnamurthy (1974). Casein was used as the source of protein. The rats were maintained on the respective diets for 45 days and were killed at the end of experimental period by ether anaesthesia. The blood was collected by cardiac puncture and serum was separated. The liver, kidney and heart tissues were excised quickly and placed in ice-cold 0.25 M sucrose solution. The tissues were washed free of blood, minced, homogenized using a Potter-Elvehjem glass homogenizer with teflon pestle and made upto 10 volumes with 0.25 M sucrose. Fractionation was carried out according to the procedure of Hogeboom (1955) and mitochondrial pellet was collected by centrifugation at 10,000 x **g** for 30 min. Since the microsomal fraction does not contain the aminotransferase activity, the post-mitochondrial fraction was taken as the supernatant fraction for all routine analyses.

ALA activity in liver cell fractions was assayed spectrophotometrically (Segal and Matsuzuwa 1970). This enzyme activity in serum and other tissues and ASA activity were measured according to the method of Tonhazy et al. (1950) as modified by Caldwell and McHenry (1953). Alkaline and acid phosphatase activities in homogenates (E.C. 3.1.3.1 and 3.1.3.2, respectively) were assayed by the method of Hubscher and West (1965) and inorganic phosphate liberated was estimated according to the procedure of Taussky and Shorr (1953). Protein was estimated by the method of Oyama and Eagle (1956), using Folin-Ciocalteu reagent. Significance of the results among treatments was evaluated by Student's 't' test.

All the chemicals used were of reagent grade from BDH or E. Merck or Sigma Chemical Company, USA. All the experiments were repeated 3 to 4 times.

Results and Discussion

The effects of varying levels of dietary protein on serum and liver mitochondrial and supernatant

* Corresponding Author

TABLE 1. THE INFLUENCE OF DIFFERENT LEVELS OF PROTEINS ON ALANINE AND ASPARTATE AMINOTRANSFERASE ACTIVITIES IN THE RAT LIVER AND SERUM.

Level of protein in the diet, %	L-alanine-2-oxoglutarate aminotransferase*			L-aspartate-2-oxoglutarate aminotransferase*		
	Liver, g tissue/min			Liver, g tissue/min		
	Mitochondria	Supernatant	Serum, ml/h	Mitochondria	Supernatant	Serum, ml/h
5	1.15±0.12	3.25±0.41	0.81±0.12	1.35±0.03	9.56±0.38	4.48±0.15
16	2.25±0.19[a]	10.19±0.96[a]	0.44±0.08[d]	2.10±0.09[a]	9.45±0.36	4.25±0.21
32	3.16±0.16[a]	19.14±0.84[a]	0.42±0.04[c]	2.95±0.05[a]	11.92±0.35[a]	4.04±0.36
48	4.15±0.56[a]	35.24±2.87[a]	0.28±0.05[b]	3.65±0.06[a]	14.85±0.45[a]	3.56±0.36[d]

* μ moles pyruvate formed. Values are averages of 8 animals in each group and SEM. Significance compared to the rate fed low protein (5%) (P value). a: 0.001, b: 0.002, c: 0.01, d:0.05.

aminotransferase activities are presented in Table 1. The ALA activities were considerably enhanced in both cell fractions with the increase of dietary protein. The enhancements were 1.95, 2.70 and 3.61 folds in mitochondria and 3.14, 5.96 and 10.84 folds in supernatant in rats fed 16, 32 and 48% dietary protein levels, respectively. The ASA activity was not significantly altered in liver supernatant fraction at 16% protein level when the values were compared with low protein diet group (5%), whereas enhanced ASA activity was observed at 32 and 48% protein levels. The mitochondrial ASA activities showed increases of 1.6, 2.2 and 2.7 folds in rats fed 16, 32 and 48% dietary protein, respectively as compared to 5% protein diet. The serum ALA levels were considerably decreased with the increase of protein content in the diet. The ASA activities were affected only at 48% protein levels in the diet. The influence of different levels of protein on alanine and aspartate aminotransferase activities in heart and kidney cell fractions were not affected.

The results of serum, liver and kidney alkaline and acid phosphatase activities are summarized in Table 2. The serum alkaline phosphatase activities in the groups receiving higher protein diets (32 and 48%) were significantly lower than those of the 5 and 16% protein fed groups. The enzyme activities in liver were found to decrease by 46, 48 and 68% in rats fed 16, 32 and 48% protein in the diet, respectively. The enzyme activities in kidney were not affected. The liver acid phosphatase activities did not show any change at 5 and 16% levels of protein in the diet, but were slightly enhanced at higher levels of protein.

TABLE 2. THE INFLUENCE OF DIFFERENT LEVELS OF PROTEINS ON PHOSPHATASE ACTIVITIES OF SERUM AND LIVER.

Level of protein in the diet %	Alkaline phosphatase*		Acid phosphatase*	
	Serum	Liver	Serum	Liver
5	45.69±1.41	57.75±3.58	2.75±0.19	288.42±33.21
16	41.01±2.65	31.50±3.57[a]	2.30±0.25	295.40±34.22
32	34.05±1.09[a]	29.95±1.42[a]	2.41±0.13	382.25±40.33
48	36.95±3.15[a]	18.50±3.02[a]	2.62±0.27	361.40± 9.83

* μ moles of inorganic phosphate formed per hour per gram tissue or per ml serum. Values are average of 8 animals in each group and SEM. Significance compared to the rats fed low protein (5%) (P value) a: 0.001.

Diets were given *ad libitum*, since preliminary experiments in this laboratory have shown that pair-feeding the control animals results in abnormal increases in aminotransferase levels of the liver due to partial starvation. Since the activities in the homogenate are the sum of both mitochondrial and supernatant activities, the values for homogenates are not given.

The results show that both liver mitochondrial and supernatant ALA activities were increased with the increase of protein content in the diet. According to Harper (1965), decreased activities of aminotransferases were observed in liver homogenates of rats on low protein diet. Waldorf et al. (1963) reported that in rats fed with 80% casein, the ALA activity increased by 400% of the control value. Rosen et al. (1958) noted that ALA activity of liver was directly related to the protein content of the diet. It was also reported that ALA activity was greatly increased in conditions known to increase the rate of gluconeogenesis (Rosen et al. 1959). In all these experiments, the studies were confined to liver homogenates. In the present study, the response of the enzymes was also studied in sub-cellular fractions of organs of rats fed with different levels of proteins. The observed increases in ALA activities of liver mitochondria and supernatant may probably be the result of the increased synthesis of enzyme proteins. In rats fed at low protein levels, reduced ALA activity was observed because of the increasing

need for efficient trapping of amino acids for tissue protein synthesis.

It was observed that the ASA activity in liver mitochondria was elevated with increased levels of protein in the diet, whereas the supernatant ASA activity was enhanced only when rats were fed above the level of 16% dietary protein. Lalitha and Radhakrishnamurthy (1974) fed the animals only upto 18% levels of casein and observed that the activity was not affected when compared to the rats fed at 8% level. Heger and Kejmer (1976) noted that with increase in the dietary protein content from 10 to 60%, ALA activity in liver homogenate was elevated with increased levels of protein intake, whereas ASA activity in liver homogenate was increased only at levels between 40 and 60%. In the present experiment, the ASA activity in liver supernatant was not influenced significantly until the protein intake exceeded the normal level (16%).

As shown in Table 1, the serum ALA activity was reduced considerably at higher levels of protein. The serum ASA activity was not found to be affected significantly by the level of protein in the diet. In case of serum ALA, similar observations were reported by Yashiro et al. (1980). Our results are in contrast to the observations of Bolter and Critz (1974), who noted higher levels of plasma ALA activity in rats fed 45% protein diet when compared to 25% protein fed rats.

The alkaline phosphatase activities of liver homogenates and serum were found to decrease with increasing levels of protein. Muramatsu and Ashida (1962) indicated that the activity of liver alkaline phosphatase did not change in rats receiving the diets containing different levels of protein (0-60%) for 15 days, but the activity of this enzyme was maximal in rats fed low protein or protein-free diets for 29 days. Similar response was reported by Ross and Batt (1956). Miller (1950) has also reported increased concentration of hepatic alkaline phosphatase activity in protein-deficient rats.

The acid phosphatase activities were not significantly altered on feeding higher levels of dietary protein. Srinivasan and Patwardhan (1955) reported that this enzyme activity in liver was not changed appreciably in rats fed with different diets.

Among the various enzymes studied in the rat, the liver mitochondrial ALA and ASA activities, and liver supernatant ALA activities increased with the increase of dietary protein, whereas the supernatant ASA increased only at higher dietary protein levels. The mitochondrial and supernatant enzymes of kidney and heart were not influenced by the level of protein in the diet. The serum ALA and alkaline phosphatase activities declined with the increase of protein content in the diet. Acid phosphatase activities in serum, liver and kidney were not influenced by the dietary protein levels.

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Development of High Fibre Biscuits Using Wheat Bran

K. LEELAVATHI AND P. HARIDAS RAO*
Baking Technology Discipline,
Central Food Technological Research Institute, Mysore-570 013, India.

Studies on development of high fibre soft biscuits indicated that flour could be substituted with raw wheat bran upto 30% level, as a source of dietary fibre, without affecting the overall quality. Minimum levels of fat and sugar required in the formulation were 15 and 26%, respectively. Incorporation of 0.5% sodium stearoyl lactylate improved the quality of biscuits. The dietary fibre content of these biscuits was about 7 times higher than the control biscuits. High fibre biscuits wrapped in 100 gauge polypropylene pouches had a shelf-life of about 90 days when stored at 27±2°C and 60±2% RH.

Keywords : Wheat bran, High fibre biscuits, Dietary fibre.

Presence of low levels of fibre in the diet has been reported to cause non-infectious diseases, such as diverticulosis, atherosclerosis, and colonic cancer (Jeltema et al. 1983). The hypocholestremic and hypolipidemic action of fibre has been well documented (Uberoi et al. 1992). For this reason, interest has been shown to increase the uptake of fibres in the diet. Being one of the best avenues, several studies have been reported on the incorporation of fibres from various sources in bread (Lai et al. 1989), cake (Katherine and Zabik 1976), cookies (Vratanina and Zabik 1978) and bakery products (Leelavathy et al. 1991). However, no information is available on high fibre soft dough biscuits, even though these constitute one of the popular baked products in several countries, including India. Therefore, studies were undertaken to develop high fibre biscuits by incorporating wheat bran, since it is a rich source of dietary fibre (Sosuliki and Wu 1988). Wheat bran, in addition, contains proteins of high biological value and also is a rich source of B group vitamins and several minerals (Pomeranz et al. 1976).

Materials and Methods

Wheat flour (*maida*) and coarse bran from an *aestivum* wheat variety were obtained from a pilot roller flour mill of 20 tonnes capacity of the Institute. Whole wheat flour was obtained by grinding wheat in a disc mill. Bran, after removing fines by sieving through 20 mesh sieve (1110 μ), was spread on a tray to a thickness of about 2.5 cm and toasted in an oven maintained at 160°C for 30 min. Both raw and toasted bran were powdered in a Kamas mill (Slaggy-2A) using 800 μ sieve. Moisture, ash, gluten, total protein, diastatic activity and sedimentation value were determined according to AACC methods (1976). Calcium, total phosphorus, iron and starch were estimated as per AOAC methods (1984).

Blends of *maida* and bran were prepared by replacing flour with 10 to 60% of raw or toasted bran, respectively. Biscuits were prepared from *maida;* blends of *maida* and bran; and from whole wheat flour according to the method described by Haridas Rao and Shurpalekar (1976). Weight, diameter and thickness of 6 biscuits at a time were measured from which, values for a single biscuit were calculated. Density of biscuits was calculated by dividing weight by volume. Volume of biscuits was determined by rapeseed displacement method (Haridas Rao and Shurpalekar 1976). Spread ratio was calculated by dividing diameter with thickness according to AACC method (1976). Biscuits were packed in polypropylene pouches (gauge 100) and stored at room temperature (27±2°C) for 4 months. The samples were evaluated at regular intervals for moisture (AACC 1976), fat acidity (AOAC 1984) and peroxide value (AOCS 1973). The biscuits were evaluated by a panel of 6 semi-trained judges using a 9 point Hedonic scale system for different parameters like appearance, colour, crispness, mouthfeel and overall quality (Haridas Rao and Shurpalekar 1976). All the experiments were carried out in duplicate and the statistical analysis of the data was done by Duncan's Multiple range test (Duncan 1957).

Results and Discussion

Quality characteristics : The quality characteristics of *maida*, raw bran, and toasted bran are given in Table 1. Suitability of flour selected for the preparation of biscuits was justified by its low protein content and low sedimentation value. The values obtained for calcium, phosphorus,

* *Corresponding Author*

TABLE 1. PHYSICAL AND CHEMICAL CHARACTERISTICS* OF WHEAT FLOUR (*MAIDA*) AND WHEAT BRAN.

Constituents	Flour	Wheat bran	
		Raw	Toasted
Ash, %	0.62	14.7	14.5
Dry gluten, %	9.1	-	-
Protein, %	9.7	14.9	14.8
Sedimentation value, ml	21.0	-	-
Diastatic activity, mg/10 g flour at 30°C	203	-	-
Starch, %	73.0	11.2	11.0
Total phosphorus, mg %	92	930	960
Iron, mg %	2.1	8.4	8.9
Total dietary fibre**, %	2.7	46.1	43.3
Overs of 10 XX (128 μ) sieve, %	3.0	38.5	28.1

* Expressed on 14% moisture basis
** As reported by Pomeranz et al. (1976)

and iron contents in both flour and bran conform to those values reported by Betschart (1988). Accordingly, bran samples used in this study, both raw and toasted, had iron and calcium four times and phosphorus 10 times to those of the flour. Toasting of bran was carried out to inactivate the enzymes as well as to improve the keeping quality of bran. Toasting did not alter the composition of bran. However, a slight difference in the particle size distribution of powdered bran was observed. The quantity of raw bran retained over 128 μ sieve was 38.5%, while the same was 28.1% for the toasted bran. This was probably due to the fragile nature of the toasted bran.

Incorporation of raw bran : Effect of incorporation of different levels of raw wheat bran on the water requirements, to obtain the desired biscuit dough consistency, is shown in Table 2. The results show that the water requirement increased from 15 to 22%, as the bran content increased from 10 to 60%. This increase in the water requirement was probably due to the presence of high amounts of

TABLE 2. QUALITY CHARACTERISTICS OF BISCUITS CONTAINING WHEAT BRAN

Level of bran %	Water added %	Physical				Sensory				
		Density g/cc	Thickness (mm)	Diameter (mm)	Spread ratio	Appearance	Colour	Crispness	Mouth feel	Overall quality
Raw bran										
0	15.0	0.6168^{a}	7.246^{A}	50.02^{A}	6.99^{A}	8.50^{A}	8.67^{A}	8.83^{A}	8.50^{A}	8.83^{A}
10	15.0	0.6198^{AB}	8.181^{A}	50.25^{AB}	7.24^{B}	8.75^{A}	8.33^{AB}	8.38^{AB}	8.50^{A}	8.50^{A}
20	16.0	0.6315^{BC}	7.050^{B}	50.13^{A}	7.44^{C}	8.42^{A}	7.83^{BC}	8.35^{AB}	7.75^{B}	8.42^{A}
30	17.5	0.6348^{C}	6.916^{C}	50.33^{AB}	7.61^{C}	8.58^{A}	7.92^{C}	8.33^{AB}	7.25^{B}	7.92^{AB}
40	19.5	0.6785^{D}	6.435^{D}	50.37^{AB}	8.34^{D}	8.42^{A}	7.08^{D}	7.50^{B}	6.42^{C}	7.42^{B}
50	20.8	0.7133^{E}	6.095^{E}	51.07^{C}	8.72^{E}	8.58^{A}	6.58^{D}	6.92^{B}	6.00^{C}	6.75^{C}
60	22.0	0.7501^{F}	5.961^{F}	50.73^{BC}	9.08^{F}	8.58^{A}	6.67^{D}	6.83^{B}	5.00^{D}	5.50^{D}
SEm		±0.0045 (35 df)	±0.0271 (35 df)	±0.17 (35 df)	±0.06 (35 df)	±0.15 (35 df)	±0.17 (35 df)	±0.17 (35 df)	±0.23 (35 df)	±0.20 (35 df)
Toasted bran										
0	15.0	0.611^{A}	7.145^{A}	50.08^{A}	6.987^{A}	8.42^{A}	8.75^{A}	8.58^{A}	8.75^{A}	8.50^{A}
10	17.5	0.614^{A}	7.115^{A}	49.90^{A}	7.080^{A}	8.67^{A}	8.50^{A}	8.58^{A}	8.67^{A}	8.50^{A}
20	18.5	0.640^{A}	7.160^{A}	50.00^{A}	7.130^{A}	8.42^{A}	7.83^{B}	8.17^{AB}	8.58^{A}	8.25^{A}
30	19.5	0.654^{B}	6.882^{B}	49.85^{B}	7.435^{B}	8.42^{A}	7.75^{B}	7.92^{B}	7.83^{B}	7.42^{B}
40	21.0	0.713^{D}	6.102^{C}	50.18^{AB}	8.053^{C}	8.50^{A}	6.42^{C}	6.75^{C}	7.33^{C}	7.33^{B}
50	22.0	0.732^{E}	5.930^{D}	50.53^{B}	8.917^{D}	8.33^{A}	6.50^{C}	6.58^{C}	6.50^{D}	6.42^{C}
60	23.5	0.775^{F}	5.847^{D}	51.17^{C}	9.358^{E}	8.00^{A}	6.08^{C}	5.83^{D}	6.08^{D}	5.75^{C}
SEm		±0.004 (35 df)	±0.029 (35 df)	±0.144 (35 df)	±0.070 (35 df)	±0.18 (35 df)	±0.14 (35 df)	±0.17 (35 df)	±0.15 (35 df)	±0.16 (35 df)

Each observation is mean of six values.
Mean of the same column followed by different letters differ significantly ($p<0.05$) according to Duncan's New Multiple Range Test.

non-starch polysaccharides, which are present in the bran. Handling properties of the dough were slightly altered, as the dough became sticky beyond 40% addition of the bran. Density of the biscuits increased gradually with increase in the level of bran incorporation. Thickness of the biscuits, on the other hand, decreased gradually with increase in the amount of bran. No significant changes were observed in the spread of the biscuits due to the incorporation of bran. The above changes in the physical parameters were reflected in the spread ratio of the biscuits, which increased with the addition of bran. Inclusion of bran in the biscuit formulation did not affect the appearance of the biscuits significantly. Addition of bran beyond 30% affected the colour and texture of the biscuits only to a slight extent. The colour and texture of the biscuits became slightly darker and harder, respectively, beyond 30% level of bran addition. At that level, the biscuits were also slightly gritty and had residual branny mouthfeel. Overall quality of the biscuits, containing added raw bran upto 30%, did not vary significantly.

Incorporation of toasted bran: Water requirement of the biscuit formulation containing toasted bran was slightly more than that containing raw bran. The physical quality characteristics of biscuits containing toasted bran showed the same trend as those containing raw bran (Table 2). The density of the biscuits containing toasted bran was slightly more than those containing raw bran. The biscuits containing toasted bran were gritty and had residual branny mouthfeel at a lower level of incorporation (20%) than the raw bran. Therefore, the overall quality of biscuits containing toasted bran was significantly different from the control at a lower level (20%) than those containing raw bran (30%). Since raw bran could be used in biscuits upto 30% level without any effect on its quality, studies were conducted on further improving the quality of biscuits containing raw bran.

Quality of whole wheat flour biscuits : Since whole wheat flour contains about 12% dietary fibre, biscuits were made with whole wheat flour and were compared with the biscuits made from blends of wheat flour (*maida*) and raw bran (70:30). The results (Table 3) indicated that the biscuits made from whole wheat flour were more dense than the biscuits made from the blend of wheat flour and bran. The thickness of whole wheat flour biscuits was lower, while the spread was higher as compared to the biscuits made from the blend. The latter had better overall quality, probably due to finer and uniform particle size of *maida* as compared to whole wheat flour. This indicated that use of blends of *maida* and bran for the preparation of high fibre biscuits is better than using whole wheat flour.

