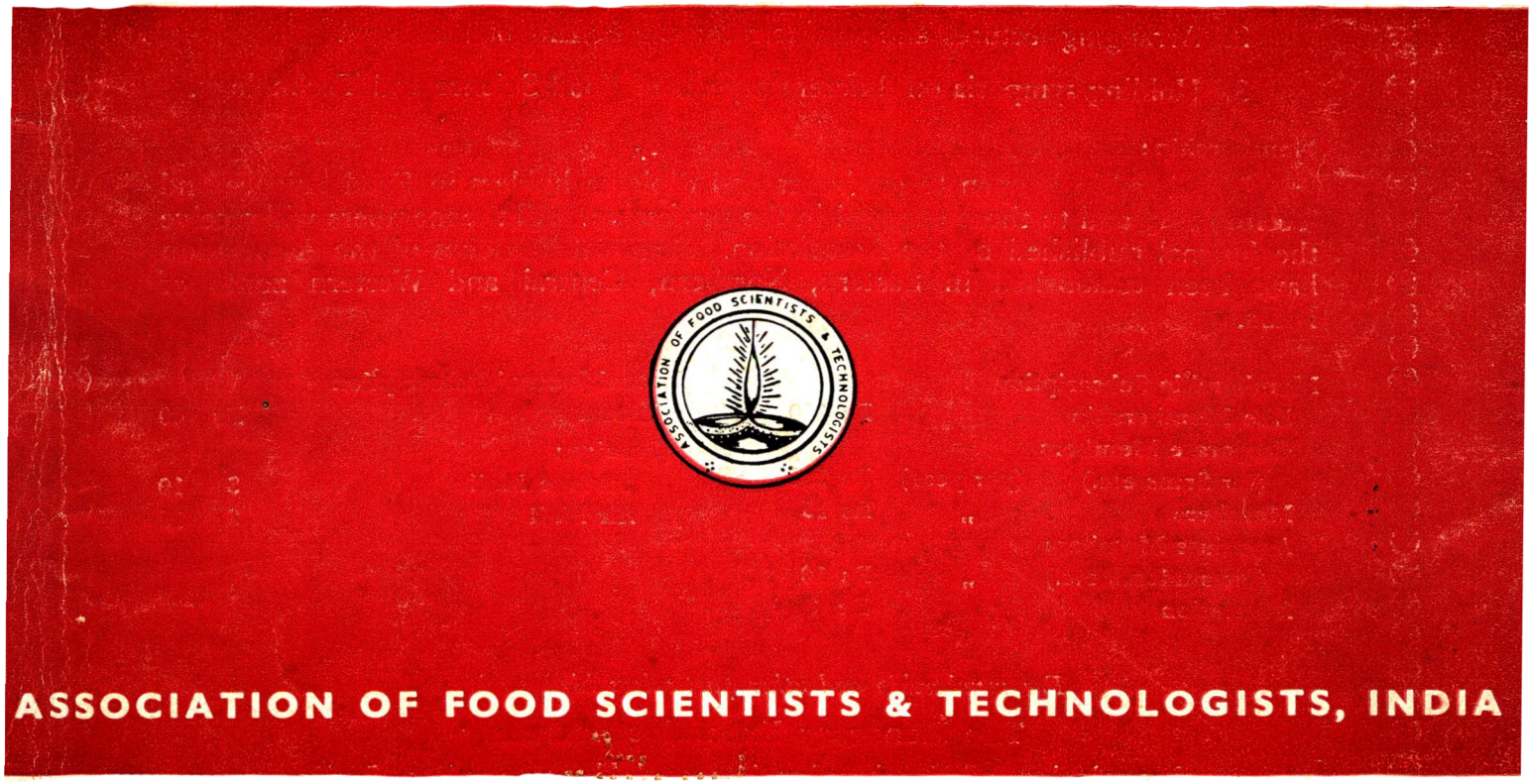
JOURNAL OF

FOOD SCIENCE

AND

TECHNOLOGY



VOL. 10 NO. 3

JULY-SEPTEMBER 1973

ASSOCIATION OF FOOD SCIENTISTS AND TECHNOLOGISTS

(INDIA)

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

AFFILIATED TO THE INSTITUTE OF FOOD TECHNOLOGISTS, USA

Objects:

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

The ultimate object is to serve humanity through better food.

Major Activities:

1. Publication of a quarterly—Journal of Food Science and Technology.
2. Arranging lectures and seminars for the benefit of members.
3. Holding symposia on different aspects of Food Science and Technology.

Membership:

Membership is open to graduates and diploma holders in Food Science and Technology, and to those engaged in the profession. All the members will receive the Journal published by the Association. Regional branches of the Association have been established in Eastern, Northern, Central and Western zones of India.