TABLE 3. COMPARATIVE QUALITY CHARACTERISTICS OF BISCUITS MADE FROM WHOLE WHEAT FLOUR AND BLEND OF *MAIDA* AND RAW WHEAT BRAN (70:30)

Quality characteristics	Whole wheat flour	Blend	Level of significance
Physical			
Density, g/cc	0.755	0.643	p<0.01
Thickness, mm	6.539	7.245	p<0.001
Diameter, mm	51.158	50.803	p<0.05
Sensory •			
Appearance	8.33	8.417	p<0.05
Colour	6.000	7.917	p<0.001
Crispness	6.633	8.000	p<0.001
Mouthfeel	6.583	7.583	p<0.01
Overall quality	6.117	7.583	p<0.001

• Maximum score of 9 signifying the most desirable.

Effect of ingredients : In order to reduce the calorific value of high fibre biscuits, the possibilities of reducing fat and sugar levels were explored and the results are given in Table 4. Reduction in the level of sugar made the biscuits harder as indicated by increase in the density. Similar observation has also been made for normal soft dough biscuits (Smith 1972). This also resulted in the lowering of spread ratio due to increased thickness. The crispness of biscuits was not significantly affected, when the sugar level was reduced from 35 to 28%. However, overall quality was affected significantly, when the sugar level was reduced to 26.0%. With reduction in fat from 25 to 10%, while maintaining the sugar level at 35.0%, the density of biscuits increased from 0.622 to 0.708 g/cc, the spread reduced from 51.42 to 48.67 mm, while thickness remained the same. Similar effect of fat in sweet biscuits was also reported by Smith (1972). The overall quality of biscuits was significantly different from control, when fat was used at a level lower than 20%.

Use of additives : Since no difference in the taste was observed, when 26% sugar and 15% fat were used in biscuits, studies were carried out to improve the textural characteristics of these biscuits by using certain additives (Table 4). Incorporation of glycerol-mono-stearate (GMS) at 0.5% level improved the crispness and overall quality of biscuits. However, the use of sodium stearoyl lactylate (SSL) brought about greater improvement

TABLE 4. EFFECT OF INGREDIENTS AND ADDITIVES ON THE QUALITY OF HIGH FIBRE BISCUITS CONTAINING RAW BRAN

Treatments		Physical				Sensory				
		Density g/cc	Diameter (mm)	Thickness (mm)	Spread ratio	Appea-rance	Colour	Crispness	Mouth-feel	Overall quality
Sugar *	35	0.628^{A}	50.10^{A}	7.14^{A}	7.04^{AB}	8.75^{A}	8.67^{A}	8.67^{A}	8.83^{A}	8.42^{A}
"	30	0.621^{A}	50.13^{A}	7.26^{BC}	6.87^{C}	8.67^{A}	8.33^{AB}	8.67^{A}	8.58^{ABC}	8.50^{A}
"	28	0.643^{B}	51.37^{B}	7.24^{B}	7.15^{F}	8.20^{B}	8.33^{AB}	8.67^{A}	8.67^{AB}	8.42^{A}
"	26	0.662^{C}	51.52^{B}	7.34^{CF}	6.97^{B}	8.25^{B}	8.33^{AB}	8.17^{C}	8.50^{ABC}	7.92^{AB}
"	24	0.684^{D}	51.55^{B}	7.60^{D}	6.85^{C}	8.25^{B}	7.83^{CD}	7.67^{CD}	8.50^{ABC}	7.62^{C}
Fat **	25	0.622^{A}	51.42^{B}	7.68^{D}	7.05^{A}	8.25^{B}	8.51^{A}	8.08^{AB}	8.67^{AB}	8.42^{A}
"	20	0.630^{A}	50.38^{C}	7.33^{C}	6.82^{C}	8.17^{B}	8.27^{AB}	8.42^{AB}	8.53^{ABC}	8.05^{AB}
"	17	0.639^{B}	49.99^{AC}	7.34^{CF}	6.84^{C}	8.08^{B}	8.37^{AB}	7.92^{CD}	8.43^{ABC}	7.83^{BC}
"	15	0.641^{B}	49.58^{A}	7.46^{E}	6.68^{D}	8.17^{B}	7.26^{AB}	7.17^{E}	8.55^{ABC}	7.25^{CA}
"	10	0.708^{E}	48.67^{D}	7.62^{D}	6.31^{E}	8.17^{B}	7.85^{C}	6.67^{F}	8.25^{C}	5.75^{DF}
Fat ***	15	0.681^{D}	50.20^{B}	7.63^{D}	6.83^{D}	8.21^{B}	7.81^{C}	6.31^{D}	8.31^{C}	5.80^{DE}
GMS***	0.5	0.622^{A}	50.30^{C}	7.47^{E}	6.72^{D}	8.25^{B}	7.33^{D}	7.00^{EF}	8.42^{ABC}	7.68^{BC}
SSL***	0.5	0.601^{F}	51.75^{B}	7.42^{EF}	6.68^{D}	8.25^{B}	8.25^{B}	7.75^{CD}	8.50^{ABC}	7.91^{AB}
SEm		±0.003 (60 df)	±0.19 (60 df)	±0.03 (60 df)	±0.02 (60 df)	±0.11 (60 df)	±0.12 (60 df)	±0.14 (60 df)	±0.13 (60 df)	±0.20 (60 df)

* Contains 25% fat in the recipe. ** Contains 35% sugar in the recipe. *** Contains 26% sugar and 15% fat. GMS - Glycerol-mono-stearate, SSL - Sodium stearoyl lactylate. Each observation is mean of six values. Means of the same column followed by different letters differ significantly ($p<0.05$) according to Duncan's New Multiple Range Test.

in crispness and overall quality of biscuits and the quality was comparable to the control high fibre biscuits made with normal levels of sugar and fat.

Storage studies : The biscuits made with 30% toasted bran was also included in the storage studies to determine the effect of toasting on the keeping quality. In case of control biscuits, an increase in moisture for a total storage period of 4 months was only 0.9%, while the same was 1.9 to 2.0% for biscuits containing raw or toasted bran. The higher moisture pick up of biscuits containing bran during storage could be due to greater hygroscopicity of wheat bran. Its greater water retention capacity was also indicated by the higher initial moisture content in biscuits which ranged from 2.5 to 3.0%.

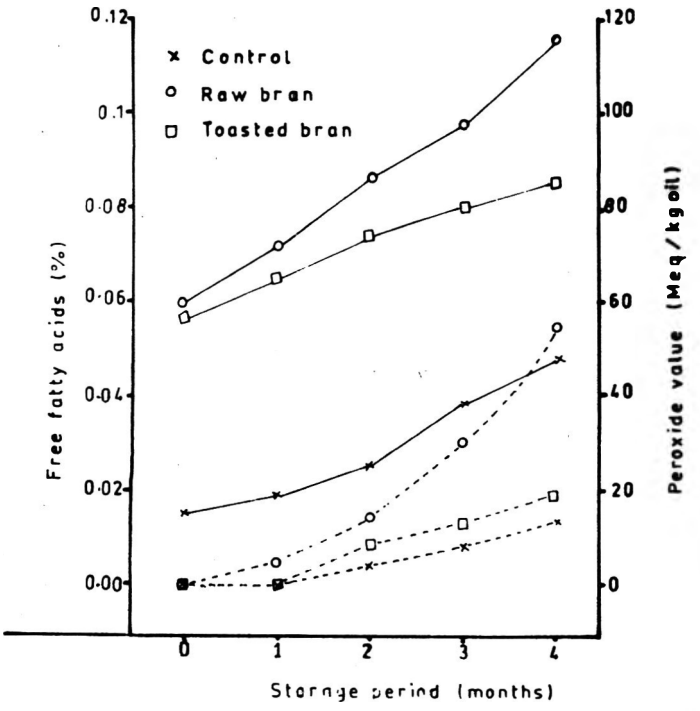

Fig. 1. Effect of storage period on the free fatty acid (———) and peroxide value (– – – –) contents of biscuits.

The changes in fat acidity and peroxide values during storage are shown in Fig. 1. A greater increase in fat acidity was observed in biscuits containing both raw and toasted bran during storage, as compared to control biscuits. In biscuits containing raw bran, the increase in FFA during the storage period was 2 times than that in the biscuits containing toasted bran. This difference in the values could be due to the inactivation of lipolytic enzyme during toasting (Vetrimani and Haridas Rao 1991). The control biscuits were crisp and devoid of any rancid taste upto a storage period of 4 months. Biscuits containing both raw and toasted bran had become slightly damp on 4 month storage period. Mild rancid taste was observed at 4 months storage in biscuits containing raw bran.

The above studies indicated that an acceptable quality high fibre biscuits could be prepared by

incorporating 30% raw bran. Such biscuits would contain about 10.0% dietary fibre as compared to that of 1.5% in normal biscuits.

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Packaging Of *Vanaspati* in Low Tin Coated Cans and Cans with Lacquered Black Plate Components

R.V. GOWRAMMA, M. MAHADEVIAH* AND R. NARESH
Centre for Food Packaging,
Central Food Technological Research Institute, Mysore-570 013, India.

Two batches of cans with 6 tinplate variables of varying tincoating weight and surface coatings, were used to pack *vanaspati*. These cans were evaluated by storing at ambient temperature (25-30°C), 37°C and conducting periodical cutout examination by chemical analysis and organoleptic evaluation. E-25 (with lithograph on external surface), E-50 (both sides plain), E-20 and E-25 tinplate cans (with tinplate or black plate lacquered components) coated with lacquer on the internal surface and lacquer or lithography on the external surface, were found suitable for packing *vanaspati*. However, storage for 6 months or longer at high humidity, the external rusting would be more, especially at the seam ends. E-10 cans, even with lacquer coating on both the internal and external surfaces, were not suitable for long storage.

Keywords : Packing of *vanaspati*, Low tincoated cans, Shelf-life, Sensory evaluation, External rusting, Cans with lacquered black plate components.

At present, tinplate with a tincoating of 5.6 g/m² (E-50, electrolytic) is being used for packing *vanaspati* (hydrogenated vegetable fat). Tinplate of grade E-25 (2.8 g/m²) and tin-free steel plate are used only for some general line cans in India. Suitability of electrolytic tinplates with varying thickness of tincoating for packing a few vegetable and meat products (Davis 1954, 1962); dried prunes in water, peas and vegetables (Barbieri et al. 1960) and orange juice (Mahadeviah et al. 1976) have been examined and being used in some countries. We have also earlier reported on the relationship between sulphur staining and corrosion in food cans (Mahadeviah et al. 1971). Other studies on some used tin containers indicate that some oils like peanut oil could be stored upto a period of 5 months (Grower et al. 1982).

There has been a consistent demand for reducing tincoating in containers used for packing *vanaspati*, as tin is a scarce commodity and it has to be imported. Hence, investigations were undertaken, at the instance of Bureau of Indian Standards, to find the suitability of tinplates with lower tincoating, and the results are presented in this paper.

Materials and Methods

Tinplate variables : The first batch involved two types of tinplates as described below :

1. E-25 (2.8 g/m²) - Plain internally with lithography and lacquer externally on bodies and ends, respectively, and 2. E-50 (5.6 g/m²) - Plain on both surfaces.

The second batch involved the following tinplate variables :

1. E-20 (2.24 g/m²) - Lacquered (internally and externally) for body and components (straight walled). 2. E-25 (2.8 g/m²) - Lacquered (both inside and outside) for body and lacquered black plate for components (straight walled). 3. E-10 (1.12 g/m²) -Lacquered (both inside and outside) for body and components (straight walled), and 4. E-10 (1.12 g/m²) - Lacquered (both inside and outside) for body and components (beaded can).

In all the cans, the container size was 509x 607 mm and it consisted of ring - lid - tagger assembly and with total weight of 2 kg. The type of lacquer used was food grade epoxyphenolic. Beaded can in one batch was included just for a comparative study with straight walled can.

Shelf-life studies : Cans packed with *vanaspati* were stored at ambient temperature (25-30°C; RH 50-75%) and 37°C (without humidity control) and analysed periodically upto 12 months. As the packed cans were supplied by the industry after two months of packing, immediate initial analysis could not be carried out. One set of cans from each batch were also stored at 38°C with 92% RH. Fifty samples in each variable were exposed to each condition evaluated in studies. Cans were examined for internal corrosion and external rusting and the product was analysed for different characteristics. Two cans in each variable were taken for periodical observation and testing.

Methods of analysis : Moisture content was determined by drying 10 g of samples in an oven at 105°C±1°C for 1 h (BIS 1968). Free fatty acids and peroxide values were determined by using the

* Corresponding Author

TABLE 1. SHELF-LIFE STUDIES OF *VANASPATI* CANS - BATCH I

Storage period	Storage temp., °C	Code	FFA (% oleic acid)	Peroxide value (milliequivalent/kg of fat)	Kries value (OD/g of fat)	Colour (Lovibond colour units)	Odour quality score*
2	RT	A	0.07	1.44	-	0.6 R + 2.3 Y	1
		B	0.11	1.00	-	0.4 R + 2.0 Y	1
6	RT	A	0.08	2.10	0.03	0.6 R + 2.5 Y	1
		B	0.11	2.52	0.05	0.5 R + 2.3 Y	1
9	RT	A	0.11	2.26	0.07	0.6 R + 2.7 Y	1
		B	0.10	3.99	0.09	0.8 R + 2.9 Y	1
	37	A	0.08	2.70	0.20	0.5 R + 2.6 Y	1
		B	0.09	3.90	0.10	0.8 R + 2.8 Y	1
12	RT	A	0.15	3.29	0.35	0.8 R + 2.6 Y	1
		B	0.15	4.09	0.43	0.8 R + 2.6 Y	1
	37	A	0.23	3.48	0.36	0.8 R + 2.7 Y	3
		B	0.23	2.73	0.50	0.9 R + 2.7 Y	1

R = Red, Y = Yellow

* Moisture was 0.03% in both E-25 and E-50 cans upto 2 months storage period and beyond that moisture was nil

A : E-25 (internal plain and external lithograph); B: E-50 (both sides plain)

There was slightly more headspace in E-50 cans as compared to E-25 cans.

* Mean score on a 4 point scale - 1: Typical and fresh, 2: Incipient rancidity, 3: Just noticeable rancidity, 4: Clearly rancid.

methods of AOCS (1960) and Wheeler (1932), respectively. Kries test was carried out by the method of Poole and Prater (1945). Colour of *vanaspati* was measured in the Lovibond Tintometer and expressed as red (R) and yellow (Y) units.

Sensory evaluation : This was carried out with a view to determine freshness of *vanaspati*, identification of rancidity and also of possible incipient rancidity by a 10-member panel. Four stage quality parameters, i.e. 1: fresh and typical, 2: indicative of incipient rancidity, 3: slight rancid and 4: clearly rancid (Shanthi Narasimhan et al. 1986) were used in evaluation of odour quality of *vanaspati* with modified method of sampling (CFTRI 1988-89). The mean score on the 4 point scale was taken into consideration to assess the overall quality of *vanaspati*.

Results and Discussion

I Batch (Internal-plain. External-lithograph): Quality of the product with respect to colour, odour, and other chemical characteristics was acceptable and there was no difference between products in E-25 and E-50 tinplate containers upto 6 months storage.

External rusting was perceptible in the seam ends of E-25 tinplate cans after 6 months storage at 38°C with humidity of 92%, as compared to E-50 tinplate cans which showed a few isolated rust spots at the top lid. After 12 months storage, the quality of the product was acceptable both at ambient temperature and 37°C (without humidity) in E-50 tinplate cans. However, in E-25 tinplate cans, slight rancid taste and flavour were noticed at 37°C. There was no perceptible corrosion in the can interior. The values of chemical characteristics are given in Table 1.

After 2 months, the moisture content was considerably less and thereafter, it was free from moisture. Regarding FFA, peroxide value and Kries value, there were only marginal differences during storage between ambient and 37°C in both E-25 and E-50 containers. Similarly, there was not much difference in Lovibond colour units. Internal condition of the cans was normal without any feathering or detinned spots. Maximum permissible value for moisture in *vanaspati* is 0.25% and FFA is 0.25% as oleic acid. In the case of peroxide value, there is no maximum limit prescribed, probably because the value reaches to a maximum during certain storage period and then decreases gradually. For Kries test also, there is no maximum limit.

II Batch : Upto 6 months storage, both at ambient temperature and 37°C, the quality of the product with respect to colour and odour was acceptable in all the four types of cans. Upto six months, the moisture content ranged from 0.04 to 0.05% in four

TABLE 2. SHELF-LIFE STUDIES OF *VANASPATI* CANS - BATCH II

Storage period month	Storage temp., °C	Code	Moisture g %	FFA (% oleic acid)	Peroxide value (milliequivalent/kg of fat)	Kries value (OD/g of fat)	Colour (Lovibond colour units)	Odour quality score *
2	RT	A	0.07	0.07	0.54	0.11	0.4 R + 3.3 Y	1
		B	0.09	0.08	0.58	0.11	0.4 R + 3.5 Y	1
		C	0.06	0.10	0.80	0.11	0.4 R + 3.5 Y	1
		D	0.06	0.07	0.86	0.11	0.4 R + 3.5 Y	1
6	RT	A	0.04	0.19	3.38	0.18	0.4 R + 3.4 Y	1
		B	0.04	0.19	4.21	0.18	0.4 R + 3.4 Y	1
		C	0.06	0.19	4.26	0.19	0.4 R + 3.5 Y	1
		D	0.05	0.18	4.17	0.17	0.4 R + 3.5 Y	1
	37	A	0.04	0.18	2.84	0.19	0.4 R + 3.5 Y	1
		B	0.04	0.18	2.81	0.19	0.4 R + 3.5 Y	1
		C	0.05	0.18	2.70	0.19	0.4 R + 3.5 Y	1
		D	0.05	0.16	2.80	0.18	0.4 R + 3.4 Y	1
9	RT	A	Nil	0.19	7.71	0.24	0.5 R + 3.3 Y	1
		B	"	0.19	7.82	0.26	0.5 R + 3.2 Y	1
		C	"	0.21	7.72	0.25	0.5 R + 3.3 Y	1
		D	"	0.21	8.61	0.29	0.5 R + 3.4 Y	1
	37	A	Nil	0.21	16.52	0.35	0.5 R + 3.3 Y	1
		B	"	0.21	17.71	0.35	0.5 R + 3.4 Y	1
		C	"	0.21	17.51	0.35	0.6 R + 3.5 Y	2
		D	"	0.20	17.33	0.36	0.6 R + 3.5 Y	2
12	RT	A	Nil	0.19	10.58	0.59	0.5 R + 3.3 Y	1
		B	"	0.21	10.27	0.61	0.5 R + 3.5 Y	1
		C	"	0.20	4.03	0.36	0.5 R + 3.4 Y	2
		D	"	0.19	3.67	0.33	0.5 R + 3.4 Y	2
	37	A	Nil	0.22	2.12	0.32	0.5 R + 3.4 Y	1
		B	"	0.22	2.21	0.33	0.5 R + 3.4 Y	1
		C	"	0.22	2.41	0.32	0.7 R + 3.5 Y	3
		D	"	0.23	2.62	0.41	0.7 R + 3.5 Y	3

R = Red, Y = Yellow

A : E-20 - Lacquered for body and components (straight walled), B :E-25 - Lacquered for body and black plate lacquered for components (straight walled), C :E-10 - Lacquered for body and components (straight walled), D :E-10 - Lacquered for body and components (beaded can). * Mean score on a 4 point scale. 1 : Typical and fresh, 2 : Incipient rancidity, 3 : Just noticeable rancidity 4 : Clearly rancid

different types of containers stored at 37°C and thereafter, it was free from moisture. There was a marginal difference during storage in FFA. Regarding peroxide value, it reached the maximum value of 17.71 after 9 months storage at 37°C and then started declining. Among the four different types of containers, there were not much differences in peroxide values. Regarding Kries test values, there were marginal increases from 0.11 to the maximum value of 0.61 after 12 months storage. After 9 months storage at 37°C, slight rancid odour was noticed in E-10 cans. In E-20 and E-25 tinplate cans, the product was free from rancidity and it was acceptable even after 12 months storage at ambient temperature and 37°C. The values for moisture, FFA, peroxide value, Kries test and colour are presented in Table 2.

Regarding the external appearance of the cans stored at 38°C with 92% RH, the observation was that there had been light rusting in top seam and medium rusting in bottom seam in all types of cans, while there was no rusting in the side seam. External rusting was noticed only in the top and bottom ends of the cans, irrespective of whether they are beaded or straight walled. Can interior was normal in all the four variables, which were coated

with lacquer internally. There was no perceptible corrosion in the can interior.

Conclusion

The quality of *vanaspati*, packed in low tincoated cans, was acceptable in E-20 and E-25 tinplate upto 12 months storage at 37°C and ambient temperature (25-30°C). E-10 cans were not found suitable for storing for more than 6 months.

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Effect of Blanching Treatments on the Quality Characteristics of Dehydrated Fenugreek Leaves

MUKTI BAJAJ, POONAM AGGARWAL, K.S. MINHAS AND J.S. SIDHU*
Department of Food Science and Technology,
Punjab Agricultural University, Ludhiana-141 004, India.

Different blanching treatments were given to fenugreek leaves to get better quality dried product. Results showed that the ascorbic acid retention was highest in potassium metabisulphite (0.5%) treated sample, while chlorophyll retention and quality scores were highest in water-blanched samples, immediately after dehydration. Six months storage showed best retention of ascorbic acid in unblanched samples, while retention of chlorophyll was maximum in magnesium oxide (0.1%) treated samples.

Keywords : Fenugreek leaves, Blanching treatment, Dehydration, Rehydration, Quality characteristics.

An increasing trend of improving the dietary standards among the people has been observed in recent years (Srikantia 1989). Green leafy vegetables are gaining importance, mainly because of being good sources of vitamins, minerals and dietary fibre (Narasinga Rao et al. 989). Fenugreek (*Trigonella foenum graecum*) is a popular green leafy vegetable in India and the chemical composition of the seed has already been reported (Shankaracharya et al. 1973). Being a seasonal crop, it is available in plenty at lower cost during winter season (Patil et al. 1978) and therefore, can be dehydrated to make it available in off-season, provided the quality of dehydrated product is maintained to be acceptable. In fact, dehydration is the method of choice for vegetables (Mandhyan et al. 1988), cauliflower (Srivastava and Nath 1985) and tomato (Gupta and Nath 1984). Colour of food is one of the most important quality attributes demanded by consumers and is, therefore, important in the overall product acceptance (Joachim and LaBoide 1989). Attempts have, therefore, been made to improve the colour and flavour characteristics of dehydrated fenugreek leaves using various blanching treatments.

Fresh fenugreek leaves were procured from local market. The roots as well as undesirable leaves were trimmed and the leaves were washed in water to remove the adhering dirt/soil etc. After draining off the excess water, they were divided into ten lots for blanching purposes.

Blanching treatment sclutions : Different blanching solutions, prepared in water, consisted of (%) (1) sodium chloride 2, (2) magnesium oxide 0.1, (3) sodium metabisulphite 0.5, (4) potassium metabisulphite 0.5, (5) sodium bicarbonate 0.1, (6) sodium bicarbonate 0.2, and (7) magnesium oxide 0.1 + potassium metabisulphite 0.5 + sodium bicarbonate 0.1. Using the criterion of absence of peroxidase activity, the preliminary studies showed that blanching in boiling water at 99°C for 2 min (Patil et al. 1978) is adequate for fenugreek leaves and hence, adopted in the present studies. One lot was blanched in plain water. Two lots were kept unblanched, one to serve as fresh and the other as control unblanched dehydrated sample. After blanching, the material was immediately dipped in cold water.

Drying : Blanched samples and one lot of the unblanched fenugreek leaves were spread evenly in trays and dried in the cabinet drier (Friedrick make, Bombay) at 60±5°C for 5-6 h. The dried samples were sealed in 250 gauge polyethylene bags and stored at room temperature (25-32°C), till further study.

Analysis : Fresh as well as dehydrated samples were analysed for moisture and ascorbic acid, using 2, 6 dichlorophenol-indophenol dye (AOAC 1980). Chlorophyll was extracted with 80% acetone and intensity of colour measured at 663 and 645 nm in spectronic-20 colorimeter, while results expressed in terms of chlorophyll a, chlorophyll b and total chlorophyll (as g/100 g) on dry weight basis (Anderson and Boardman 1964). Dehydrated samples were analysed at an interval of 90 days over the period of six months. Dehydrated samples were also analysed for dehydration and rehydration ratio.

Culinary quality evaluation : Rehydrated fenugreek samples were evaluated at an interval of 90 days over a period of six months by a panel of semi-trained judges using a 9-point Hedonic scale (1 for extremely disliked and 9 for extremely liked). The

* *Corresponding Author*

TABLE 1. EFFECT OF BLANCHING SOLUTIONS AND STORAGE ON CHLOROPHYLL AND ASCORBIC ACID CONTENTS* OF DEHYDRATED FENUGREEK LEAVES.

Treatments	Storage period, months								
	0	3	6	0	3	6	0	3	6
	Ascorbic acid, g/100g			Chlorophyll a, g/100g			Chlorophyll b, g/100g		
Fresh leaves	17.3	-	-	8.2	-	-	6.4	-	-
Unblanched, control	5.7	4.4	4.0	3.3	2.7	2.7	2.7	2.3	2.2
Plain water	3.9	3.2	2.6	6.6	4.3	4.2	6.9	3.5	3.4
Sodium chloride, 2%	2.8	2.4	1.7	6.2	4.5	4.3	5.3	3.7	3.4
Magnesium oxide, 0.1%	2.8	2.4	1.8	5.4	4.9	4.6	4.6	4.4	4.1
Sodium metabisulphite, 0.5%	5.6	4.1	3.2	4.6	4.7	4.6	4.4	3.7	3.6
Potassium metabisulphite, 0.5%	6.8	4.8	3.7	4.4	3.7	3.6	3.5	2.9	2.7
Sodium bicarbonate, 0.1%	4.6	3.6	3.0	5.4	4.5	4.2	4.5	4.0	3.9
Sodium bicarbonate, 0.2%	3.9	3.0	2.6	4.1	4.1	4.0	3.3	3.4	2.9
Magnesium oxide, 0.1% + potassium metabisulphite, 0.5% + sodium bicarbonate, 0.1%	2.9	2.4	1.8	6.0	4.7	4.4	5.4	4.1	4.0

* Results expressed on moisture free basis

samples were compared with fresh leaves for colour, texture, aroma and overall acceptability.

The fresh fenugreek leaves contained 17.3 g ascorbic acid and 14.6 g total chlorophyll on dry basis (Table 1). The moisture content of fresh fenugreek leaves was 87.8%. In dehydrated fenugreek leaves, the moisture contents ranged from 6.0 to 8.0%. Ascorbic acid retention among the dehydrated samples was maximum (39.2%) in potassium metabisulphite blanching treatment. The improved ascorbic acid retention by sulphite treatment was also reported by Chaudhary (1979) and Patil et al. (1978). Total chlorophyll loss was minimum (7.3%) in sample blanched in plain water, while potassium metabisulphite-blanching resulted in considerable loss (46%). Blanching in water for chlorophyll retention was also reported by Eheart (1969) and El-Sherbiny et al. (1986). Patil et al. (1978) reported improvement in chlorophyll retention with magnesium oxide, potassium metabisulphite and sodium bicarbonate blanching, while improved chlorophyll retention with sulphite treatment was reported by Chaudhary (1979).

TABLE 2. EFFECT OF BLANCHING TREATMENTS ON THE CULINARY CHARACTERISTICS OF DEHYDRATED FENUGREEK LEAVES*, IMMEDIATELY AFTER DRYING.

Treatments	Colour	Texture	Aroma	Overall score
Unblanched, control	5.0^{b}	5.0^{a}	4.0^{b}	4.7^{b}
Plain water	8.0^{ab}	7.0^{ab}	9.0^{a}	8.0^{a}
Sodium chloride, 2%	7.0^{ab}	7.0^{ab}	7.0^{ab}	7.0^{ab}
Magnesium oxide, 0.1%	8.0^{ab}	8.0^{ab}	8.0^{a}	8.0^{a}
Sodium metabisulphite, 0.5%	6.0^{ab}	7.0^{ab}	5.0^{b}	6.0^{ab}
Potassium metabisulphite, 0.5%	6.5^{ab}	6.0^{ab}	6.0^{ab}	6.5^{ab}
Sodium bicarbonate 0.1%	7.5^{ab}	8.0^{ab}	6.5^{ab}	8.0^{a}
Sodium bicarbonate 0.2%	7.0^{ab}	9.0^{b}	8.0^{a}	6.0^{ab}
Magnesium oxide, 0.1% + potassium metabisulphite, 0.5% + sodium bicarbonate 0.1%	9.0^{a}	8.0^{ab}	6.0^{ab}	7.7^{ab}
L.S.D.	3.96	3.96	3.61	3.23

* Average score of 8 panelists, values with similar superscript are non-significant

Blanching treatments did not significantly affect the dehydration ratio. Dehydration ratio ranged from 7.5 to 7.7 for all the samples. Rehydration ratio, however, ranged from 5.9 to 7.2, the highest being with sulphite treatment. Blanching considerably improved the culinary quality of rehydrated dried fenugreek leaves. Aroma retention was highest in plain water blanching. Sodium bicarbonate (0.2%) treatment resulted in best texture. No undesirable aroma development was noticed in any of the blanching treatments studied. During six months storage, the maximum loss was of ascorbic acid (45%) as compared to other constituents (Table 1). Unblanched fenugreek leaves were found to possess maximum stability of ascorbic acid. Chlorophyll content also decreased with the length of storage (Table 1).

Considering the culinary characteristics, colour, aroma retention and overall quality, it can be concluded that blanching of fenugreek leaves in plain boiling water for 2 min and dehydration at 60±5°C for 5-6 h in a tray drier gave best results, immediately after drying (Table 2). However, magnesium oxide (0.1%) treated sample and the

sample treated with magnesium oxide 0.1% + potassium metabisulphite 0.5% + sodium bicarbonate 0.1% showed higher stability in chlorophyll content than the plain water-blanched dehydrated sample. After the storage period of six months, the quality of all the treated samples was found to be acceptable, without any sign of undesirable colour or off-flavour.

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Sucrose Mobilisation in Maturing Seeds of Water Chestnut (*Trapa bispinosa* Roxb.) and Litchi (*Litchi chinensis* Sonn.)

D.K. DAS, S. KUMAR, A.K. SINGH AND U.S. PRASAD*
Biosciences Research Centre, Department of Botany,
T.N.B. College, Bhagalpur University, Bhagalpur-812 007, India.

In water chestnut, the activities of sucrose synthetase and invertase run parallel during seed maturation with their high activities in immature seeds. On the other hand, in litchi, the activities of sucrose synthetase and invertase reveal almost a contrasting pattern during seed maturation. Nevertheless, rapid turnover in sucrose is indicated through the changes in the activities in these enzymes, which tend to differ in the two seeds. In water chestnut, invertase predominates over sucrose synthetase, whereas in litchi cultivars, sucrose synthetase predominates over invertase during seed maturation.

Keywords : Seed maturation, *Trapa bispinosa*, *Litchi chinensis*, Sucrose, Sucrose synthetase, Invertase.

Sucrose is usually the principal carbon source for starch synthesis in reserve tissues (Preiss 1982). Use of labelled sucrose in paddy (Rao and Sane 1985) and in *in vitro* growing maize seeds (Cobb and Hannah 1986) has shown that sucrose is preferentially utilized in comparison to reducing sugars. Invertase activity as well as total sugar content has been found to decrease with the advancement of seed development in rice (Singh and Singh 1983) and okra (Malik et al. 1982). In sugarcane, activities of sucrose synthetase, sucrose phosphate synthase and invertase have been correlated with the contents of sucrose and hexose (Batta and Singh 1986). However, data available on this aspect are rather scanty and it is still not clear whether sucrose synthetase enzyme has a greater role to play in sucrose synthesis or in its degradation (Duffus and Duffus 1984). In the present study, an attempt has been made to explain sucrose turnover in developing seeds of water chestnut and litchi.

The composition of different litchi cultivars has already been reported (Ajay Singh et al. 1987). Water chestnut (*Trapa bispinosa* Roxb) has been valued as a delicacy and used as a source of starch and some studies on canning have also been reported (Rodrigues et al. 1964). In the present experiment, fruits of two cultivars 'Purbi' and 'Early Bedana' of *Litchi chinensis* Sonn. were collected from Agriculture College, Sabour (Bhagalpur) on the 40th and 36th day after anthesis, respectively. Fruits were later picked up regularly at an interval of seven days upto over-ripe stage (75 days after anthesis in 'Purbi' and 71 days after anthesis in 'Early Bedana'). Similarly, fruits of 'Pinkish Red' variety of *Trapa bispinosa* Roxb. were collected first on the 15th day after anthesis and subsequently, at a regular interval of four days upto over-ripe stage (35 days after anthesis).

All the chemicals used were of analytical grade. Absorbance was recorded in a Bausch and Lomb 'Spectronic 20' colorimeter.

Sucrose, from 80% ethanolic extract of litchi seed and edible portion of water chestnut, was chromatographically separated on Whatman No. 3 paper and characterized according to the methods of Gauch et al. (1979). Sucrose chromatogram was scanned in a densitometer (Type CM 11, Toshniwal make) and its content was determined with the help of the area of transmittance of standard sucrose of known concentration, also scanned densitometrically.

Sucrose synthetase activity was assayed at 37°C in the direction of sucrose synthesis using a colorimetric assay (Claussen et al. 1984). The enzyme invertase was assayed by estimating the reducing sugars (Somogyi 1945).

In water chestnut, fluctuating trend in sucrose concentration has been observed at various stages of seed development (Table 1). The activities of sucrose synthetase and invertase enzymes decline continuously from immature (15 days after anthesis) to fully mature (27 days after anthesis) seeds, followed by a considerable increase in over-mature seeds at 31 days after anthesis. However, the activities of these enzymes immediately decline to their minima at the next stage, i.e. 35 days after anthesis.

Sucrose has been non-detectable in partially mature seeds in litchi cultivars 'Purbi' (47 days after anthesis) and 'Early Bedana' (43 days after

* Corresponding Author

TABLE 1. SUCROSE CONTENT AND ACTIVITIES OF SUCROSE SYNTHETASE AND INVERTASE IN WATER CHESTNUT DURING SEED DEVELOPMENT

Stages of fruit development	Stages of seed maturation	Days after anthesis	Sucrose,* µg/mg tissue	Sucrose synthetase,* µg sucrose/mg tissue/h	Invertase,* µg glucose/ mg tissue/h
One-third mature	Immature	15	16.6±1.8	16.6±3.8	24.2±5.6
Two-third mature	Immature	19	14.8±0.8	2.8±1.3	16.5±5.0
Ripening initiation	Partially mature	23	20.0±1.2	1.9±0.5	11.1±3.3
Partially ripe	Fully mature	27	15.0±1.2	1.4±0.3	10.7±4.4
Fully ripe	Over-mature	31	18.6±2.0	2.9±0.4	11.3±1.5
Over-ripe	Over-mature	35	14.9±2.1	0.7±0.2	8.9±1.8

* Mean of six replicates ± S.E.

TABLE 2. SUCROSE CONTENT AND ACTIVITIES OF SUCROSE SYNTHETASE AND INVERTASE IN LITCHI CULTIVARS DURING SEED DEVELOPMENT

Stages of fruit development	Stages of seed maturation	Days after anthesis	Sucrose,* µg/mg tissue	Sucrose synthetase,* µg sucrose/mg tissue/h	Invertase,* µg glucose/ mg tissue/h
		cv. 'Purbi'			
One-third mature	Immature	40	11.2±1.1	10.1±0.7	1.4±0.2
Two-third mature	Partially mature	47	-	74.5±2.3	0.1±0.0
Ripening initiation	Fully mature	54	9.9±0.4	4.3±1.0	0.2±0.1
Partially ripe	Over-mature	61	10.7±0.7	2.4±0.3	0.4±0.1
Fully ripe	Over-mature	68	10.9±0.8	5.6±2.5	0.2±0.0
Over-ripe	Over-mature	75	12.1±0.3	10.2±3.1	0.4±0.1
		cv. 'Early Bedana'			
One-third mature	Immature	36	10.4±0.5	3.4 ±0.4	1.1±0.3
Two-third mature	Partially mature	43	-	27.0 ±8.5	0.2±0.1
Ripening initiation	Fully mature	50	17.2±1.9	1.8 ±0.5	0.5±0.2
Partially ripe	Over-mature	57	-	23.4±10.2	0.3±0.2
Fully ripe	Over-mature	64	8.1±0.6	35.6±14.2	0.6±0.2
Over-ripe	Over-mature	71	10.1±0.4	14.8 ±9.9	3.0±0.7

* Mean of six replicates ± S.E.

anthesis) as well as in over-mature seeds (57 days after anthesis) of 'Early Bedana' (Table 2). This suggests its probable conversion into starch as storage material at seed maturity. Such a mobility of sucrose for starch accumulation is well-known (Duffus and Duffus 1984). At a time when sucrose is non-detectable, sucrose synthetase activity is high in partially mature seeds of both litchi cultivars. In litchi cv. 'Purbi', this enzyme exhibits its optimum activity in partially mature seeds (i.e. 47 days after anthesis), whereas in 'Early Bedana' its activity is optimum in over-mature seeds (i.e. 64 days after anthesis). However, invertase is optimum in its activity in immature seeds of litchi cv. 'Purbi' (i.e. 40 days after anthesis) and in over-mature seeds of 'Early Bedana' (i.e. 71 days after anthesis).

It has been observed that sucrose synthetase activity is high in tissues having heavy demand for sugar nucleosides for the synthesis of structural or storage polysaccharides (Davies 1973; Duffus and Duffus 1984). In rapidly growing wheat kernels, the first step in conversion of sucrose to starch is catalysed by sucrose synthetase (Dale and Housley 1986). Claussen et al. (1985), in their studies on brinjal, cassava, grape vine, maize and sugarcane, have concluded that sucrose synthetase

may have an important role in regulation of sucrose content.

In litchi, particularly in 'Early Bedana', high invertase activity may be possibly associated with the supply of hexoses, as observed in okra (Malik et al. 1982). In spite of high invertase activity, presence of high sucrose content may be possibly due to persistent sucrose synthesis for which sucrose synthetase plays a crucial role. This viewpoint gathers support from very high sucrose synthetase activity in litchi (Table 2). The concurrent changes in the activities of both invertase and sucrose synthetase suggest that both synthesis and degradation of sucrose are in operation during litchi seed maturation.

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Storage Stability of *Aonla* Fruits - A Comparative Study of Zero-Energy Cool Chamber *Versus* Room Temperature

SANJEEV KUMAR*[1] AND V. NATH
Department of Horticulture, N.D. University of Agriculture and Technology, Kumarganj, Faizabad-224229, India.

Physiological loss in weight, decay and loss of vitamin C content were considerably less in fruits stored under zero-energy cool chamber as compared to those stored at room temperature. Under zero-energy cool chamber, the fruits of 'Chakaiya' cultivar can be stored upto 12 days with acceptable minimum decay and quality loss, as against 4 days at room temperature.

Keywords : *Aonla* (*Emblica officinalis* G), Storage stability, Zero-energy cool chamber, Ambient temperature storage, Physiological loss, Ascorbic acid.

Aonla (*Emblica officinalis* Gaertn) fruits are highly perishable in nature, as the length of time between harvest and consumption is limited to a few days (Shetty 1959). Cold storage facilities are not, generally, available near production centres. Moreover, the cold storage facilities, being expensive and constrained by power shortage, cannot be made available to accommodate all perishable commodities. Taking into consideration the above difficulties, it is important that some economical structures are made available to farmers. The zero-energy cool chambers, designed by Roy and Khurdiya (1983), are reported to enhance shelf-life of fruits and vegetables by lowering down the temperature and maintaining high humidity inside the chamber. Therefore, the study was planned to evaluate the extent of shelf-life of *aonla* fruits in a zero-energy cool chamber.