Membership Subscription		
Life Membership		**Rs 250**
Corporate Members (for firms etc.)	**(per year)**	**Rs 250**
Members	**„**	**Rs 15**
Associate Members (for students etc.)	**„**	**Rs 10**
Admission		**Re 1**

Annual Journal Subscription	
Inland	**Rs 40**
Foreign:	
Surface Mail	**$ 10**
Air Mail	**$ 15**

For membership and other particulars kindly address

The Honorary Executive Secretary
Association of Food Scientists and Technologists, India
Central Food Technological Research Institute, Mysore-13, India

The Journal of Food Science and Technology is a quarterly publication of the Association of Food Scientists and Technologists, India, (AFST).

Manuscripts for publication and books for reviewing in the Journal should be addressed to the Editor, Journal of Food Science and Technology, AFST, Central Food Technological Research Institute, Mysore-570013. The Editor reserves the privilege of editing the manuscript to make it suitable for publication in the Journal.

Correspondence regarding subscriptions and advertisements should be addressed to the Executive Secretary, AFST, Central Food Technological Research Institute, Mysore-570013, India. Payment may be sent by cheque (include additional 1 Re bank commission), draft, postal or money order in favour of Exe. Secretary, AFST.

JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

Volume 10 Number 3 July-September 1973

CONTENTS

Research Papers

Continued

Research Notes

Chemical Score of the Proteins of Rations Developed for Defence Forces

M. V. Rama Rao, M. R. Tara and T. S. Satyanarayana Rao
Defence Food Research Laboratory, Mysore

Manuscript Received: 28 November 1972

A few Service rations were analysed for their amino acid composition by ion exchange chromatography. There was a close agreement in the values of total nitrogen and total essential amino acids as calculated from tables as well as determined experimentally. The determined value for lysine in the case of Ration I was found to be low compared to the calculated value; the reverse seems to be the case with methionine and tryptophan. However, the protein scores calculated by the FAO/WHO method did not show much variation excepting in the case of Ration I where lysine content was found to be much lower than the calculated values.

A great deal of information exists on the amino acid composition of foods and rations, and calculation made therefrom of the chemical score or the protein score[1,2]. The compilation of Orr and Watt[3] and that issued by FAO[4] bring together the data available on the amino acid composition of the various foods but they indicate a wide range of values reported by various workers from which the average value has to be computed. Using the average values recommended, the protein score of the diets computed may not reflect their true protein quality since no consideration is given to the losses of amino acids during cooking of foods. Accurate and quick analysis for all the amino acids is now possible with automated amino acid analyser and in this paper data have been presented on chemical scores of three rations developed for use by the Armed Forces of India, calculated on the basis of the amino acid contents determined by ion-exchange chromatography and compared with the scores calculated from the food composition tables.

Materials and Methods

Three rations described in Table 1, developed at this laboratory for meeting specific Service requirements and consisting of packed/preserved foodstuffs with adequate storage life have been utilized in the study. Table 2 gives the list of various food ingredients used in the formulation of those food items together with the total protein of the rations as calculated from standard tables. Each ration forms a complete diet for a man per day and comprises of all the usual meals in a day including tea.

Preparation of sample for analysis: The entire one day's ration is mixed and homogenised in a blender and analysed for moisture and nitrogen by standard methods.

Amino acid analysis: Well mixed ration (78-80 mg) was treated with concentrated HCl (1 ml) and water added to make the sample 6N in acid. The sample was hydrolysed by the sealed tube method and the hydrolysate prepared further according to the method described in an earlier paper[5].

Calculation of the amino acid values from standard tables: The amounts of the various amino acids from each of the protein sources of the ration was calculated from Orr and Watt[3].

Protein score: The chemical scores of essential amino acids and protein scores of the rations were calculated based on egg protein as reference standard[4].

Results and Discussion

From the data given in Table 1, it will be seen that the nitrogen content (calculated value) amounts to 1.23 per cent of Ration I which is vegetarian and 1.96 per cent for Ration II which is non-vegetarian. This increase is due to the inclusion of 250 g of mutton in non-vegetarian diet with only a slight reduction in the amounts of potato and peas. The data also illustrate how a strict equality in protein content of rations between vegetarian and non-vegetarian type is not usually possible without ignoring the taste,

TABLE 1. QUANTITY OF INGREDIENTS IN THE RATION AND THEIR PROTEIN CONTENT

Ingredient	Protein %	Ration I g	Ration II g	Ration III g
Atta	13.3	573	573	300
Potato	2.0	360	240	400
Peas	6.7	45	22	—
Milk powder (whole)	25.8	20	20	20
Mutton	18.5	—	250	—
Groundnut	26.9	—	—	50
Bengal gram	20.3	—	—	30
Sesame	19.3	—	—	16.6
Total protein*	—	91.6	133.3	76.6
Nitrogen%*	—	1.23	1.96	1.61