Two quintals of 'Chakaiya' cultivar fruits were stored in a zero-energy cool chamber, as designed by Roy and Khurdiya (1983). Simultaneously, five kg fruits were packed in ventillated polythene bags (thickness:100 gauge, size:40 x 23 cm) and stored at room temperature for comparison. The maximum-minimum temperatures and relative humidity during the entire storage period are given in Table 1. The cumulative loss in weight and rotting (pathological loss) were calculated on the basis of initial weight at 4-day intervals upto 16 days. Vitamin C content was analysed according to AOAC (1975).

Losses in terms of fruit weight, decay and vitamin C content during storage of *aonla* fruits under room conditions and inside zero-energy cool chamber were compared. It is clear from Fig. 1 that physiological loss in weight (PLW) increased during storage of fruits under both the conditions. The PLW was much higher at room temperature and atmospheric relative humidity. High rate of transpiration (at room conditions due to higher temperature as compared to zero-energy cool chamber - Table 1) and the higher moisture loss are mainly responsible for higher physiological loss in weight at room temperature. It is also evident from Fig. 1 that no decay was observed in fruits upto 4 days of storage and thereafter, it increased

TABLE 1. TEMPERATURE AND HUMIDITY DURING STORAGE PERIOD (1988-89)

Month and date	Temperature (°C)				Relative humidity (%)	
	Maximum		Minimum		ZECC	RT
	ZECC	RT	ZECC	RT		
December						
21	20.5	19.5	16.0	15.0	78	58
22	19.0	19.0	13.0	15.5	89	62
23	19.0	20.0	12.8	15.5	82	56
24	16.0	20.0	11.5	16.0	89	61
25	17.5	18.0	13.0	13.5	91	58
26	18.5	21.0	13.0	14.5	100	64
27	16.0	21.0	13.0	14.5	93	60
28	16.0	21.0	13.8	15.5	90	54
29	18.0	21.5	15.5	15.8	95	61
30	20.0	22.0	12.0	15.0	98	63
31	16.5	22.0	12.0	15.5	91	57
January						
1	18.0	23.0	14.0	17.0	98	59
2	16.5	23.5	13.5	18.5	100	65
3	17.0	23.5	14.0	20.0	100	64
4	18.5	23.0	14.0	18.5	86	55
5	19.5	24.0	14.5	18.5	93	58

ZECC : Zero-energy cool chamber, RT : Room Temperature

* *Corresponding Author* [1]*Present address : U.P. Council of Agricultural Research, A-11, Nirala Nagar, Lucknow-226 007, India*

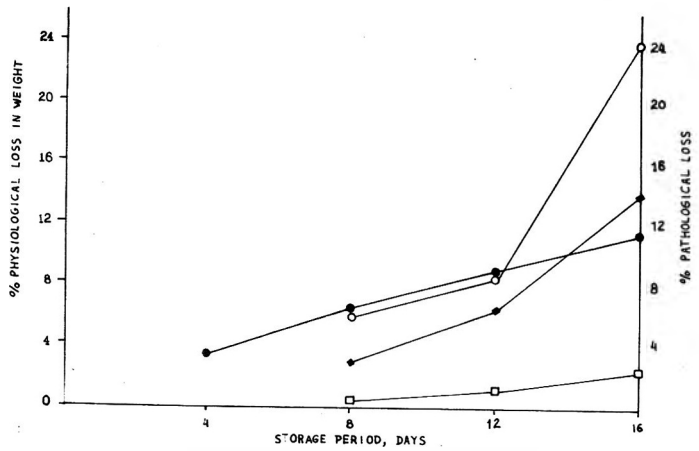

Fig.1. Changes in physiological loss in weight and pathological loss during storage of *aonla* (cv. 'chakiya') fruits.
—□— Physiological loss in weight under ZECC,
—●— Physiological loss in weight at RT,
—■— Pathological loss under ZECC,
—○— Pathological loss at RT, Replication = 2,
S.D. (i) PLW-ZECC = 1.06, = RT = 4.54, (ii) Pathological loss = ZECC = 5.90. = RT = 9.95

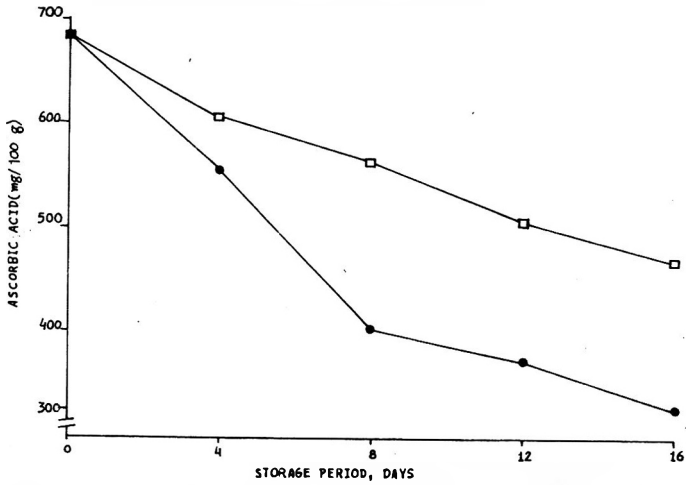

Fig.2. Changes in ascorbic acid content (mg/100g) during storage of *aonla* (cv. chakaiya) fruits
—□— Ascorbic acid content under ZECC,
—●— Ascorbic acid content at RT, Replication = 2,
S.D. (i) PLW-ZECC = 84.85 = RT = 148.12

continuously. Pathological losses were more at room temperature as compared to those in zero-energy cool chamber. The fungi responsible for decay were *Penicillium islandicum, Aspergillus niger and Fusarium* sp. Vitamin C content decreased continuously during storage of fruit under both the conditions (Fig 2), the reduction being higher at room temperature.

Considering 10% PLW (a parameter for economic shelf-life of fruits) as suggested by Dalal and Subramanyam (1970) and decay, the 'Chakaiya' cultivar of *aonla* can be stored upto 12 days under zero-energy cool chamber. Earlier reports (Pathak 1988; Singh et al. 1987) also support the present findings that fruits stored under zero-energy cool chamber have longer shelf-life due to less weight loss, decay and vitamin C content. Better storage life of *aonla* fruits under zero-energy cool chamber is mainly due to slow rate of transpiration or better environment (Table 1), as compared to those stored at ambient temperature.

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In Vitro Study on the Effect of Lactic Acid and Sodium Chloride on Spoilage and Pathogenic Bacteria of Meat

K. SYED ZIAUDDIN*[1], D.N. RAO AND B.L. AMLA
Central Food Technological Research Institute, Mysore-570 013, India.

In vitro studies demonstrated the growth inhibitory property of lactic acid on pathogenic bacteria. A combination of lactic acid and sodium chloride markedly enhanced the inhibitory effect against different species of bacteria responsible for microbial spoilage of meat and meat products as well as those causing meat-borne infections and intoxications.

Keywords : Lactic acid, Sodium chloride, Inhibition, Pathogenic bacteria, Meat.

Microbial contamination in meat is a major concern, causing spoilage of meat and consequent economic loss and public health problems. The type of bacterial flora involved has been studied by various workers (Vijaya Rao et al. 1983; Gupta et al. 1983). Increased acidity or change in pH of foods by adding organic acids is one of the ways for limiting microbial growth to control spoilage, thereby extending the shelf-life of meat. Many organic acids are used in natural form in the preservation of meat and meat products (Acuff et al. 1987; Jensen 1954; Sankaran et al. 1986; Cook and Pierson 1983; Gill and Penney 1985). During recent years, considerable interest has been shown on the use of lactic acid as a decontaminant. It is easily accepted in food system since it occurs in many varieties of foods and is also generally recognised as safe (Smulders et al. 1986). An attempt was, therefore, made to study the *in vitro* effect of lactic acid alone and in combination with sodium chloride, on spoilage and pathogenic bacteria of meat and the results are reported in this communication.

Microorganisms used in this study were *Staphylococcus aureus, Salmonella newport, Streptococcus faecalis, Bacillus cereus, Pseudomonas fragi, Escherichia coli,* (maintained in the Animal Products Technology Discipline of the Institute) and a mixed culture which consisted of both Gram positive and Gram negative cocci and rods (isolated from meat purchased from the local market). These organisms were grown in nutrient broth at 37°C for 24 h, except for *P. fragi* which was incubated at 20°C for 4 days. Total count per ml of the broth was determined. Eight sterile broth tubes containing (i) different levels of lactic acid - 0.5% at pH 5.0, 1.0% at pH 4.8, 1.5% at pH 4.5 and 2.0% at pH 4.0 and (ii) different levels of lactic acid with 0.5% sodium chloride; at each concentration mentioned above; were used in inoculation studies. One ml of inoculum of each culture of known bacterial count was inoculated and incubated at 37°C for 24 h. Total counts were made at different intervals and expressed as log 10 of colony forming units (cfu/g). The pH was determined as per the procedure described in AOAC (1984) using glass electrodes.

The behaviour of the test organisms when grown in the medium with different levels of lactic acid is shown in Fig. 1 a, b. The effect of lactic acid on the growth of the test organisms has been almost uniform except for very minor variations. Lactic acid at 1.5% (pH 4.5) and 2.0% (pH 4.0) was found to completely inhibit growth of *Streptococcus, Staphylococcus, Pseudomonas, Salmonella, E. coli* and *Bacilli* cultures at 24 h. However, the percentage inhibition varied with different cultures (Fig. 1 a, b).

The effect of different levels of lactic acid, in combination with 0.5% sodium chloride, on the growth of test organisms is presented in Fig. 2 a, b. Since these combinations were more effective in inhibiting growth of both the spoilage and pathogenic bacteria, the results upto 12 h incubation are only presented. Considerable reduction in the counts of *Staphylococcus, Salmonella, Streptococcus, Bacillus, Pseudomonas* and *Escherichia* was observed under these conditions at pH 4.0, 4.5 and 4.8. However, the inhibition of the growth of *Staph. aureus,*

* *Corresponding Author; Present Address : Department of Meat Science, Veterinary College, Hebbal, Bangalore-560 024.*

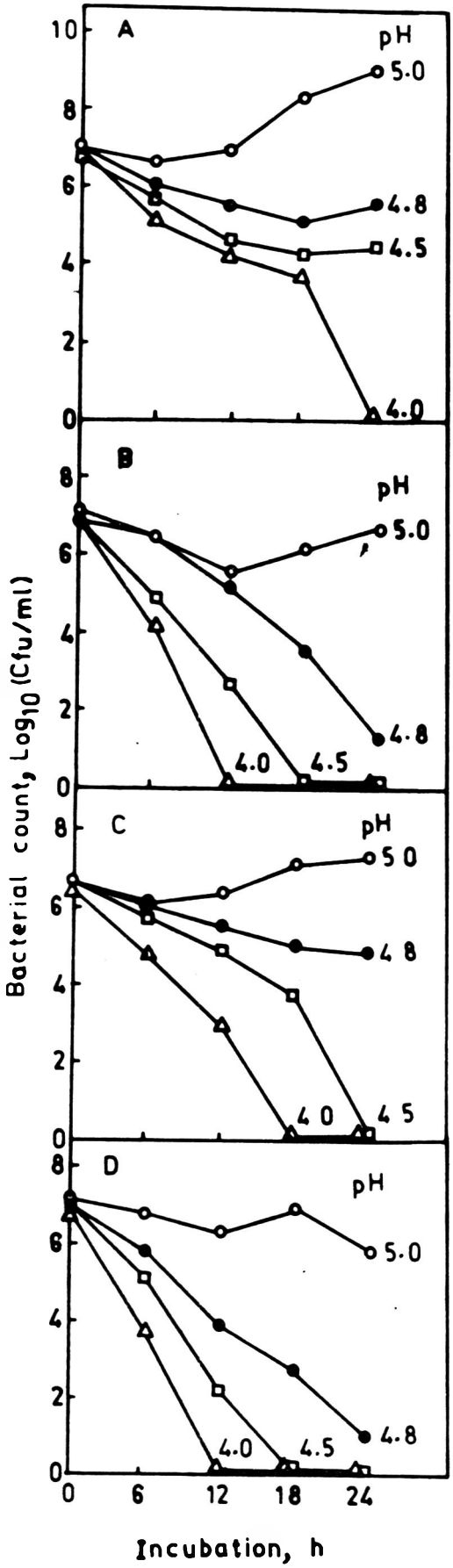

Fig. 1 a, Effect of lactic acid on bacterial growth (*in vitro*). Each value is mean of six experiments. A=Mixed culture, B=*Staph. aureus*, C=*Str. faecalis*, D=*E. coli*.

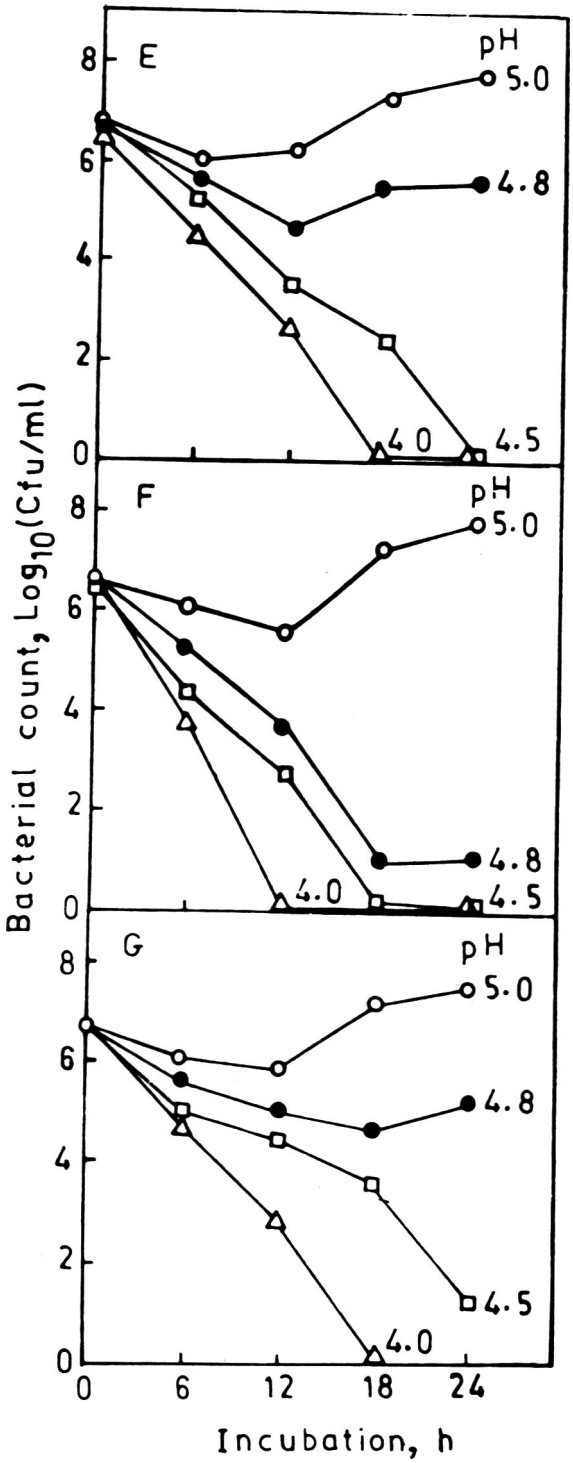

Fig. 1 b. Effect of lactic acid on bacterial growth (*in vitro*). Each value is mean of six experiments. E=S. *newport*, F=*P. fragi*, G= *B. cereus*.

E. coli, and *P. fragi* at 12 h incubation was complete under these conditions at pH 4.0 (Fig.2 a, b). After an initial lag period of 6 h, the growth of the cultures continued at pH 5.0, as in case of the use of lactic acid alone.

The results demonstrate that a combination of lactic acid and sodium chloride exerts synergistic effect of bacteriostatic and bactericidal properties at different pH levels, thereby indicating that the

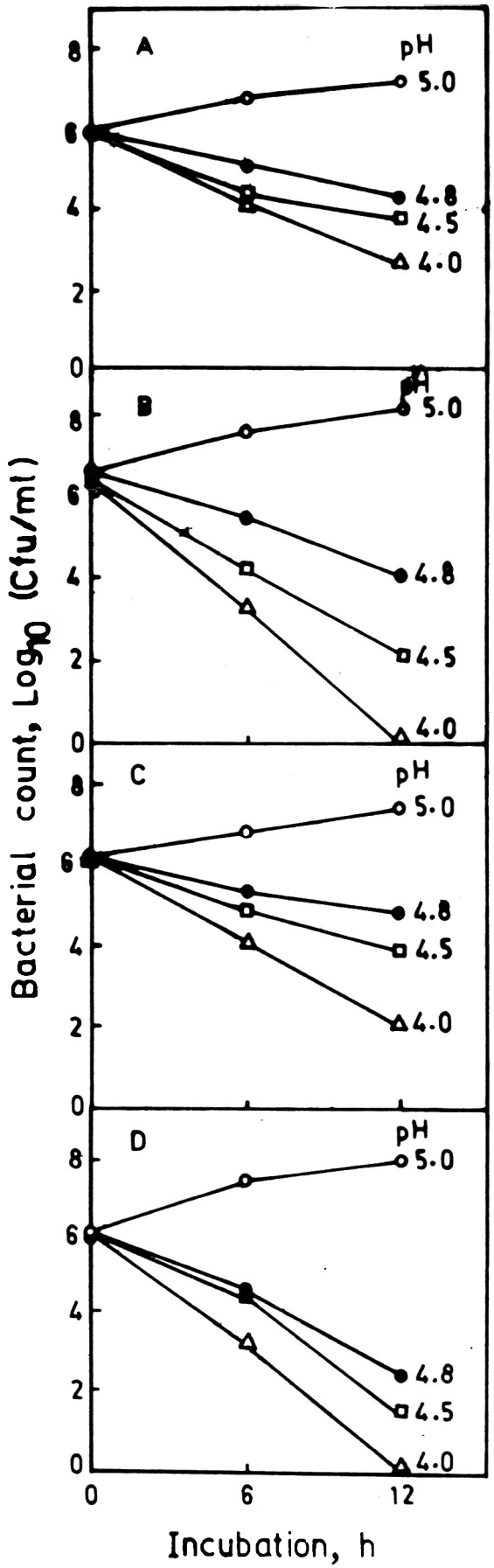

Fig. 2 a, Effect of lactic acid and NaCl on bacterial growth (*in vitro*). Each value is mean of six experiments. A=Mixed culture, B=*Staph. aureus*, C=*Str. faecalis*, D=*E. coli*.