*by calculation

TABLE 2. COMPOSITION OF THE RATIONS AS SERVED AND THEIR MOISTURE AND NITROGEN CONTENTS

Items	Ration I g	Ration II g	Ration III g
Parotta, stuffed	300	300	1,000
Chapati, preserved	350	350	—
Vegetable *curry*, canned	700	350	—
Mutton *curry*, canned	—	350	—
Parotta, preserved	360	360	—
Fruits, canned	320	320	—
Cane sugar	80	80	—
Milk powder, whole	20	20	—
Pickles	50	50	—
Chikki bar	—	—	200
Instant tea	—	—	32
Net weight	2180	2180	1232
Moisture%	42.0	47.4	34.3
Nitrogen% (moisture free basis)	1.24	2.13	1.54

satiety and culinary practices as well as total calories. The nitrogen content determined in the actual compounded ration by the Kjeldahl method (Table 2) was found to be 1.24 per cent for the vegetarian ration which is in very close agreement with the calculated value. Similarly the value of 2.13 per cent for the nitrogen content of Ration II (non-vegetarian) is in fair agreement with the value of 1.96 per cent obtained by calculation. The discrepancy in these values may be attributed to the difference in the nitrogen content of mutton actually used and that reported in tables. Mutton and lamb have been used interchangeably in standard tables and it would appear that there is need to establish the relevance of published values for the nitrogen content of various meats and cuts as available from the markets to actual users. This is again borne out by the fact that value of 1.54 per cent for nitrogen content of Ration III determined by Kjeldahl method is in close agreement with that obtained by calculation (1.61 per cent) and in this case the ration is completely vegetarian although the sources are more varied than those in Ration I.

From the data, it is evident that the total protein content of 91.6, 133.3 and 76.6 g in Ration I, II and III respectively, are well above the recommended allowance for a 60 kg adult man. It is however, necessary to confirm that the total protein in the ration is actually consumed and that it is of the required nutritional quality. A ready way of reckoning this would be by determining the protein score of the ration from the known amino acid values. Accordingly, in Table 3 data are presented on the essential amino acid composition of the three rations calculated from the standard tables as well as determined. After the separation and estimation of the individual amino acids, their total nitrogen has been computed as recommended by Jacobs[6]. The values of 1.20, 2.10 and 1.61 per cent for the three rations are in fair agreement with the values determined by the Kjeldahl method (1.23, 2.13 and 1.54 per cent respectively).

On the average, the experimentally determined value for individual amino acids in most cases was found to be different from the one calculated from the tables by about 25 per cent. In the case of methionine in Ration III the observed value of 2.3 g is higher by 100 per cent over the calculated value of 1.16. In the case of the other two rations, the agreement between the observed and calculated values for the same amino acid is close (1.5 and 1.4 g; 2.48 and 2.44 g for Rations

TABLE 3. AMINO ACID CONTENT (GRAMS) OF THE THREE RATIONS CALCULATED FROM TABLES AND DETERMINED

	Ration I		Ration II		Ration III	
Amino acid g	Calculated	Found	Calculated	Found	Calculated	Found
Tryptophan	1.11	1.89	1.80	1.66	0.92	1.40
Threonine	2.83	3.28	4.36	4.74	2.45	2.35
Isoleucine	4.10	5.90	5.70	6.25	3.76	2.53
Leucine	6.16	5.75	8.25	9.44	5.26	3.82
Lysine	3.01	1.03	8.00	6.46	3.00	1.11
Methionine	1.50	1.40	2.48	2.44	1.16	2.30
Cystine	1.88	1.80	1.88	1.88	1.31	1.37
Phenylalanine	4.00	4.51	4.92	6.12	3.90	2.40
Tyrosine	2.24	3.32	2.86	4.82	2.82	1.44
Valine	4.38	2.98	5.04	6.40	3.85	2.53
Arginine	4.65	1.05	8.00	7.14	4.94	3.71
Histidine	1.84	1.17	5.32	1.90	1.68	1.03
Alanine	3.25	4.65	4.85	5.62	4.94	2.14
Asparagine	4.90	6.87	9.05	5.81	5.30	7.00
Glutamic acid	26.01	37.30	35.20	32.41	18.11	22.60
Glycine	4.86	3.64	5.72	7.44	3.97	4.72
Proline	8.86	8.50	9.85	10.78	6.16	6.26
Serine	4.11	5.00	5.04	5.88	3.76	3.06
Nitrogen%*	1.23	1.20	1.96	2.10	1.61	1.54

* Moisture free

I and II respectively). Since methionine and cystine have been determined after a hydrolysis procedure specially meant for these sulphur amino acids, and since the agreement between the values is good excepting in the case of Ration III, it is logical to look for an explanation for this variation. The raw materials are more in number in Ration III and include sesame which is known to be high in methionine content[7]; this may be contributing to the increased content of methionine found in Ration III.

Next to methionine, tryptophan content was higher than the calculated values by nearly 70 per cent in Ration I and by nearly 50 per cent in Ration III. In this case also, the method of determination was specially meant to prevent losses during hydrolysis. In a previous communication from this laboratory[6], we have reported that the tryptophan content of *Arhar dhal* as determined by us was higher compared to the literature values and this has been ascribed to the modified techniques adopted for the estimation of tryptophan. Thus, a satisfactory explanation for the large variation between the calculated and determined values is perhaps only possible when the raw materials used are individually examined.

Considerable amount of variation has also been observed in the case of lysine and arginine. However, the values determined were less than those calculated. The susceptibility of these basic amino acids to destruction during heat processing and also during hydrolysis procedures are well known[8-9].

The data on the essential amino acid content of the three rations and the protein scores are given in Table 4. The chemical score of lysine in Ration I by calculation was 73 but was actually found to be 25 on the basis of the analytical data; the wide difference in the values for total lysine content by calculation (3.01 g) and analysis (1.03 g) would indicate considerable destruction of this amino acid during cooking of Ration I. This aspect requires further study. Ration II was found to have a protein score of 80.5 with valine as the limiting amino acid and this correlates well with the calculated protein score of 81; the latter however, shows that the total sulphur acids are most limiting in the diet followed by valine. In the case of Ration III also valine was found to be limiting from the calculated as well as determined values for protein score followed by aromatic amino acids as the next limiting.

TABLE 4. PROTEIN SCORES OF THE THREE RATIONS BASED ON THE CHEMICAL SCORES OF ESSENTIAL AMINO ACIDS

Essential amino acid (g/16g N)	Ration I		Ration II		Ration III		
	Calculated	Found	Calculated	Found	Calculated	Found	Hen's egg
Isoleucine	4.3	5.9	4.1	4.1	4.4	3.5	6.6
Leucine	6.4	6.1	5.9	6.3	6.5	4.9	8.8
Lysine	3.1	1.1	5.7	4.3	3.7	3.0	6.4
Methionine+ cystine	3.5	3.4	3.1	2.9	3.0	4.7	5.5
Phenylalanine+ tyrosine	6.5	8.3	5.5	7.2	4.7	4.9	10.0
Threonine	3.0	3.5	3.1	3.1	3.0	3.0	5.1
Tryptophan	1.2	2.0	1.3	1.1	1.1	1.8	1.6
Valine	4.6	3.2	3.6	4.3	3.1	3.5	7.3
Total	32.6	33.5	32.3	33.3	29.5	29.3	51.3
Protein score	73	25	81	81	74	84	100
Limiting amino acids	Ly. Thre	Ly. Val.	Val. T.S.	T.S. Val.	Val. Ar.	Val. Ar.	...

Acknowledgement

The authors are grateful to Dr H. Nath, Director, for his guidance during the course of the work and to Sri K. C. Eapen and H. Umesh Rao for the supply of the rations.

References

1. Munro, H. N. and Allison, J. N., *Mammalian Protein Metabolism*, Academic Press, N.Y., 1964, 9.
2. *Protein Requirements*, Report of Joint FAO/WHO Expert Group, WHO, Geneva, 1965.
3. Orr, M. L. and Watt, B. K., *Legumes in Human Nutrition*, FAO, Rome, 1964, 117.
4. *Amino Acid Contents of Food and Biological Data on Proteins*, FAO, Rome, 1968.
5. Tara, M. R. and Rama Rao, M. V., *J. Fd Sci. Technol.*, 1972, **9**, 76.
6. Jacobs, S., *Methods of Biochemical Analysis*, 1965, **13**, 241.
7. Kuppuswamy, S., Sreenivasan, M. and Subrahmanian, V., *Proteins in Foods*, Special Report Series No. 33, ICMR, New Delhi, 1958, 198.
8. Roach, A. G., Sanderson, P. and Williams, D. R., *J. Sci. Fd Agric.*, 1967, **18**, 274.
9. Mallikarjuna Rao, N. and Narayana Rao, M., *J. Fd Sci. Technol.*, 1972, **9**, 66.