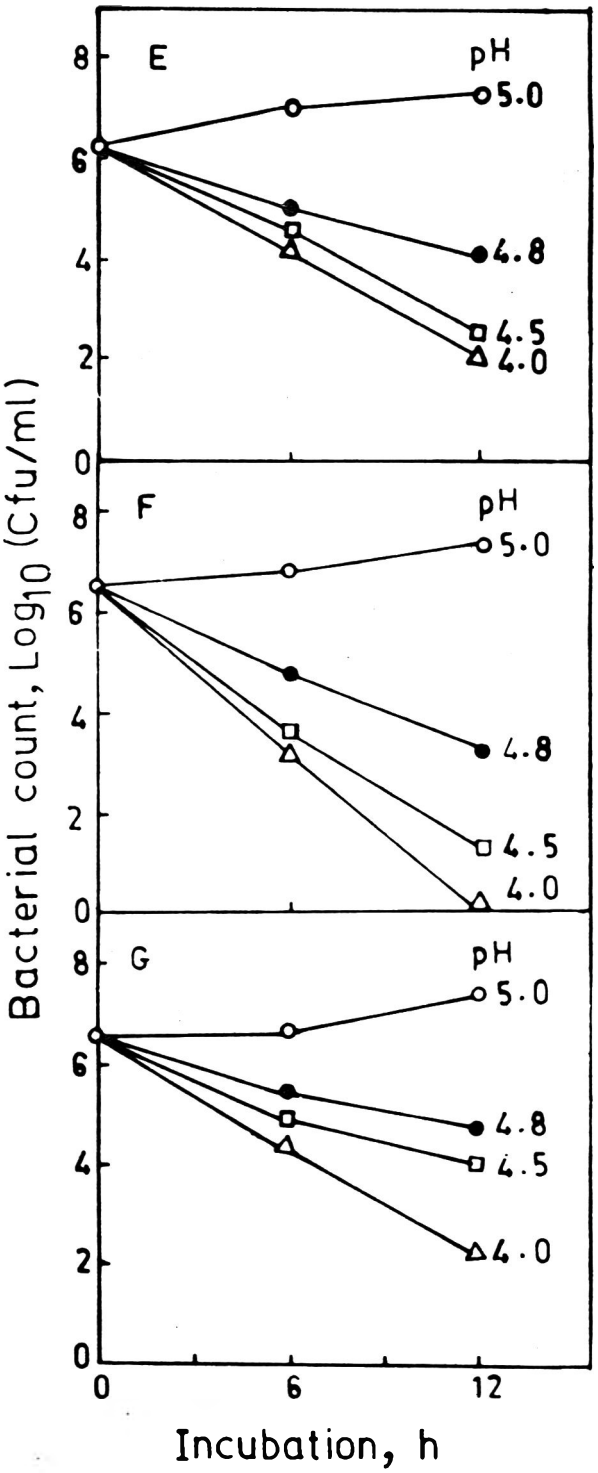

Fig. 2 b, Effect of lactic acid and NaCl on bacterial growth (*in vitro*). Each value is mean of six experiments. E= *S. newport*, F=*P. fragi*, G= *B. cereus*.

appropriate selection of the combination would be beneficial in controlling the pathogenic and spoilage bacteria on meat surface.

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Evaluation of Enzymatically Extracted Plum Juice for Preparation of Beverages

V.K. JOSHI*, S.K. CHAUHAN AND B.B. LAL
Department of Post-harvest Technology,
Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan, India.

Evaluation of enzymatically extracted plum juice showed that a product with 40% juice and 10° Brix was most acceptable. For nectar, 20% juice with 15° Brix was found to be the optimum. Plum appetizer with added spices extract was liked the most, at all the TSS and juice concentrations tried. The physico-chemical, sensory characteristics and details of preparation of the products have been described.

Keywords : Plum, Enzymatic juice extraction, Juice, Nectar, Appetizer, Plum beverages.

Plum (*Prunus saliciana*) constitutes about 60% of the total stone fruits produced in Himachal Pradesh (Anon 1988). The fruit is highly perishable and requires immediate processing. Among the possible products, beverage is one alternative, but extraction of juice from plum fruits is difficult due to higher amount of pulp content (Woodroof and Luh 1986). Therefore, the water extract of the fruit is being used presently for the preparation of beverages. A process for preparation of plum-based alcoholic beverages has also been standardized (Vyas and Joshi 1982; Joshi et al. 1991). Methods of juice and pulp preparation from plum varieties, combining mechanical and enzymatic treatment are available (Wani and Saini 1990). In our earlier work, an enzymatic process of juice extraction for plums, peaches and apricots was standardized using pectinases (Joshi et al. 1991). This communication reports the study carried out on utilization of enzymatically extracted plum juice for beverage preparation.

The fruits of 'Santa Rosa' variety were obtained from the university orchard. Soft, fully ripened fruits were pulped and juice was extracted by the enzymatic process as reported earlier (Joshi et al. 1991). Different proportions of extracted plum juices (2.1% titratable acidity and pH 3.3) were taken and their total soluble solids were raised to 19° Brix with sugar syrup (72%), the control being 100% juice. The juice was pasteurized in boiling water (96°C) for 20 min, after hot filling and bottling in 200 ml juice bottles. For the preparation of plum nectar, 20, 25 and 30% juice contents were used and their TSS was raised to 16° Brix with sugar syrup. The products were processed in a similar manner as the plum juice. To prepare plum appetizer, the TSS of plum juice was raised with sugar syrup to 45° to 55° Brix. Similarly, appetizers were prepared using 35% pulp, instead of the juice. In one set of each product, spices/flavour extract was added. The extract included mint (0.4%), ginger (0.5%), salt (1.3%), black salt (0.7%), cumin (0.25%), cardamom (0.25%), black pepper (0.1%), citric acid (0.5%) and sodium benzoate (0.065%). The ground spices were extracted in water after boiling for 10-20 min. The composition of spices extract was optimized in the preliminary trials. In every set, non-spiced appetizer was used as a control. All other details of the appetizer preparation were the same as per the conventional procedure. In all, there were 8 types of preparations viz., T_1 to T_8.

The products were analysed for TSS (° Brix), pH, titratable acidity, viscosity (flow/unit time), colour (units) as per the standard methods (Ranganna 1986). Sensory analysis was carried out using a panel of 10 judges. Coded samples were presented at random to the panelists and responses were recorded on the Hedonic rating or composite scoring on the weighed attributes (Ranganna 1986). The data of sensory analysis were analysed statistically by analysis of variance.

The physico-chemical characteristics of the sweetened plum juices (Table 1) show that the decrease in the juice content reduced the titratable acidity and colour, but increased the pH. Accordingly, TSS to acid ratio also registered an increase with the decrease in the juice contents, while its optimum value was obtained in the product with 40% juice. The values for vacuum were almost similar in all the treatments apparently due to the use of same procedure in pasteurization. The sensory analysis revealed a definite improvement in the sensory score of the sweetened juice with the decrease in juice content. Product of the

* *Corresponding Author*

TABLE 1. PHYSICO-CHEMICAL CHARACTERISTICS AND SENSORY EVALUATION OF SWEETENED PLUM JUICES OF DIFFERENT TREATMENTS.

Treatments	Vacuum inches of Hg	TSS °Brix	Acidity % MA	pH	Colour			Mean sensory score
					Red	Yellow	Blue	
PJ-0 Plum Juice (100%, 12° Brix)	12.0	18.6	2.0	3.2	25.3	5.4	0.2	5.0
PJ-1 Plum Juice (100%, 19° Brix)	12.5	18.7	2.0	3.2	28.7	11.0	0.1	6.8
PJ-2 Plum Juice (80%, 19° Brix)	12.5	18.6	1.6	3.3	24.9	10.6	0.1	6.2
PJ-3 Plum Juice (60%, 19° Brix)	12.4	18.7	1.2	3.5	16.7	11.8	0.1	6.7
PJ-4 Plum Juice (40%, 19° Brix)	12.5	18.8	0.8	3.6	10.2	11.0	0.1	7.8

CD (p = 0.05) for mean sensory score was 1.21.

TABLE 2. PHYSICO-CHEMICAL AND SENSORY PROPERTIES OF PLUM NECTAR

	Juice content		
	20%	25%	30%
Vacuum, inches of Hg	12.0	12.0	12.5
pH	3.4	3.3	3.2
TSS, ° Brix	15.8	15.6	15.9
Acidity, % MA	0.4	0.5	0.7
Relative flow time, sec.	42.3	44.7	45.9
Red colour	7.9	8.4	8.9
Yellow colour	5.0	4.5	4.9
Sensory attributes Maximum score = 20			
Colour	16.5	13.6	14.7
Body and consistency	15.0	14.5	15.4
Flavour	15.8	14.1	15.0
Taste	15.8	14.1	15.0
Overall acceptability	16.1	14.3	15.5

CD (p=0.05) : Colour 0.39; Body and consistency 0.24; Flavour 0.17; Taste 0.21; Overall acceptability 0.27

acceptable quality could be obtained by using 40% juice. The products with higher juice contents had too high acidity to be acceptable. It can be concluded that higher than 40% juice could not be utilized even for preparation of sweetened juice.

The physico-chemical properties of plum nectars (Table 2) showed an increase in titratable acidity (% MA), decrease in pH and colour units, with increase in juice content. However, no difference in vacuum was observed. Significant differences among the treatments for various sensory attributes were observed (Table 2). The treatment involving 20% juice was found to be the best in all the sensory characteristics studied. It could be mainly due to acceptable acid/sugar blend which is known to influence the taste perception of the nectar (Piggott 1988).

Table 3 shows the comparison of appetizer from pulp and enzymatically extracted juice. The products showed large variations in titratable acidity, pH, red colour unit and apparent viscosity. However,

TABLE 3. DETAILS OF TREATMENTS AND SOME PHYSICO-CHEMICAL CHARACTERISTICS OF PLUM SQUASHES

Treatments	Cut-out TSS (°Brix)	Acidity % M.A.	pH	Apparent viscosity,	Colour		Sensory analysis				
					Red	Yellow	Colour	Body	Taste	Flavour	Overall quality
Appetizer from plum pulp											
T_1 - 45°B no flavour/spices	45.0	0.89	2.6	96	19.0	3.0	13.8	12.6	15.4	15.0	12.8
T_2 - 45°B with flavour/spices	45.0	0.86	2.6	80	17.0	3.0	14.2	13.6	15.0	14.0	16.0
T_3 - 55°B no flavour/spices	55.0	0.81	2.6	98	18.0	3.0	12.8	12.4	12.8	13.8	12.2
T_4 - 55°B with flavour/spices	55.0	0.80	2.6	82	16.0	3.0	12.0	14.2	15.1	12.5	15.1
Appetizer from enzymatically extracted juice											
T_5 - 45°B no flavour/spices	44.5	1.36	2.8	77	20.0	3.0	12.4	12.8	13.4	13.6	12.4
T_6 - 45°B with flavour/spices	45.0	1.29	2.5	69	17.0	3.0	13.2	12.8	15.8	16.4	13.8
T_7 - 55°B no flavour/spices	55.0	1.29	2.7	79	20.0	2.0	14.0	14.6	13.1	14.0	12.8
T_8 - 55°B with flavour/spices	54.5	1.00	2.4	79	16.0	3.0	13.8	13.2	15.0	17.4	16.4
CD (p=0.05)	-	-	-	-	-	-	0.48	0.28	0.72	1.35	2.36

not much variation in cut-out TSS of the appetizer prepared from pulp or the enzymatically extracted juice was noted. The appetizer prepared from juice had comparatively higher titratable acidity, lower apparent viscosity, higher colour values as compared to those prepared by using the pulp. This is understandable as utilization of higher juice level contributes more acid and colour than that with 35% pulp. But, the use of clarified juice resulted in a reduction in viscosity of appetizer as compared to the pulp-based appetizer, apparently due to removal of pectin, which contributes towards viscosity. On the basis of sensory evaluation of various appetizers, the treatment T_8 was found to be the best. Individual comparison for various characteristics also showed differences between the treatments. Product with 45° Brix was found to be suitable, when pulp based product with flavour extract was used. In case of the enzymatically extracted juice, the product with 55° Brix was adjudged the best. The products, with added spices extract, showed considerable improvement over those without it, especially with respect to taste and flavour. Addition of salt must have also balanced the perception of acid in the products. It could be concluded that enzymatically extracted juice could be utilized in appetizer preparation with recipe used in the present study. Moreover, higher juice could be incorporated as compared to the pulp-based product. In addition, the product shall have higher fruit pulp, thereby, facilitating higher utilization of the perishable fruits.

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Effect of Homogenization of Milk on the Quality of *Gulabjamun*

SMITA DESHMUKH, R.D. SAMMANWAR* AND G.D. SORTE
Department of Animal Husbandry and Dairying,
Punjabrao Krishi Vidyapeeth, Akola - 444 104, India.

Khoa prepared from unhomogenized and homogenized milk was blended with maida at the ratio of 3:1 and baking powder was added at different levels. The *Gulabjamun* (an Indian sweet) prepared from unhomogenized milk *khoa* with 0.08% baking powder showed good acceptability. The homogenization could not improve the quality of *Gulabjamun*.

Keywords : Baking powder, *Gulabjamun*, Homogenization of milk, Milk product, *Khoa*.

The total production of milk in India is estimated to be 57.10 million tonnes per annum, of which nearly 7% is converted into *Khoa* (concentrated moist milk solids). The annual preparation of *Khoa* in India is estimated at 6 lakh tonnes (Dairy India 1992). The keeping quality of *Khoa* could be enhanced by adding sugar or jaggery or by preparing delicious sweets. Amongst the Indian sweets, *Gulabjamun* is one of the sweet preparations popular throughout the country.

Preparation of *Gulabjamun* is an art, as it requires expertise in the methodology of preparation (Rangi et al. 1985). Homogenization is an important step in the dairy industry to improve the quality of milk and milk products (Mulay and Ladkani 1973). The literature regarding manufacturing technique and the effect of homogenization on the quality of *Gulabjamun* is meagre. A scope exists to improve the manufacturing technique and the quality of *Gulabjamun*, on the basis of modern technology. The present study was undertaken with a view to prepare *Gulabjamun* from homogenized milk *Khoa*.

Fresh cow milk was standardized to contain 4% fat and 8.5% solids-not-fat. Half of the quantity of the milk was heated to 55°C and then homogenized in a single step at a pressure of 2500-3000 psi in FAS-100 homogenizer (De 1980). Unhomogenized and homogenized milk samples were taken in separate *Karahi* (frying pan) and heated on brisk fire (non-smoky) for preparation of *Khoa* as per the method recommended by Srinivasan and Anantakrishnan (1964). *Khoa* bits and *maida*, in the proportion of 3:1 (w/w), were mixed, kneaded and kept as such for about 30 min (Ghosh et al. 1986). *Khoa* preparations were divided into 5 equal parts, each for treatment with baking powder at the levels of 0, 0.02, 0.05, 0.08 and 0.11% of mixture individually. The baking powder was mixed well and balls of 1.5 cm size were prepared.

The vegetable *ghee* (hydrogenated fat) in a frying pan was heated to 140°C and the pan was taken off from the fire (Gill and De 1974). The balls were fried till deep brown in colour and removed with perforated laddle to permit drainage of *ghee*. The balls were immersed in sugar syrup for 4h before sampling and evaluation. The sugar syrup was prepared by dissolving 2 kg sugar in 1 L water and boiling vigorously. To obtain a clear solution, about 10 ml of milk was added and dirt/scum floating at the top were removed. The syrup was ready when sugar concentration reached 70% as measured by a hand refractometer.

The determination of fat content of the milk was carried out as per IS : 1479-1961 (ISI 1961), while total solids were estimated by using Quevenne's lactometer and Richmond's modified formula (Ling 1963). In case of *Khoa* and *Gulabjamun*, the fat content was determined by Soxhlet's extraction (AOAC 1970) and total solids were estimated by gravimetric method (ISI 1961). Sugar syrup absorption of balls was determined by the difference in weight before and after soaking in sugar syrup. The difference in size before and after frying of *Gulabjamun* balls was also determined. The *Gulabjamuns* were evaluated by a trained panel of judges based on a 9 point Hedonic scale. The results were statistically analysed (Panse and Sukhatme 1967). The volume of *Gulabjamun* increased with the increase in baking powder levels in both unhomogenized and homogenized samples, the extent of increase being greater in unhomogenized than homogenized milk *Gulabjamun* (Table 1). Statistically, these differences were significant at 5% level. Sugar absorption was more in unhomogenized milk *Gulabjamun* at all levels of

* *Corresponding Author*

TABLE 1. EFFECT OF BAKING POWDER ON PHYSICO-CHEMICAL PROPERTIES AND QUALITY OF *GULABJAMUN*

Attribute	Unhomogenized milk					Homogenized milk				
	Baking powder level, %					Baking powder level, %				
	0.00	0.02	0.05	0.08	0.11	0.00	0.02	0.05	0.08	0.11
Increase in volume over the initial, cm^3	0	1.1	2.0	2.3	2.4	0	0.8	1.6	1.8	2.1
Sugar syrup absorption, %	10.3	20.3	24.6	31.4	37.7	9.5	14.1	19.4	22.2	26.0
Fat in *Gulabjamun*, %	14.8	15.6	19.3	20.9	23.4	14.8	15.6	19.4	20.9	23.4
Total solids, %	68.0	69.0	70.2	73.0	75.3	68.0	69.0	70.2	73.0	75.4
Body and texture score	1.0	2.6	4.9	8.7	6.0	1.0	2.2	3.9	5.4	7.1
Overall acceptability score	1.0	3.1	6.9	8.0	6.8	1.0	3.0	6.0	7.0	6.0

F test was significant except for total solids content. CD range is 0.0048 - 0.17

baking powder as compared to homogenized milk *Gulabjamun*. Increase in the level of baking powder has shown increase in absorption of sugar syrup. It appears that homogenization of milk inhibits the porosity and hence, lower absorption of sugar syrup, whereas the use of baking powder creates conditions for porous texture in the product. These results on volume increase and sugar syrup absorption are in agreement with the results of Mulay and Ladkani (1973).

There was significant increase in the fat and total solid contents of *Gulabjamun* with increasing levels of baking powder in both the samples. However, no effect of homogenization on fat and total solids was observed (Table 1). The results agree with those reported by Minhas et al. (1985). *Gulabjamun*, having no baking powder, showed distinctly hard body and close texture and scored less in both the cases (Table 1). Addition of baking powder in *Khoa* improved the body and texture and was better at all the levels of baking powder added in unhomogenized milk *Gulabjamun*, as compared to homogenized milk *Gulabjamun*.

Results reveal that increase in levels of baking powder showed increase in the acceptability of *Gulabjamun* (Table 1). The unhomogenized milk *Gulabjamun* scored higher than the homogenized milk *Gulabjamun*. It seems that there was no positive effect of homogenization on the quality of *Gulabjamun* and it rather reduced the porosity of the product. Unhomogenized milk *Gulabjamun* made with the use of 0.08% baking powder showed significantly superior acceptability over all other levels of baking powder tested. Addition of 0.11% baking powder reduced the acceptability due to increase in porosity.

It is, therefore, concluded that homogenization has a negative effect on the quality of *Gulabjamun*. Addition of 80 mg baking powder to 100 g dough gives spongy body, smooth texture and good quality *Gulabjamun*.

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Phytate/Zinc and Phytate x Calcium/Zinc Ratios of Common Cereals, Legumes and Their Combinations

CHARANJEET KAUR HIRA* AND ANUPINDER PAL KAUR
Department of Foods and Nutrition,
Punjab Agricultural University, Ludhiana-141 004, India.

Zinc availability from common cereals, legumes and their combinations were studied using different availability indicators. The level of HCl-soluble zinc ranged from 46.3-81.9%. Phytate/zinc molar ratio was less than 20 for cereal-legume combinations, while phytate x calcium/zinc molar ratio for cereals and cereal-legume combinations was less than 50 mM/100 g. No association was observed among HCl-soluble zinc, phytate/zinc and phytate x calcium/zinc ratios.

Keywords : Zinc availability, Phytate/zinc, Phytate x Calcium/zinc, Cereals, Legumes.

Marginal zinc deficiency is known to occur in several populations (Prasad 1989) and is associated with retarded growth. Zinc deficiency is primarily due to its low availability in plant foods. Phytic acid found in cereals and legumes is reported to be primarily responsible for low zinc availability (Ellis et al. 1982; Forbes et al. 1984; Bafundo et al. 1984; Pawar and Ingle 1988). Recently, it has been suggested that phytate x calcium/zinc molar ratio is a better indicator of zinc utilization than soluble zinc or phytate/zinc ratios (Bindra et al. 1986). In the present study, commonly consumed cereals, legumes and their combinations in Punjab were tested for HCl-soluble zinc, phytate/zinc and phytate x calcium/zinc molar ratios.

Common cereals and legumes (Table 1) were procured from local market. All legumes were pressure-cooked. *Chapatis* (unleavened bread) were prepared from whole wheat and maize flours. *Parathas* (shallow fried unleavened bread) were prepared from whole wheat flour. Maize grains were roasted in sand at 250°C and rice was cooked to obtain boiled rice. For obtaining fried rice, the boiled rice was cooked in water and fried in small amount of fat. Rice-green gram (50:50) combination was pressure-cooked. Other food preparations were based on the food consumption pattern of young adult women in the ratios as indicated in Table 1.

All raw and cooked food samples were dried (60±2°C) and used for analysis. Total calcium and zinc were estimated using titrimetric method (AOAC 1980) and atomic absorption spectrophotometer, respectively. The levels of HCl-soluble calcium and zinc were estimated after incubating samples in 0.3 N HCl at 37°C for 3 h and the supernatant was used for the estimation of total minerals. Phytic acid was estimated according to the method of Hang and Lantzsch (1983).

Maize, among cereals, and blackgram, among legumes, contained the highest total zinc (Table 1). Among cereals, HCl-soluble zinc was maximum (81.7-81.9%) in wheat and minimum in rice (46.3-52.3%). The various cereal-legume combinations showed maximum HCl-soluble zinc (81.9%) in *chapati*-lentil and minimum (61.5%) in rice-green gram combination. The *paratha*-curd combination had 85% of HCl-soluble zinc content.

Among raw cereals, phytate/zinc molar ratio was higher (40) in maize flour and lower (25) in rice, whereas among raw legumes, it was higher (25) in greengram and lower (12) in lentils. Cooked cereals and legumes showed decrease in phytate/zinc molar ratios, which may be due to the breakdown of phytic acid (Kumar et al. 1978; Pawar et al. 1986). *Chapati*-legume combinations (5:1, dry wt) showed phytate/zinc ratios in the range of 19-22, except for *chapati*-lentil combination which showed a ratio of 14. Phytate/zinc molar ratio of *paratha*-curd (4:1, dry wt) combination was 21, whereas rice-green gram (50:50, dry wt) gave a ratio of only 14. Among foods analysed, roasted maize grains, fried rice and cooked lentils had phytate/zinc ratios of less than 10. Earlier reports (Davies and Olpin 1979) indicated that molar ratios of 10 or less are usually associated with adequate zinc bio-availability and the ratios above 20 are associated with clinical or chemical evidence of zinc deficiency.

The phytate x calcium/zinc molar ratios varied from low values of 2-11 for maize, 2-6 for rice and 13-21 for lentils, to high values of 32-42 for wheat and 49-68 for blackgram. These ratios for *chapati*-legume combination, ranged between 17-59 and for

* Corresponding Author

TABLE 1. HCL-SOLUBLE ZINC, PHYTATE/ZINC AND PHYTATE X CALCIUM/ZINC OF CEREALS, LEGUMES AND THEIR COMBINATIONS (Per 100 g, Dry Wt.).

Foods	Zinc, mg		Zinc mM	Calcium mM	Phytate mM	Phytate/ zinc	Phytate x calcium/ zinc
	Total	HCl-soluble					
Wheat flour	2.24	1.83	0.034	1.12	1.24	36	41
Chapati	2.21	1.81	0.030	1.13	0.97	32	37
Paratha	2.21	1.81	0.030	1.11	0.95	31	35
Maize flour	2.50	1.67	0.038	0.26	1.53	40	10
Maize *chapati*	2.36	1.64	0.035	0.24	1.23	35	8
Maize grains, raw	2.80	1.72	0.043	0.28	1.64	38	11
Maize grains, roasted	2.60	1.80	0.039	0.26	0.23	6	2
Rice, raw	1.30	0.68	0.020	0.23	0.51	25	6
Rice, boiled	1.34	0.62	0.020	0.23	0.22	11	3
Rice, fried	1.28	0.60	0.019	0.23	0.20	10	2
Blackgram, raw	3.16	2.00	0.047	3.60	0.89	19	68
Blackgram, cooked	2.90	1.94	0.043	3.61	0.58	13	49
Greengram, raw	2.80	1.93	0.043	1.87	1.08	25	47
Greengram, cooked	2.70	1.93	0.041	1.84	0.60	15	27
Chickpea, raw	1.71	1.23	0.035	1.41	0.72	21	29
Chickpea, cooked	1.65	1.20	0.033	1.38	0.55	17	23
Lentil, raw	3.00	2.00	0.046	1.72	0.57	12	21
Lentil, cooked	2.90	1.95	0.041	1.70	0.32	8	13
Chapati-blackgram[a]	2.48	2.00	0.038	2.25	0.77	20	27
Chapati-blackgram-curd[b]	2.36	1.90	0.036	2.84	0.69	19	54
Chapati-greengram[a]	2.45	1.84	0.037	1.34	0.74	20	27
Chapati-chickpea[a]	2.03	1.43	0.030	1.23	0.67	22	27
Chapati-lentil[a]	2.53	1.96	0.038	1.29	0.52	14	18
Paratha-curd[c]	2.00	1.70	0.030	2.46	0.64	21	52
Rice-greengram[d]	2.05	1.26	0.031	1.04	0.42	14	14

a Wheat-legume combination, 5:1; b Wheat-legume-curd combination, 4:1:1; c Wheat-curd combination, 4:1; d Rice-legume combination, 1:1. Values are means of three replicates. The combination ratios are expressed on dry weight basis.

rice-greengram combination, it was 14. Fordyce et al. (1987) have predicted that phytate x calcium/ zinc molar ratios above 50 mM/100 g(0.5M/kg) dry diet or 200 mM/1000 Kcal may be of concern for poor zinc status in humans. The results of the present study revealed that phytate x calcium/zinc ratios were below 50 mM/100 g dry food for all cooked products, except for *chapati*-blackgram-curd combination (54 mM/100g). Bindra et al. (1986) evaluated the diets of 112 lacto-ovo-vegetarian *Punjabi Sikh* Canadian immigrants and reported phytate x calcium/zinc molar ratios were 90 mM/ 100 g, compared to 30 mM/100 g for diets of omnivorus population. Correspondingly, low serum zinc values found in *Punjabi* immigrants compared to omnivorus population.

It may be concluded from the results that zinc bio-availability could be maximum from rice and minimum from wheat, as indicated by phytate/zinc and phytate x calcium/zinc ratios obtained for these cereals. The cooked foods showed marked improvement in indicator ratios due to drop in phytate content. Wheat-legume combination is a better source of available zinc than wheat alone, as indicated by both phytate/zinc and phytate x calcium/zinc ratios. Among all cooking treatments, roasting seemed to be the best in lowering the ratio due to drastic drop in phytate. However, further work is necessary to confirm the above correlation.

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Fatty Acid Composition of Adult Buffalo Meat During Processing and Storage

V. KESAVA RAO* AND B.N. KOWALE
Division of Livestock Products Technology,
Indian Veterinary Research Institute, Izatnagar - 243 122, India

Three muscles viz. *Triceps brachii*, *Longissimus dorsi* and *Biceps femoris* from adult buffalo (*Murrah* type), were subjected to broiling and pressure cooking and analysed for changes in fatty acids at storage intervals of 0, 3, 6, 9, 30, 60 and 90 days under refrigerated and frozen conditions, respectively. Influence of anatomical location on fatty acid composition was evident. A gradual decrease in mono- and poly-unsaturated fatty acid contents was associated with the increase in saturated fatty acids due to processing. There were significant increases in myristic, palmitic, stearic acids and significant decreases in oleic and linoleic acid contents during storage.

Keywords : *Longissimus dorsi*, *Triceps brachii*, *Biceps femoris*, Broiling, Pressure cooking, Fatty acids, Refrigerated storage, Frozen storage, Buffalo meat.

Sparce information is available on lipid composition of buffalo meat as compared to those of cattle, pigs and sheep (Igene et al. 1980; Gokalp et al. 1981; Sharma et al. 1987). However, some data are available on the composition of lipids of bone marrow of buffalo (Sharma et al. 1990). The fatty acid composition of buffalo meat, as affected by anatomical location as well as different methods of cooking and storage, is reported in this communication.

Six adult entire male buffaloes (*Murrah* type) of about 10 years of age, with similar conformation, were selected and slaughtered at the local slaughterhouse. Muscles *Triceps brachii* (TB) from forelimb, *Longissimus dorsi* (LD) between 7th and 12th thoracic vertebrate and *Biceps femoris* (BF) from hind limb were collected. Muscles from two animals were pooled. The external adhering fat was trimmed off and muscles were cut into slices of about 100 g. Two slices from each muscle were subjected to (a) broiling in a hot-air oven (pre-heated at 160°C) to an internal temperature of 70°-80°C, (b) pressure cooking at 1 kg/cm^2 pressure for 30 min in a pressure cooker and (c) raw control without any processing. The samples were packed (about 100 g each) separately in polyethylene bags of 150 gauge and stored at 4±1°C in a refrigerator for 9 days and −10±1°C for 90 days in the deep freezer. Samples were analysed at intervals of 0, 3, 6, 9 days and 30, 60, 90 days for refrigerated and frozen storage, respectively. At the end of each storage period, muscle samples were thawed and minced in a Hobart mincer. Lipid was extracted from 10 g of minced muscle tissue (Folch et al. 1957) and total lipids were analysed gravimetrically. Methyl esters were prepared (James 1970) from approximately 100 mg lipid samples and the final concentration of methyl ester in hexane was 1 mg/ml. The fatty acid methyl esters were analysed isothermally using a modular gas liquid chromatograph (CIC, India), equipped with a flame ionisation detector and a recorder. A coiled stainless steel column [2m x 4m], packed with diethylene glycol adipate (DEGA) on chromosorb W (60-80 mesh)] was used. The operating conditions were : column temperature 185°C, injector temperature 220°C and detector temperature 240°C. Ultra high purity nitrogen (Indian Oxygen Limited, India) was used as a carrier gas at a flow rate of 30 ml/min. The fatty acid peaks were identified by comparing their retention time with those of standard fatty acids (Sigma chemicals) on a semilog paper. Peak areas were calculated by triangulation. The corresponding fatty acid was expressed as percentage of total peak area. A factorial design with 3 x 3 x 4 pattern was adopted to conduct analysis of variance (Snedecor and Cochran 1967).

Fatty acid profile of the buffalo meat observed in the present study (Tables 1 and 2) was similar to the earlier reports for Italian (Romita et al. 1976) and Indian buffaloes (Sharma et al. 1986). However, the contents of two major fatty acids viz. palmitic (C_{16}) and stearic (C_{18}) were lower than those reported by Sharma et al. (1986). Lower values for stearic acid content in the intramuscular lipid of Australian buffaloes have been reported (Sinclair et al. 1982).

The influence of anatomical location on the fatty acid composition, as reported earlier (Sharma et al. 1987; Romita et al. 1976), was also evident in the present study. Significantly higher amount

* Corresponding Author

TABLE 1. MEANS SHOWING THE EFFECT OF COOKING METHOD, MUSCLE AND STORAGE PERIOD ON FATTY ACIDS FROM TOTAL LIPIDS OF BUFFALO MEAT STORED UNDER REFRIGERATION (4±1°C)

Effect		Total lipids mg/g tissue	Fatty acids (% total fatty acids)										
			C_{10}	C_{12}	C_{14}	$C_{14:1}$	C_{16}	$C_{16:1}$	C_{17}	C_{18}	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$
M	TB	30.85^{b}	1.73^{a}	0.40^{a}	3.67^{b}	1.75^{b}	17.04	4.90^{a}	1.99^{a}	19.53^{b}	40.08^{c}	8.39^{b}	1.19
	LD	55.17^{c}	1.53^{b}	0.90^{c}	4.05^{c}	1.47^{a}	16.60	6.24^{b}	2.19^{a}	18.84^{a}	38.83^{b}	7.17^{a}	2.07
	BF	23.35^{a}	1.48^{b}	0.76^{b}	2.97^{a}	1.33^{a}	17.53	5.00^{a}	2.72^{b}	19.83^{c}	37.80^{a}	8.55^{b}	2.16
		(1.15-2.77)	(0.21-0.41)	(0.15-0.39)	(0.57-0.66)	(0.22-0.29)	(2.41-2.64)	(0.62-1.03)	(0.16-0.41)	(1.03-1.92)	(1.22-1.57)	(1.73-2.06)	(0.41-0.59)
SP(d)	0	35.50	1.47^{c}	0.91^{c}	3.05^{a}	1.66^{b}	16.09^{a}	5.60	2.21	18.07^{a}	40.04^{d}	8.91^{d}	2.13
	3	37.20	1.33^{bc}	0.71^{b}	3.60^{b}	1.57^{b}	16.54^{a}	5.45	2.30	18.81^{b}	39.51^{c}	8.26^{c}	2.00
	6	36.15	1.20^{ab}	0.63^{ab}	3.73^{ab}	1.48^{b}	17.29^{ab}	5.24	2.40	19.93^{c}	38.29^{b}	7.81^{b}	2.02
	9	36.97	0.98^{a}	0.49^{a}	3.87	1.24^{a}	18.07^{b}	5.24	2.29	20.78^{b}	37.78^{a}	7.15^{a}	2.02
		(3.12-3.59)	(0.41-0.56)	(0.34-0.49)	(0.42-0.89)	(0.23-0.31)	(2.33-2.67)	(0.77-1.21)	(0.28-0.41)	(0.88-1.10)	(1.25-1.64)	(1.76-2.05)	(0.28-0.61)
CM	R	26.19^{a}	1.04^{a}	0.61	3.03^{a}	1.50^{ab}	20.10^{b}	6.02^{c}	2.27	18.78^{a}	39.80^{c}	5.70^{a}	1.65^{a}
	B	43.69^{c}	1.37^{b}	0.75	3.84^{b}	1.37^{a}	15.08^{a}	4.59^{a}	2.38	19.79^{b}	39.03^{b}	9.34^{b}	2.36^{b}
	PC	39.51^{b}	1.33^{b}	0.69	3.82^{b}	1.60^{b}	15.81^{a}	5.54^{b}	2.26	19.62^{b}	38.17^{a}	9.05^{b}	2.12^{b}
		(2.36-2.95)	(0.41-0.58)	(0.25-0.44)	(0.60-0.72)	(0.26-0.32)	(0.73-1.24)	(0.44-0.95)	(0.22-0.54)	(1.14-1.78)	(1.13-1.60)	(0.77-1.29)	(0.26-0.48)

Means with at least one similar superscript in each column are not significantly different (P≥0.05). Values within the parentheses represent the range of standard deviation. CM = Cooking method, R = Raw, B = Broiled, PC = Pressure cooked, M = Muscle, TB = *Triceps brachii*, LD = *Longissimus dorsi*, BF = *Biceps femoris*, SP(d) = Storage period (days)

TABLE 2. MEANS SHOWING THE EFFECT OF COOKING METHOD, MUSCLE AND STORAGE PERIOD ON FATTY ACIDS FROM TOTAL LIPIDS OF BUFFALO MEAT STORED UNDER FROZEN CONDITIONS (-10°C)

Effect		Total lipids mg/g tissue	Fatty acids (% total fatty acids)										
			C_{10}	C_{12}	C_{14}	$C_{14:1}$	C_{16}	$C_{16:1}$	C_{17}	C_{18}	$C_{18:1}$	$C_{18:2}$	$C_{18:3}$
M	TB	31.35^{b}	0.81^{a}	0.40^{a}	3.72^{b}	1.39	16.96^{a}	4.65^{a}	2.03^{a}	19.93^{b}	39.11^{c}	8.82^{b}	1.88^{a}
	LD	54.73^{c}	1.51^{b}	0.93^{c}	3.72^{b}	1.28	17.63^{b}	5.92^{b}	2.36^{b}	19.06^{a}	38.37^{b}	7.26^{a}	2.12^{a}
	BF	24.06^{a}	1.34^{b}	0.71^{b}	3.09^{a}	1.44	17.62^{b}	4.98^{a}	2.45^{b}	20.25^{b}	37.11^{a}	8.46^{b}	2.56^{b}
		(1.29-2.65)	(0.35-0.46)	(0.19-0.36)	(0.43-0.72)	(0.27-0.40)	(2.25-3.09)	(0.57-0.82)	(0.21-0.41)	(1.54-2.11)	(1.64-1.85)	(1.73-2.23)	(0.55-0.90)
SP(d)	0	35.50	1.47^{c}	0.91^{c}	3.05^{a}	1.66	16.09^{a}	5.60^{b}	2.21	18.07^{a}	40.04^{a}	8.91^{c}	2.13
	30	36.57	1.37^{bc}	0.83^{a}	3.39^{b}	1.42	16.77^{b}	5.29^{b}	2.34	19.88^{b}	38.89^{c}	8.45^{bc}	2.42
	60	36.69	1.20^{b}	0.63^{b}	3.61^{b}	1.14	17.90^{c}	5.14^{ab}	2.45	20.01^{c}	37.74^{b}	7.97^{b}	2.16
	90	37.69	0.83^{a}	0.34^{a}	3.88^{c}	1.28	18.90^{d}	4.71^{a}	2.21	21.94^{d}	36.19^{a}	7.38^{a}	2.04
		(3.21-3.61)	(0.24-0.56)	(0.19-0.42)	(0.42-0.64)	(0.23-0.43)	(2.50-2.55)	(0.71-1.04)	(0.28-0.40)	(0.79-1.29)	(1.09-1.38)	(1.84-2.21)	(0.61-0.83)
CM	R	25.58^{a}	1.04^{a}	0.57	3.15^{a}	1.42	20.47^{a}	5.62^{b}	2.20	19.26^{a}	39.01^{c}	5.78^{a}	1.60
	B	44.28^{b}	1.46^{b}	0.75	3.53^{b}	1.39	15.69^{ab}	4.69^{a}	2.26	19.84^{b}	38.31^{b}	9.43^{b}	2.75
	PC	40.27^{b}	1.16^{a}	0.71	3.84^{c}	1.29	16.09^{a}	5.25^{b}	2.39	20.07^{b}	37.27^{a}	9.33^{b}	2.21
		(2.30-3.14)	(0.40-0.53)	(0.37-0.38)	(0.35-0.66)	(0.23-0.41)	(1.11-1.58)	(0.57-1.00)	(0.29-0.43)	(1.44-2.29)	(1.72-1.80)	(0.93-1.24)	(0.38-0.80)

Means with at least one similar superscript in the same column are not significantly different (P≥0.05). Values within the parentheses represent range of standard error. CM = Cooking method, R = Raw, B = Broiled, PC = Pressure cooked, TB = *Triceps brachii*, LD = *Longissimus dorsi*, BF = *Biceps femoris*, SP(d) = Storage period (days).

of oleic acid ($C_{18:1}$) was observed in TB as compared to LD and BF (Tables 1 and 2). Linoleic acid ($C_{18:2}$) content was significantly lower in LD, compared to TB and BF. As described by Monin (1980), the three muscles used in the present study fall into three different classes, based on the metabolic activity and this explains the changes observed in fatty acid composition of three muscles. PUFA contents were lower (9-11%) in the present study, compared to those reported earlier (16%) and the differences in PUFA content might be attributed to different types of animals used by these workers (Sharma et al. 1986). Sinclair et al. (1982) reported that muscles of wild buffalo are particularly rich in PUFA. Various workers have demonstrated that the lipid and fatty acid composition of animals were altered

by age, live weight, environment, diet etc. (Jeremiah 1982).

Heat processing significantly increased capric (C_{10}), myristic (C_{14}), stearic (C_{18}), linoleic ($C_{18:2}$) and linolenic ($C_{18:3}$) acids and decreased palmitic (C_{16}) acid contents (Tables 1 and 2). The decrease in C_{16} and increase in C_{18}, $C_{18:2}$ and $C_{18:3}$ fatty acid contents on cooking was also reported by Janicki and Appledorf (1974). Contrary to these findings, Siedler et al. (1964) and Campbell and Turkki (1967) concluded that the fatty acid composition remained unchanged due to cooking. A marginal increase in total saturated fatty acids was observed during refrigerated as well as frozen storage (Tables 1 and 2), indicating the buffalo meat lipids to be stable in composition and less susceptible to changes during refrigerated and frozen storage.

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Cooking Quality and Nutritional Characters of *Mungbean* [*Vigna radiata* (L.) Wilczek] Varieties

G. ROSAIAH [1]*, D. SANTHA KUMARI[1], A. SATYANARAYANA[2], V. RAJARAJESWARI[2], N.V. NAIDU[2] AND UMAID SINGH[3]

[1]Department of Botany, Nagarjuna University, Nagarjunanagar- 522510, India.

[2]Regional Agricultural Research Station, Andhra Pradesh Agricultural University, Lam, Guntur-552 034, India.

[3] Crop quality unit, International Crops Research Institute for the Semi-Arid Tropics, Patancheru-502 324, India.