Use of Nisin for Extending Shelf Life of Processed Cheese and *Khoa*

M. S. KALRA, H. LAXMINARAYANA* AND A. T. DUDANI†
National Dairy Research Institute, Karnal

Manuscript Received: 23 November 1972

The possible use of nisin for extending shelf life of processed cheese and *Khoa* has been studied. Processed canned cheese with added nisin (100 Ru/g) remained good upto 90 days of storage at 30°C while cheese without nisin spoiled within 30 days. Nisin was particularly effective in controlling growth of anaerobic spore formers.

Addition of nisin to *khoa* (100 Ru/g) packed in cans resulted in increase of shelf life by more than 1 month at 10°C and by 2 and 3 weeks at 30° and 22°C respectively. The samples containing nisin failed to show the presence of any bacteria. However, in the corresponding *khoa* samples without nisin, there was a gradual increase in bacterial counts. Nisin also appeared to prevent development of yeasts and molds in *khoa* stored at low temperature.

Certain strains of *Streptococcus lactis* occurring naturally in milk have been known to produce an active antibacterial substance, 'Nisin' which is inhibitory to several gram positive organisms including species of *Bacillus*, *Clostridium* and *Lactobacillus*[1]. This property has been successfully used to combat the problem of late gas formation in natural gruy'ere cheese[2]. Nisin has also been extensively used for improving shelf life of processed cheese[3-6]. Heinemann *et al.*,[7] have used nisin to help lower heat treatment of sterilized chocolate flavoured milk in bottles. Similarly nisin has been profitably used to reduce heat treatment of evaporated milk thereby preventing lowering of its nutritive value[8].

There is a need for such studies in our country in view of poor quality of raw milk generally used for cheese manufacture and high temperature at which processed cheese cans are usually stored.

Materials and Methods

Incorporation of nisin in processed cheese: Cheddar cheese of different ages (3-6 months) was blended, comminuted finely and divided into 2 parts. To one lot Nisaplin (Commercial nisin preparation of Aplin and Barret Ltd., England) with an activity of 10^6 Ru/g (Reading unit[9]) was added to give a concentration of 100 mg/kg of cheese. Nisin was incorporated in the cheese along with the emulsifying salts (2 parts of sodium citrate and 1 part of disodium orthophosphate -20 g/kg of cheese). The above mixture was added slowly into the kettle containing melted cheese. The cheese melt, heated at 80°C for 5 min, was transferred to sterilized tins to fill completely (300 g) and the tins were sealed. The tins were sterilized at 161°C for 90 min in hot air oven. The control lots were prepared in exactly the same manner but without the addition of Nisaplin.

The experimental and control processed cheese cans were stored at 10 and 30°C and examined at various intervals for bulging or any other defect and were also tested for microbiological quality.

Nisin prepared in the laboratory from milk cultures of *S. lactis*-4‡ with an activity of 250,000 Ru/g was also similarly tested, the method of incorporating nisin into processed cheese being the same as in the case of Nisaplin preparation.

Incorporation of nisin in khoa: Khoa was prepared according to procedure described by De and Ray[10] and divided into 2 parts. To one part of *khoa*, nisin dissolved in about 50 ml sterile water was added

* Veterinary College, University of Agricultural Sciences, Bangalore. †Food and Agriculture Organisation, Lusaka, Zambia.

‡ *S. lactis*-4 was grown in milk till it curdled. The curd was then cut and warmed to get clear whey containing nisin. Nisin was recovered from whey by precipitating with sodium chloride. The precipitate was filtered out and dried under vacuum. Extra salt was removed by dialysis.

(100 Ru/g) and thoroughly mixed. The *khoa* was then filled at 70-75°C into sterilized tins in 300-g quantities so as to fill them upto the brim leaving very little air space. The other part of *khoa* was directly filled in tins without addition of nisin to serve as controls. For determination of shelf life both the experimental and control samples of *khoa* were stored at 10, 22 and 30°C and examined at intervals for changes in texture, flavour, visible signs of spoilage and microbiological quality.

Microbiological analysis: Standard plate counts were made on tryptone-dextrose agar and yeast and mold count on potato-dextrose agar, according to standard procedures[11]. For anaerobic count, the procedure recommended by Gibbs and Freame[12] was followed. The methods for microbiological analysis of *khoa* were identical to those used for cheese.

Results and Discussion

The results of trials on the preservative effect of nisin in processed cheese showed that at 30°C cheese tins containing nisin remained in a good condition upto 90 days against control cheese tins without nisin which were spoiled within 30 days. The cheese tins which showed heavy bulging, on opening generally showed gas pockets, fat separation and putrid odour. However, cheese tins, with and without addition of nisin stored at 10°C remained in good condition upto 120 days of storage.