Cooking quality and nutritional characters of nine genotypes of *mungbean* showed wide range of variations in the volume and weight of cooked seed and cooking time. Variations were lower for specific gravity, reducing sugars, initial seed weight and volume of seed. Amino acid analysis indicated considerable differences among the genotypes examined. In general, glutamic and aspartic acids were predominant, whereas cystine and methionine were present in low amounts. Among the genotypes, 'Pusa 105', 'Neelalu' and 'Patchapesalu' were observed to be better with respect to the cooking and nutritional traits as compared to other genotypes.

Keywords : *Mungbean*, Cooking quality, Nutritional traits, Amino acids, Genotypes.

Legumes are good sources of nutritionally important dietary nutrients (proteins), minerals (Fe and Ca) and vitamins (niacin and thiamine). Legumes take considerably longer time for cooking than any other vegetable products. This is especially true with whole pulses. Hence, the cooking time is an important factor influencing the consumer preference for *dhals* (decuticled grains) because of time and fuel. From nutrition point of view, the protein content and its digestibility, the levels of limiting amino acids and the anti-nutritional factors are important. Consumers prefer the greengram varieties which cook early and expand greatly in volume after cooking (Shivashankar et al. 1974; Neelakantan et al. 1977). This calls breeders to consider these characteristics in addition to high yielding abilities in their breeding programmes. In the present study, various physico-chemical characteristics of greengram varieties were studied to assess their cooking quality and nutritional characters.

Fully matured, unbroken seeds, free from disease and insect infestation, were selected in nine genotypes of greengram grown during *rabi* 1989-1990, following recommended package of practices, at the Regional Agricultural Research Station, Lam, Guntur, A.P. Initial weight and volume of 100 seeds were recorded in each genotype. Specific gravity was determined according to the method described by Lalitha Reddy and Gowramma (1987), while cooking time was recorded by performing the cooking test as suggested by Shivashankar et al. (1974). An increase in volume after cooking was recorded as the volume of water displaced by the seeds after cooking and draining the water. Increase in the volume was expressed in terms of percentage. The weight increase after cooking, over the initial weight, was expressed in terms of percentage. Solids leached into the cooking water were determined as per the method of Santha et al. (1978). Nitrogen in the samples was analysed by the micro-Kjeldahl procedure (AOAC 1970) and the crude protein content was calculated by multiplying the nitrogen content with 6.25. Total sugars in seed were estimated by the colorimetric method (Dubois et al. 1956). The reducing sugars were estimated by the method outlined by Nelson (1944). Non-reducing sugar contents were obtained by substracting the reducing sugars from total sugars. For amino acid analysis, defatted samples (50 mg) were refluxed in 50 ml of 6 N HCl for 24 h. After refluxing, the acid was removed in a rotary flash evaporator and residue was taken in a known volume of citrate buffer (pH 2.2). Suitable aliquot of each sample was used for analysis in a Beckman 119-CL amino acid analyser. Analysis of variance was carried out, according to the method suggested by Panse and Sukhatme (1978).

Analysis of variance revealed significant differences among genotypes for all the quality traits studied. The mean and range of variation for different quality traits are presented in Table 1. A large variation was observed among the genotypes for % increase in volume and weight of cooked seeds and for the cooking time. Protein content was

* Corresponding Author

TABLE 1. MEAN VALUES OF DIFFERENT QUALITY CHARACTERS OF MUNGBEAN VARIETIES.

Variety	Seed protein, %	100 seed weight, g	Volume of 100 seeds, ml	Specific gravity	Cooking time, min	Increase in weight, %	Increase in volume, %	Leached out solids, %	Total sugars, %	Reducing sugars, %	Non-reducing sugars, %
'Pusa 105'	25.0	3.31	2.90	1.14	36.7	90.4	154.3	4.54	7.97	0.48	7.49
'ML 267'	23.4	3.24	2.63	1.23	39.7	89.2	149.7	3.93	7.15	0.53	6.62
'CoGG 123'	21.9	2.94	2.33	1.26	45.3	77.3	142.0	4.03	6.84	0.58	6.25
'Lam M2'	21.1	3.10	2.77	1.12	42.0	85.3	141.7	3.15	6.20	0.79	5.41
'MUG 125'	22.4	3.04	2.13	1.43	43.3	84.2	122.0	3.71	7.24	0.44	6.79
'MHGG'	20.5	4.01	3.38	1.19	39.0	83.0	148.0	3.84	6.74	0.48	6.26
'Patchapesalu'	23.5	2.95	2.60	1.13	32.0	90.3	157.7	2.88	7.70	0.40	7.30
'UPM 79-4-12'	24.4	3.14	2.47	1.27	48.0	73.3	124.0	4.52	6.57	0.42	6.16
'Neelalu'	25.9	2.46	2.01	1.22	34.3	97.1	162.3	2.54	9.22	0.80	8.42
Mean	23.12	3.13	2.58	1.22	40.0	85.6	144.6	3.68	7.29	0.55	6.75
Range	20.5-25.9	2.46-4.01	2.01-3.38	1.12-1.43	32-48	73.3-97.1	122.0-162.3	2.54-4.54	6.20-9.22	0.40-0.79	5.41-8.42
CD at 5%	0.13	0.13	0.11	0.004	1.74	1.9	3.7	0.24	0.27	0.03	0.27

highest for 'Neelalu' (25.9%) followed by 'Pusa 105' (25.0%). These cultivars also required shorter cooking time as compared to others. 'Patchapesalu' showed the shortest cooking time (32.0 min) and this cultivar contained 23.5% protein. A small variation was noted for specific gravity, reducing sugars, initial seed weight and initial volume of 100 seeds. Similar results were also reported in greengram for protein content (Neelakantan et al. 1977), seed weight (Choudhary et al. 1982; Ramana and Singh 1987), cooking characters (Shivasankar et al. 1974) and total sugars and non-reducing sugars (Sood et al. 1982).

Two genotypes viz., 'Neelalu' and 'Pusa 105' recorded higher mean values for most of the quality traits viz. seed protein, % increase in weight and volume after cooking, total sugars, non-reducing sugars and took less time for cooking. The variety 'Neelalu' also recorded high percentage of reducing sugars. 'Patchapesalu', another local variety recorded shortest cooking time and considerably higher values for % increase in weight, volume and total sugars as compared to others. The variety 'MHGG' possessed higher initial seed weight and volume. In general, varieties with higher protein content required the shorter time to cook (Table 1). In the present study, the varieties viz., 'CoGG 123', 'Lam

TABLE 2. AMINO ACID COMPOSITION (g/100 g protein) OF VARIETIES OF MUNGBEAN

Amino acid	'Pusa 105'	'ML 267'	'CoGG 123'	'Lam M2'	'MUG 125'	'MHGG'	'Patchapesalu'	'UPM 79-4-12'	'Neelalu'	Mean ± SD
Lysine	6.8	6.8	7.1	7.0	7.1	7.1	6.9	7.1	6.9	6.97±0.13
Histidine	3.1	2.9	3.0	2.8	3.3	3.0	3.1	3.0	3.2	3.05±0.15
Arginine	7.1	6.9	7.2	7.0	7.3	7.2	7.4	7.5	7.2	7.20±0.19
Aspartic acid	11.0	11.2	11.7	10.9	11.4	11.3	11.1	10.9	10.2	11.08±0.42
Threonine	3.4	3.6	3.6	3.3	3.5	3.6	3.4	3.4	3.7	3.50±0.13
Serine	6.2	5.7	5.8	5.8	5.9	5.9	5.7	5.6	5.3	5.76±0.24
Glutamic acid	17.4	17.3	17.9	17.7	17.8	18.2	17.4	17.6	16.1	17.48±0.39
Proline	7.0	6.4	6.4	6.5	6.9	6.4	6.4	6.1	4.1	6.24±0.35
Glycine	3.7	3.7	4.1	3.9	3.9	3.9	3.8	3.9	3.8	3.85±0.12
Alanine	4.8	4.6	4.7	4.4	4.6	4.6	4.4	4.4	4.4	4.54±0.15
Crystine	0.7	0.4	0.4	0.4	0.5	0.6	0.6	0.4	0.7	0.52±0.13
Valine	4.9	4.8	5.0	4.9	4.9	4.9	4.7	4.8	5.3	4.91±0.17
Methionine	1.4	1.4	1.4	1.4	1.6	1.5	1.8	1.4	1.7	1.51±0.15
Isoleucine	4.5	4.4	4.6	4.3	4.5	4.4	4.3	4.4	4.8	4.47±0.16
Leucine	7.8	7.6	7.8	7.6	8.0	7.9	7.7	7.8	7.5	7.74±0.16
Tyrosine	3.5	3.2	3.5	3.4	3.4	3.4	3.4	3.3	3.5	3.40±0.10
Phenylalanine	6.1	6.0	6.1	5.8	5.9	6.0	5.9	5.9	6.0	5.97±0.10

M2' 'MUG 125' and 'UPM 79-4-12' took longer cooking time. This may be due to thicker seed coat and low water absorption in these varieties. Similar results were also reported by Narasimha and Desikachar (1978). In case of *dhals*, it is the water absorbing capacity that makes the difference in cooking time. Grains, which absorb water quickly, will take less time for cooking. The water absorbing capacity depends on cell wall structure, composition of seed and compactness of the cells in the seed (Muller 1967).

Amino acid composition of the varieties is shown in Table 2. Glutamic and aspartic acids were the predominant amino acids in mungbean. Similar observations were also made by Buimindik et al. (1978) in mungbean. Considerable variations existed among the varieties for the individual amino acids. Like other grain legumes, sulphur containing amino acids (methionine and cystine) are the most limiting amino acids in mungbean (Khan et al. 1979). The local varieties 'Neelalu' and 'Patchapesalu' recorded comparatively higher amounts of cystine and methionine over the others. From nutrition point of view, the levels of both methionine and cystine should be considered together, since lysine and sulphur containing amino acids are the protein components which complement each other in cereal-legume-based diets.

Based on the results obtained in the present study, it is concluded that 'Pusa 105', 'Neelalu' and 'Patchapesalu' may be used extensively in the breeding programmes aimed at improving the cooking and nutritional qualities of mungbean.

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Isolation and Identification of Lactose Fermenting Yeasts from Various Dairy Products

SHILPA VIJ AND D.N. GANDHI*
Dairy Microbiology Division,
National Dairy Research Institute, Karnal 132 001, India.

Among the lactose fermenting yeasts, isolated from samples of *dahi* (curd), cream and *paneer* (cottage cheese) whey, 30 and 6% of the isolates were identified as *Kluyveromyces fragilis* and *Kluyveromyces lactis*, respectively. Samples of cream and *dahi* contained both lactose fermenting and lactose non-fermenting yeasts, the latter being predominant in *paneer* whey. About 15 isolates of lactose fermenting yeasts showed a comparable leavening activity with that of conventional Baker's yeast (*Saccharomyces cerevisiae*).

Keywords : Isolation, Lactose fermenting yeast, Dairy products, Whey, Leavening activity.

Lactose fermenting yeasts are known to have wide industrial applications (Willets and Ugalde 1987; Itoh et al. 1982; Duvnjak et al. 1987). The recent application includes the use of *Kluyveromyces fragilis* and *K. lactis* in baking industry (Kusachi 1981). Among the lactose fermenting yeasts in various dairy products, the strains of *K. fragilis*, *K. lactis* and *Candida pseudotropicalis* are reported to be predominant (Subramanian and Shankar 1983; Suriyarachchi and Fleet 1981). With this background, an attempt was made in the present study to isolate and identify lactose fermenting yeasts from selected dairy products and to evaluate their leavening activity in comparison with that of conventional Baker's yeast.

Samples of cream (10), *dahi* (20) and whey (15), collected from local market and the experimental Dairy of this Institute, were plated on yeast lactose agar (YLA). Colonies appearing on the agar plates incubated at 30°C for 48 h were selected, grown in yeast lactose broth and purified by streaking on YLA. The natural isolates were identified upto their generic and species level on the basis of the morphological, cultural and biochemical characteristics (Lodder 1971; Fowell 1967). Standard strains of *K. fragilis* (MTCC 188) and *K. marcianus* var. *lactis* (MTCC 318), obtained from Institute of Microbial Technology, Chandigarh, were used as positive controls. The leavening property of the natural isolates and standard cultures of lactose fermenting yeasts was assessed according to the method of Champagne et al. (1989).

Dahi, cream and whey samples from different sources yielded 106, 38 and 52 yeast isolates, respectively. Out of these, 28, 14 and 17 were lactose fermenters, respectively. These were identified as strains of *K. fragilis* and *K. lactis*. In the present study, lactose fermenting yeasts were obtained from *dahi*, cream and *paneer* whey as against the earlier findings (Subramanian and Shankar 1983) of its occurrence in cream and butter, but not in *dahi* and cheese whey. Among the lactose fermenting yeasts, 30 and 6% of these were identified as *K. fragilis* and *K. lactis*, respectively, which were of common occurrence in *dahi*. However, yeast isolates obtained from whey did not exhibit the characteristics of *K. fragilis* and *K. lactis*.

Among the 22 lactose fermenting yeast cultures, 15 of them showed satisfactory leavening activity as compared to the conventional Baker's yeast, *Saccharomyces cerevisiae* (Table 1). The present study reveals the occurrence of lactose fermenting yeasts, especially *Kluyveromyces* spp. in dairy products and their leavening activity which is comparable with that of conventional Baker's yeast.

TABLE 1. LEAVENING ACTIVITY OF SELECTED LACTOSE FERMENTING YEASTS ISOLATED FROM DAIRY PRODUCTS

Lactose fermenting yeasts	Leavening activity, % increase in volume of dough/h
Natural isolates	
7	60-100
8	100
7	More than 100 (upto 130)
Standard cultures	
K. fragilis (MTCC 188)	100
K. marcianus var. *lactis* (MTCC 318)	100
Baker's yeast (*Saccharomyces cerevisiae*)	130

* Corresponding Author

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Utilization of Turkey Fat and Skin for Production of Sausages

J. SAHOO AND J.S. BERWAL*
Department of Animal Products Technology,
C.C.S. Haryana Agricultural University, Hisar-125004, India.

The effect of incorporation of 15, 20 and 25% turkey fat and skin (TFS) on physico-chemical properties, proximate composition and organoleptic quality of cooked turkey sausages was evaluated. TFS levels had no effect on pH, though emulsifying capacity (EC), emulsion stability (ES) and cooking loss decreased and extract release volume (ERV) increased with increasing level of incorporation. Organoleptic scores were marginally ($p \leq 0.05$) affected by TFS levels. However, inclusion of 25% TFS scored lowest in general.

Keywords : Emulsifying capacity, Emulsion stability, Extract release volume, Cooking loss, Turkey fat and skin, Sausages.

Though turkey skin and fat are edible, these do not have much consumer appeal in India. Consequently, about 10.2 to 13% of the live weight is wasted in case of adult turkeys (Sahoo 1987). It is, therefore, vitally important to evolve production processes for gainful utilization of these parts. As negligible information is available on the use of turkey skin and fat for the production of turkey sausages, the present study was undertaken.

Adult turkey hens were slaughtered and the eviscerated carcasses were hot-boned. Deboned turkey meat (DTM) of whole carcasses and turkey fat and skin (TFS) were packed separately, chilled at 4±1°C for 24 h, comminuted separately using hand mincer, mixed thoroughly in trays manually and incorporated in 3 sausage formulations viz., 85% DTM + 15 % TFS (T_1), 80 % DTM + 20 % TFS (T_2) and 75 % DTM + 25 % TFS (T_3). Sodium caseinate (2 %), sodium chloride (2 %), tetrasodium pyrophosphate (0.3%), sodium nitrate (0.012 %), cane sugar (0.4 %), L-ascorbic acid (0.08 %), raw garlic (0.1 %) and ice (20 %) were added to the meat mix and manually mixed for a few minutes. Then, dry spice mix containing red chilli (0.05 %), black pepper (0.5 %) and cardamom (0.1 %) were added and again mixed manually. The sausage batter thus formed was stuffed into natural (sheep) casings of about 20 mm dia by manually-operated sausage stuffer and cooked in boiling water for 20 min after attaining the internal temperature of 70°C. About 10 g each of minced meat, batter, and cooked sausage samples in duplicate were homogenised with 50 ml distilled water for 10-15 sec in a Waring blender and the pH was measured. The emulsifying capacity (EC), extract release volume (ERV) (Jay 1964) of raw minced meat and emulsion stability (ES) (Krishnan et al. 1989; Selvarajah et al. 1974) were determined. The cooking loss was estimated by recording the difference between the weight, before and after cooking. The proximate composition of both raw minced meat and cooked sausages was determined (AOAC 1984). The sensory qualities viz., colour, appearance, flavour, tenderness, juiciness and acceptability of turkey sausages were evaluated following a 9 point Hedonic scale (9=most desirable and 1 = least desirable) by a semi-trained taste panel of six judges. Data were analysed statistically (Steel and Torrie 1960).

Significant difference was observed in pH values ($p < 0.05$) of minced meat, sausage emulsion and cooked sausages T_1, T_2 and T_3 treatments (Table 1). Slightly higher pH of sausage emulsion, than that of minced meat, was due to the presence of tetrasodium pyrophosphate in the former (Trout

TABLE 1. PHYSICO-CHEMICAL QUALITY OF TURKEY SAUSAGE

n=6, $\bar{x}$

Quality parameters	Group of sausages T_1	T_2	T_3	LSD (0.05)
pH				
Raw minced meat	6.1	6.0	6.0	0.467
Sausage emulsion	6.3	6.3	6.4	0.538
Cooked sausage	6.4	6.4	6.4	0.438
Emulsifying capacity, ml oil emulsified/0.75 g meat	70.0^a	63.5^b	52.8^c	1.967
Extract release volume of minced meat, ml	26.7^a	29.7^b	32.5^c	2.545
Emulsion stability, ml fat released/100 g	1.1^a	3.3^b	4.1^c	0.389
Cooking loss, %				
Minced meat	22.6^a	24.8^b	28.3^c	0.578
Sausage emulsion	17.8^a	20.9^b	25.6^c	0.667
Sausage	11.8^a	19.0^b	26.2^c	0.637

Means with different superscript differ significantly ($p < 0.05$).

* Corresponding Author

and Schmidt 1984; Stiebing 1984; Krishnan et al. 1989). The pH of cooked sausages was higher than that of raw emulsion. Previous workers (Stiebing 1985; Krishnan et al. 1989) also observed rise in pH of frankfurters, depending on the intensity of heat treatment. With the increase in TFS levels, the decreases in EC, ES and cooking loss and increase in ERV were observed. Greater collagen content in TFS may have caused decrease in EC and ES. Kondaiah et al. (1987) reported higher EC of meat when it contained lower collagen. Price et al. (1963) and Jay (1964) noticed increases in ERV with fat levels.

The data on the proximate composition (Table 2) revealed that % moisture, total fat of minced meat and cooked sausages were significantly ($p<0.05$) different among T_1, T_2 and T_3 treatments. The fat % decreased as the moisture % increased. Protein contents of raw minced meat and cooked sausages were almost equal in different samples. Ash % remained almost constant in raw meat, but differed significantly ($P\leq0.05$) in cooked sausages among T_1, T_2 and T_3 treatments. The possible reason might be the variation in % cooking losses of sausages subjected to different treatments. Moisture : protein ratio decreased significantly ($p\leq0.05$) as the level of TFS increased both in case of raw meat as well as cooked sausages. Turgut (1984) reported similar results. It has been observed that, the sausages had same moisture, whereas protein as well as fat were higher and ash was lower in the present study, as compared to the values reported by Kondaiah et al. (1988). The reasons might be the inherent species differences and variations in the sausage recipes.

TABLE 2. PROXIMATE COMPOSITION OF TURKEY SAUSAGES

Parameters	n = 6, $\bar{X}$			LSD
	T_1	T_2	T_3	(0.05)
Minced meat				
Moisture, %	64.9[a]	63.1[a]	60.9[c]	0.439
Total fat, %	13.8[a]	15.2[b]	17.9[c]	0.433
Protein, %	19.3[a]	20.2[b]	20.1[b]	0.271
Ash, %	1.1	1.2	1.2	0.086
Moisture : protein ratio	3.4[a]	3.1[b]	3.0[c]	0.069
Cooked sausages				
Moisture, %	64.0[a]	58.2[b]	53.8[c]	0.814
Total fat, %	15.3[a]	20.4[b]	26.0[c]	0.702
Protein, %	19.8	20.0	19.3	0.942
Ash, %	1.2[a]	1.3[b]	1.4[c]	0.61
Moisture : protein ratio	3.2[a]	2.9[b]	2.8[b]	0.163

Means with different superscript differ significantly ($p<0.05$).

The sensory studies of turkey sausages revealed that the mean taste panel scores were, in general, in the range of 7.1-7.6 for all the quality attributes, thereby indicating that the products were quite acceptable and the difference between the treatments being marginal ($p\geq0.05$). However, sausages containing 25% TFS were rated inferior, as compared to other two treatments.

The present study revealed that TFS, which are generally not liked by the consumers, can be utilised upto 20% level in preparation of turkey sausages, without any deleterious effect on sensory qualities and protein value of the product. However, further research is required to minimise the cooking loss by improving the functional properties of meat to make the product more economically viable.

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Fumigation of *Jamun* Ready-Mix

S. RAJENDRAN*, S. GODAVARI BAI AND K.S. NARASIMHAN
Infestation Control and Protectants Department,
Central Food Technological Research Institute, Mysore-570 013, India.

The sensory quality of *gulabjamuns* (an Indian milk-sweet preparation), prepared from *jamun* ready-mix samples fumigated with phosphine at the effective dosage of 2 g/m^3 with 5 days exposure period at 29±2°C, was satisfactory. The levels of phosphine residues in the ready-mix samples were 0.16, 0.02 and 0.01 ppm, respectively after 2, 7 and 12 days aeration, following fumigation. No residues were detected in ready-to-eat product.

Keywords : *Jamun* ready-mix, Insect control, Phosphine residues, Fumigation, Sensory quality.

Jamun or *gulabjamun*, a milk-sweet preparation, is a popular dish in India. Ready-mix for *jamuns* comprising approximately 50% refined wheat flour (*maida*), 35% milk powder, 15% hydrogenated fat (*vanaspati*) and preservatives is manufactured at cottage and small scale industry levels both for domestic consumption and export. Among instant mixes produced in India, *jamun* ready-mix has a major share (CFTRI 1987) and the composition of the mix has been reported (Rangi et al. 1985; Minhas et al. 1985). Being a composite mix containing a cereal product (*maida*), milk protein and fat, the instant mix is prone to be infested by stored-product insects including the rust-red flour beetle (*Tribolium castaneum*), the spice beetle (*Stegobium paniceum*), the cigarette beetle (*Lasioderma serricorne*) and tropical warehouse moth (*Ephestia cautella*) (Rajendran, unpublished). Infestation is, generally, carried over to the ready-mix from the raw materials like *maida* and milk powder. In addition, cross-infestation of the *jamun* flour occurs when infested food commodities are stored nearby. Problems of insect infestation in the ready-mix have been experienced by the manufacturers. Experiments were, therefore, conducted to select a suitable fumigant for disinfesting the ready-mix and to examine the extent of residues of the selected fumigant in both ready-mix and ready-to-eat product.

The *jamun* ready-mix, (initial moisture content 9.5%-oven method), obtained from the local market, was used for all experiments. In the first experiment, fumigation of ready-mix samples (1 kg each) in 2.5 l desiccators was done in duplicate, for each fumigant along with an untreated control, at 29±2°C. *Tribolium castaneum* (Herbst) at representative life stages as the test insects were placed in the ready-mix. Appropriate dosages of fumigants including phosphine at 2 g/m^3, 5 days exposure; methyl bromide 48 g/m^3, one-day exposure; ethyl formate 400 g/m^3, 3 days exposure; and 95% CO_2, 7 days exposure; were used. After the exposure period, the test insects were observed for mortality of adults. The test insects were transferred to 2.5 x 15 cm test tubes containing 15 g whole wheat flour and final mortality assessment carried out at 20 days post-treatment. The fumigated ready-mix samples were spread on separate plastic trays for aeration for 7 days. *Gulabjamuns* from each sample of fumigated and unfumigated control ready-mix were prepared. For every 100 g ready-mix, about 45 ml water was added and the dough was made into small balls of uniform size. They were deep-fried in fat under moderate heat, after which they were transferred to sugar syrup of 30° Brix. The sensory quality of prepared *jamuns* was assessed by a panel of fourteen judges. Kramer's method (Kramer 1960) was used for determining the significance of differences from rank sums.

Based on its efficacy and the sensory quality of *jamuns* prepared from fumigated ready-mix, phosphine was found to be the satisfactory fumigant for the ready-mix. Therefore, further experiments to determine the residue levels of the selected fumigant, i.e. phosphine, in the fumigated ready-mix were carried out. Ready-mix samples (1 kg each) were fumigated for 5 days at 0.6, 2.0 and 6.0 g/m^3, respectively; an underdosage, an insecticidal dose and a higher (x3) dosage. Phosphine concentrations were monitored at regular intervals using chromogenic column method (Muthu and Majumder 1973) and the concentration-time products (*cts*) achieved were estimated. The treated samples were aerated by spreading in plastic trays at 29±2°C. Residues of phosphine in the ready-mix after 2, 7 and 12 days aeration were determined according to Bruce et al. (1962), using 500 g samples. Residue determination was also carried

* Corresponding Author

out in the finished product prepared from the ready-mix fumigated with phosphine at 2 g/m³ and aerated for 7 days. The recovery of phosphine was tested by incorporating known amounts of aluminium phosphide in unfumigated ready-mix. The recovery was in the range of 85-90%.

Fumigation of the ready-mix with phosphine at 2 g/m³, 5 days exposure, resulted in 100% kill of test insects and the sensory quality of *jamuns* prepared from phosphine fumigated samples were found acceptable and satisfactory (Table 1). Luck et al. (1984) fumigated dairy products including milk powder with phosphine with an average concentration exceeding 1g/m³ for 5 days. They observed that the flavour, odour and appearance of the fumigated milk powder were normal.

TABLE 1. SENSORY QUALITY OF *JAMUNS* PREPARED FROM THE READY-MIX SUBJECTED TO FUMIGATIONS AT 29±2°C

Treatment*			Sensory quality (rank sums)**		
Fumigant	Dosage	Exposure period (days)	Flavour	Texture	Overall quality
Untreated	-	-	49.0	45.5	39.5
Phosphine	2g/m³	5	40.5	48.0	36.5
CO_2	95%	7	40.5	39.5	38.0
Ethyl formate	400 g/m³	3	49.5	48.5	56.5
Methyl bromide	48 g/m³	1	71.5	63.5	73.0

* All treated samples were aerated for 7 days before preparation of *jamuns*

** Sample fumigated with methyl bromide was inferior in terms of flavour and overall quality at 1% level of significance.

CO_2 at 95% level produced 100% insect mortality. However, the *jamun* balls showed cracking as the absorbed CO_2 was released while frying and the size of syrup-soaked *jamun* was slightly smaller. The sensory quality was, nevertheless, not affected by CO_2 treatment. Unacceptable off-flavour and texture-quality were observed in *jamuns* prepared from ready-mix fumigated with the effective dosage of methyl bromide. It is known that methyl bromide reacts with wheat protein, sulphur containing amino acids, methionine in particular, giving rise to dimethyl sulphonium derivatives which, further, decompose under humid conditions accounting for an 'organic sulphide' taint for long periods (Winteringham et al. 1955). Recently, it has been recommended not to use methyl bromide for fumigating flour and food commodities rich in fat and protein (like nuts, oilseeds, oilcakes and meals), unless required by contractual obligations or for quarantine reasons (AFHB/ACIAR 1989). Heavy sorption and resultant problems of taint and high residues are the obvious reasons for discouraging methyl bromide treatments on such commodities. The qualities of *jamuns* prepared from ethyl formate-fumigated ready-mix were better than that of the methyl bromide-treated ones. However, ethyl formate, even at 400 g/m³, 3 days exposure, produced only 50% mortality of the test insects. In view of these drawbacks with methyl bromide and ethyl formate, further studies involving their residues were not carried out.

Phosphine residue levels in the ready-mix decreased as the aeration period increased (Table 2).

TABLE 2. LEVELS OF PHOSPHINE RESIDUES IN FUMIGATED *JAMUN* READY-MIX

Phosphine dosage* g/m³	*cts* achieved (g/h/m³)	Aeration (days)	Phosphine residue** (ppm)
0.6	90	2	0.05
		12	0.01
2.0	216	2	0.16
		7	0.02
		12	0.01
6.0	983	2	0.27
		12	0.05

* Exposure period 5 days in all cases.
Temperature during fumigation and aeration was 29±2°C

** Average of 2 determinations using 500 g samples in each.

cts- concentration-time products

Thus, at the effective dosage of 2 g phosphine/m³ 5 days exposure, the residue at 2 days aeration was 0.16 ppm which decreased to 0.02 and 0.01 ppm, respectively, after 7 and 12 days of aeration. A similar trend was noted with other dosages also. Muthu et al. (1978) claimed that processed foods including *jamun* ready-mix sorb comparatively less of phosphine during fumigation at 6 g phosphine/ tonne for 5 days. They estimated phosphine residues by an indirect method of headspace gas analysis of 0.25 ppm in *jamun* flour which was aerated for 24 h following fumigation. In the present study, the ready-to-eat product, i.e. the fried *jamuns* prepared from the flour, which was fumigated at 2 g/m³, 5 days exposure and aerated for 7 days, did not show any phosphine residues.

The results indicate that at 29±2°C fumigation with phosphine at 2 g/m³, 5 days exposure is the satisfactory method for controlling insect infestation in *jamun* ready-mix. An aeration period of more than 12 days is essential to bring down the phosphine residue level in the ready-mix to less

than the permissible level of 0.01 ppm. At lower temperature, i.e. 15 to 25°C, it is necessary to extend the fumigation period upto 10 days. Then, the aeration period also has to be prolonged.

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Unsaturated Fatty Acids Nutritional and Physiological Significance : The Report of the British Nutrition Foundation's Task Force. Chapman and Hall, 2-6, Boundary Row, London SE1 8HN, 1992, pp:211, price : £ 60.

Polyunsaturated fatty acids (PUFA) have been recognised as essential for normal development and health. The question of quantities of these fatty acids that should be present in the human diet has been a subject of debate. The apparent virtues of supplementing one's diet with fish oil and/or vegetable oils with high PUFA have been widely advertised, accompanied by somewhat extravagant claims for their potential to cure or prevent a number of diseases.

The British Nutrition Foundation commissioned a Task Force, under the Chairmanship of Dr. A. Garton and with eleven eminent personalities in the field, to review the present state of knowledge of unsaturated fatty acids. The report prepared by the Task Force is very informative. It consists of twenty four chapters. The first chapter starts with chemistry and structure of the different unsaturated fatty acids. Foods in which these fatty acids are found (Ch.2) and how much of them are consumed (Ch.3), digestion, absorption and transportation of unsaturated fatty acids in the body and their functions are discussed in chapters 4 to 9. Role of PUFA in a variety of different diseases is discussed in chapters 10 to 20 and considers the implications for nutrition labelling in chapter 21. On the basis of these considerations, the Task Force has put forward its recommendations for intakes of PUFA in the diet (chapter 22). Conclusions and suggestions for future progress are given in chapters 23 and 24. The Report contains a glossary of important terms used in the text and has a big list of references.

This Task Force Report is very useful and certainly fulfils the purpose for which it was prepared. It is an invaluable reference book for nutritionists, biochemists, food scientists and medical professionals.

M.N. KRISHNAMURTHY
C.F.T.R.I., MYSORE-570 013

Alpha-and beta-hexachlorocyclohexanes - Environmental Health Criteria 123, WHO, Geneva, 1992, pp:170; Price : Sw. Fr. 20.

The book 'alpha-and beta-hexachlorocyclohexanes' is published under the joint sponsorship of the United Nations Environment Program, the ILO, and the WHO. The two isomer compounds are separately dealt with in two parts. The review discusses the available information under the following headings -Identity, Properties and Analytical methods; Sources of Human and Environmental Exposure; Environmental Transport, Distribution, and Translocation; Environmental levels and Human Exposure, Kinetics and Metabolism; Effects on Laboratory Mammals and *In Vitro* Test System; Effects on Humans, and Effects on other organisms.

Alpha-hexachlorocyclohexane (α-HCH) and beta-hexachlorocyclohexane (β-HCH) are by-products in the manufacture of lindane (<99% γ-HCH). These two HCH isomers are environmental pollutants, being sparingly soluble in water. Their biodegradation and abiotic degradation (Dechlorination) by U.V. irradiation occur in the environment at a very slower rate than that of lindane.

The chapter on environmental levels and human exposure reviews the residue levels in air over oceans, rain water, river water, plants, fishes and other aquatic species. Food is the major source of general population exposure to α-HCH and β-HCH. The levels, mainly in fat containing food items could be upto 30-50 μg/kg product, in fish products upto 500 μg α-HCH/kg, and in milk products upto 4 μg β-HCH/kg. It is noted that the human daily intake level of these HCH residues via food is gradually decreasing over the years. The plasma concentration of β-HCH ranges upto 25 μg/L, whereas it is <0.1 μg/L for α-HCH. The concentration in human adipose tissue and breast milk are reported to be low.

The chapter on Kinetics and Metabolism describes absorption, distribution, elimination and metabolic transformation of these HCH isomers in experimental animals and in humans. Absorption of 95-100% HCH residues from the GI tract has been reported. Maximum accumulation occurs in fatty tissue. β-HCH passes the blood-brain barrier much less readily than the other HCH isomers. Transplacental and translactational transfer of β-HCH has been documented. Bio-transformation involves dehydrochlorination and then, hydroxylation to tetra- and tri-chlorophenols. Half-life for clearance from fat depot is reported to be more in female animals than in males. Pretreatment of β-HCH alters the metabolism of lindane in rats. β-HCH is

metabolised more slowly than lindane.

The next chapter discusses, in detail, the effects on laboratory mammals and *In vitro* systems. The acute oral LD_{50} value for α-HCH is in the range 500-5000 mg/kg b.w. and this is still higher for β-HCH. Poisoning signs are those of CNS stimulation/depression. Long term intakes of subacute doses produce growth depression, histological and enzyme level changes in liver and immuno-suppression. No effect dose for either of the HCH isomers is reported to be 0.1 mg/kg b.w./ day. No adequate long term toxicity studies or reproduction and teratogenicity studies have been reported for α-HCH. Increased infertility and absence of teratogenic effects are reported in the case of β-HCH. There is no evidence for mutagenicity of these HCH isomers. Tumorogenicity of these compounds has been observed in mice.

Effect on humans by occupational exposure is adequately reviewed in the next chapter. Effects on organisms in environment is discussed in the subsequent chapter. These HCH isomers have low toxicity for algae and are moderately toxic for invertebrates and fish. No data are available on effects on populations and eco-systems. The monograph ends with a brief chapter on conclusions and recommendations for protection of human health and environment.

The monograph has a vast bibliography of 227 references. This extensive review is a valuable document for those engaged in studies on environmental safety of hexachlorocyclohexane.

K. SRINIVASAN
C.F.T.R.I., MYSORE-570 013

ACROLEIN : Environmental Health Criteria - 127, published under the joint sponsorship of UNEP, ILO and WHO. WHO, Geneva, 1992, pp:116, price : Sw. Fr. 15.

This document is an outcome of the meeting of WHO Task Group on Environmental Health Criteria for Acrolein, held in Geneva during 7-11th May 1990. This document contains 12 sections. Section 1 deals with the abstract information on the chemistry, analysis, toxicity and the risk potential of acrolein to human health. Section 2 contains the detailed physico-chemical properties of acrolein and the validity of different analytical methods (HPLC, GC, Fluorimetry, Spectrometry) used in the detection of very low concentrations (0.003 m^3) of acrolein. Section 3 comprises the natural and anthropogenic sources of acrolein. In this section, a Table containing the emission rates of acrolein from different sources is well represented. Section 4 deals with environmental transport, abiotic degradation and biotransformation of acrolein. An in-depth analysis of environmental levels of acrolein and human exposure is presented in Section 5. Section 6 deals with the details of absorption and metabolism of acrolein in biological systems. In Section 7, a very detailed information on the effects of acrolein on respiratory system, skin and eyes is provided. The biochemical effects of acrolein such as its interactions with proteins and nucleic acids are well discussed. An in-depth information regarding the reproductive, embryo and teratogenic toxicity of acrolein is documented. However, in the same section, there is no definite conclusion on the carcinogenic and mutagenic properties of acrolein. Section 8 deals with acrolein poisoning in humans and its impact on clinical parameters such as blood picture, etc. In the same chapter, a Table containing the thresholds for acute effects of acrolein on humans is well documented. In Section 9, the effects of acrolein on aquatic animals, birds and plants are elucidated. Section 10 comprises the detailed evaluation regarding human health risks of acrolein. In Section 11, a definite future research programme on acrolein with reference to (a) intake of acrolein from food and beverages, (b) epidemiological studies on acrolein-respiratory diseases, (c) metabolism and excretion of acrolein and (d) the efficacy of sulfhydryl compounds as antidotes is projected. In Section 12, a brief note on the evaluation reports of international bodies like IARC and EEC on acrolein are included.

WHO Task Group has done a commendable job in documenting a detailed analysis of the published literature on acrolein and also in suggesting further research programmes. This document will be very much useful to researchers, industrialists and policy makers.

K.S. JAGANNATHA RAO
C.F.T.R.I., MYSORE-570 013

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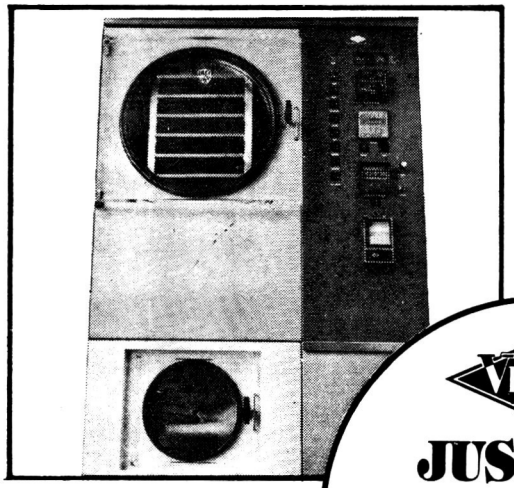

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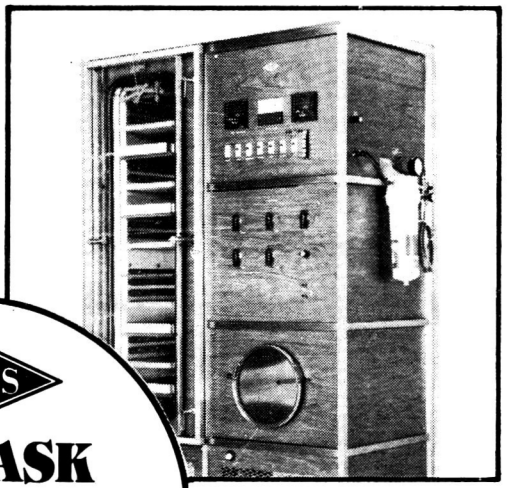

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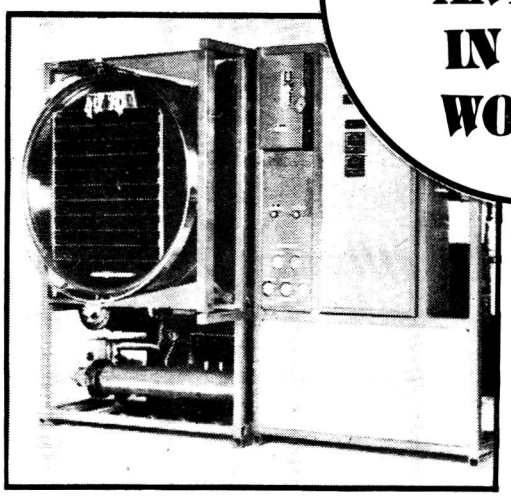

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