From the results presented in Table 1 it is clear that nisin did not have any noticeable effect on total bacterial count at 10°C, on the other hand at 30°C in cheese samples containing nisin, the bacterial count was 30 to 50 per cent lower as compared to the corresponding control samples. In case of storage at 10°C (Fig. 1) a steady build up in anaerobic count was observed in control cheese samples, whereas in cheese with nisin (Nisaplin), no anaerobes could be detected upto 60 days and at the end of 120 days storage the anaerobic count was only 53/10 g as against a corresponding count of 460/10 g in the control.

At 30°C, the anaerobic count increased steeply in the control cheese samples and at the end of 90 days storage the count was 1100/10 g cheese whereas the corresponding count in cheese containing nisin was less than 10/10 g. It was also observed that nisin failed to check growth of yeasts and molds in cheese.

Trials with nisin prepared locally using *S. lactis*-4 showed that the cheese tins containing nisin remained in good condition at 30°C upto 60 days while the corresponding cheese tins without nisin got heavily bulged within 30 days. The anaerobic count in the spoiled cheese tin was 1100/10 g against corresponding

TABLE 1. EFFECT OF NISIN* ON MICROBIOLOGICAL QUALITY OF PROCESSED CHEESE

Storage Temp. (°C)	Storage Period (days)	Standard plate count/g		Yeast and mold count/g	
		Control	Nisin	Control	Nisin
	0	23,000	13,000	30	30
	30	24,000	15,000	20	0
10	60	16,000	13,000	50	110
	90	16,000	18,000	50	30
	120	19,000	11,000	30	40
	0	23,000	11,000	20	30
	30	19,000	7,000	50	20
30	60	15,000	7,200	80	120
	90	23,000	7,200	30	80

*100 Ru/g

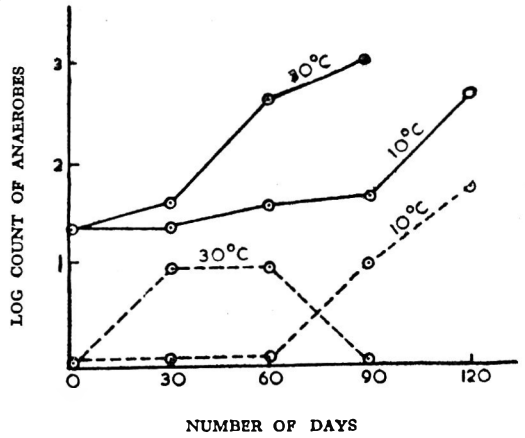


FIG. 1. Effect of nisin on anaerobic count in processed cheese stored at 10 and 30°C.

⊙——⊙ Control; ⊙- - -⊙ Containing nisin (100 Ru/g)

count of 150/10 g in the cheese tin containing nisin. It is evident that inhibitory action of nisin was directed against *Clostridia* since it prevented their multiplication in cheese preserved with nisin. These results are in conformity with the findings of McClintock *et al*[13], who observed that cheese tins containing 100 Ru/g of nisin remained normal upto 60 days while the corresponding cheese tins without nisin developed gas and were 'blown'.

In case of *khoa* samples organoleptic examination showed that after 28 days of incubation at 30°C, the control samples developed off flavour with considerable deterioration of the product. The samples containing nisin, however, did not reveal any such defect. *Khoa* samples without nisin when stored for 42 days at 22°C developed distinct off flavour while the corresponding samples containing nisin were rated to be normal at the end of this period.

Khoa samples (without nisin) on storage for 2 months at 10°C, deteriorated in flavour and taste whereas samples containing nisin did not show any undesirable change in quality even when stored beyond 3 months. There was also no mold growth at the surface in samples with nisin while the control sample was visibly damaged at the surface as a result of growth of mold.

The results of effect of nisin on bacteriological quality of *khoa* are presented in Table 2. *Khoa* samples stored upto 28, 42 and 90 days of storage at 30, 22 and 10°C respectively showed no bacterial counts which may be attributed to the combined bacteriostatic and bactericidal properties of nisin against microflora of *khoa*. In the corresponding samples without nisin there was gradual increase in total plate count upto 14 days at 30°C (85,000/g) with a decline in count (11,000/g) on further incubation for 28 days.

The pattern of change in bacterial count in the control samples at 22°C was almost similar to that observed at 30°C except that the increase in bacterial count was lower than that observed at 30°C, the bacterial count being 98,000 and 9,000/g after 21 and 42 days of storage respectively.

TABLE 2. EFFECT OF NISIN* ON MICROBIOLOGICAL QUALITY OF *khoa*

Storage Temp. (°C)	Storage Period (months)	Standard plate count/g		Yeast and mold count/g	
		Control	Nisin	Control	Nisin
10	0	47,000	51,000	55	45
	2	24,600	0	45	30
	3	6,900	0	1,000	80
	(days)				
22	0	47,000	51,000	55	45
	3	22,000	0	15	5
	7	70,000	0	5	25
	21	98,000	0	20	15
	42	9,000	0	10	15
30	0	47,000	51,000	55	45
	3	48,000	0	70	25
	7	146,000	0	10	20
	14	85,000	0	15	55
	28	11,000	0	15	20

*100 Ru/g

At storage temperature of 10°C, there was a steady decrease in total bacterial count in the control samples and at the end of 3 months, the total bacterial count was decreased from initial count of 47,000/g to 6,900/g only.

Nisin also appeared to have beneficial effect in controlling growth of yeasts and molds at 10°C, the yeast and mold count being 80 against 1000/g in the samples without nisin after storage for 3 months.

The studies conclusively show that incorporation of nisin in *khoa* can considerably enhance its shelf life without in any way impairing its characteristics, flavour or taste, the preservative effect being more effective at lower temperature of storage. Addition of nisin therefore, can be recommended as an effective and practical method of enhancing shelf life of *khoa*. From the data obtained, it is also conceivable to consider use of nisin in other canned dairy products such as *Rasogullas* and *Channa* for attaining improved shelf life.

References

1. Mattick, A. T. R. and Hirsch, A. *XII Int. Dairy Congr.*, 1949, **2**, 546.
2. Hirsch, A., Grinsted, E., Chapman, H. R. and Mattick, A. T. R., *J. Dairy Res.*, 1951, **18**, 205.
3. Pette, J. W. and Kooy, J. S., *XIII Int. Dairy Congr.*, 1953, **3**, 1172.
4. Berride, N. J., *Chemy Ind.*, 1953, **44**, 1158.
5. Hawley, H. B., *J. appl. Bacteriol.*, 1955, **18**, 388.
6. Galesloot, T. E., *Neth. Milk Dairy J.*, 1957, **11**, 58.
7. Heinemann, B., Stumbo, C. R. and Scurlock, A., *J. Dairy Sci.*, 1964, **47**, 8.
8. Gregory, M. E., Henry, K. M. and Kon, S. K., *J. Dairy Res.*, 1964, **31**, 113.
9. Mattick, A. T. R. and Hirsch, A., *Nature, Lond.*, 1944, **154**, 551.
10. De, S. and Ray, S. C., *Indian J. Dairy Sci.*, 1952, **5**, 147.
11. *Standard Methods for the Examination of Dairy Products*, American Pub. Health Assoc. Inc., New York, 1967, 12th edn., 95.
12. Gibbs, B. M. and Freame, B., *J. appl. Bacteriol.*, 1965, **28**, 95.
13. McClintock, M., Serres, L. and Marsolf, J. J., *J. Dairy Res.*, 1952, **19**, 187.

Microbial Flora of Gamma-irradiated Vacuum-packed Ground Beef Stored at Different Temperatures

NDUKA OKAFOR

Department of Microbiology, University of Nigeria, Nigeria

Manuscript Received: 23 November 1972

Vacuum-packed ground beef was stored unirradiated, as well as after irradiation at doses of 0.1, 0.3 and 1.0 Mrads at storage temperatures of 1, 5, 15, 25, 30°C. *Pseudomonas* and *Microbacterium* did not survive at lower irradiation doses. Organisms developing on media designed for *Lactobacilli*, yeasts, *Streptococci*, *Coliforms* and *Micrococci* survived the 0.3 Mrad dose to varying degrees. *Lactobacilli* and yeasts predominated among the organisms surviving the 1.0 Mrad dose. Organisms which survived the higher irradiation dose on media designed for *Coliforms* and *Streptococci* were isolated mainly from meat packs incubated at higher temperatures (25-37°C).

The nature of the micro-organisms which spoil meat depends, among other factors, on the temperature at which the material is stored. Ingram and Dainty[1] have divided meat storage temperatures into three ranges: chill (around 0°C), intermediate (15-25°C) and warm (20-40°C) and have stressed the dearth of information on spoilage micro-organisms at higher temperatures especially the intermediate.

The object of the preliminary work reported in this publication was to observe how the nature of micro-organisms developing on minced beef varied with different irradiation doses and a wide range of post-irradiation storage temperatures, including temperatures of the intermediate and warm ranges (15 to 37°C). This author believes that knowledge of the nature and behaviour of organisms spoiling meats at higher temperatures especially at low irradiation (pasteurisation) doses may be of some importance in the warmer parts of the world.

Because of the large number of samples involved the micro-organisms encountered were classified into broad groups using selective media.

Materials and Methods

Packaging: Brisket taken immediately after slaughter and evisceration in a commercial slaughterhouse in Cambridge, England, was minced in a sterilized 'Kenwood' mincer, and thoroughly mixed on an alcohol-flamed tray using a sterile ladle. 25 g samples were vacuum-packed in Metathene-X pouches (Metal Box Co., London) using a modified Claro-vac Mark V machine (Jesset and Henry, Middlesex), so that the thickness of the pack was about 0.5 cm. Two separate muscle samples were used: (*a*) from a 21 month-old Hereford × Friesian cross chilled overnight at -3°C before mincing (first experiment); and (*b*) from a 21 month-old Charolais × Friesian cross minced within 90 min of slaughter (second experiment).

Irradiation and storage: Samples were irradiated at about 25°C with 0.1, 0.3 or 1.0 Mrad in a 4,000 Ci^{60} Co source (Super Hot Spot Mr. 1-Nuclear Chemical Plant Ltd., London, W. 13) at a dose-rate of 0.9 Mrad/hr. Six packs were irradiated together at each dose and one stored at each of the following six temperatures: 1, 5, 15, 25, 30 and 37°C. An unirradiated control pack was simultaneously incubated at each temperature. Incubation was continued to spoilage (2-60 days) dependent on radiation dose and storage temperatures.

Bacterial counts: At various time intervals (Fig. 1-8), 20 g samples were aseptically mixed with 80 ml of sterile maintenance medium (0.1½ Bacto peptone, 0.5½ NaCl, pH 7.0-7.1) in an M.S.E. 'Atomix' blender, run for 30 sec at half-speed, and for 1½ min at full speed. Duplicate 140 ml drops of decimal dilutions in maintenance medium were surface plated on the media listed in Table 1.

Selective media: A total of eight media were used, seven of which are said to be selective for particular groups or genera of organisms (Table 1).

Their selectivity was studied using a representative selection of meat spoilage organisms (Table 2). Meat samples were also checked for *Clostridia* by initial

enrichment in 1 g of mince in cooked meat medium at 37°C for 48 hr, before plating on blood agar comprising Hartley's digest broth solidified with 2.4 per cent Davis' New Zealand agar and containing 5 per cent 'Wellcome' oxalated horse blood, and incubating anaerobically for 48 hr at 37°C. Similarly, samples were screened for *Salmonella* by incubating 1 g of mince meat in 20 ml of Selenite broth ('Oxoid') at 37°C for 48 hr and plating on *Salmonella-Shigella* (SS) agar ('Oxoid'). Coagulase positive *Staphylococci* were isolated on Baird-Parker Medium (Oxoid) and confirmed by the slide screening test using dried rabbit plasma[2].

TABLE 1. MEDIA ON WHICH ORGANISMS FROM THE MEAT PACKS WERE PLATED

Agar medium	Incubation temperature (°C) of medium	Organisms
Plate-count (Oxoid)	30	Total count
Rogosa's (Oxoid)	30	*Lactobacillus*
Mannitol Salt (Oxoid)	30	*Micrococcaceae*
Masurovsky (Masurovsky *et al*[3])	25	*Pseudomonas* *Achromobacter*
Barnes' Tetrazolium (B.B.L.)	37	*Streptococcus*
Violet Red Bile (Oxoid)	37	Coli-aerogenes
Gardner (Gardner[6])	25	*Microbacterium*
Malt yeast extract*	25	Yeasts

* 5% Yeast extract in malt extract plus 1.5% agar (all Difco)

Results and Discussion

Of the selective media those of Masurovsky[3], and Gardner[4] (Tables 1 and 2) were the most efficient; all the other media permitted the growth of at least one other bacterial genus outside the group for which they were originally designed.

The bacterial counts on meat at various irradiation doses, storage temperatures and storage periods are shown in Figs 1-8.

The total count as observed on Plate-count agar (Oxoid) (Fig. 1) generally tended, as might be expected, to decrease with increasing doses of irradiation. For example, the initial total log count of organisms in the unirradiated (control) packs was 4.28; the number surviving immediately after irradiation at 0.1 Mrad was 3.86. On the other hand no growth occurred on Plate-count agar immediately after irradiation (0 day) in packs irradiated at 0.3 and 1.0 Mrads. Growth did occur in packs examined on further storage but the numbers were always less, the higher the irradiation dose employed.

TABLE 2. GROWTH OF REPRESENTATIVE MEAT SPOILAGE BACTERIA ON THE TOTAL (PLATE) COUNT AND SELECTIVE MEDIA USED

Organisms tested	Media tested: Plate-count	Mannitol salt	Malt yeast extract	Gardner	Masurovsky	Violet red bile	Barnes' tetrazolium	Rogosa
Achromobacter gutatis NCIB 9405	+(100.0)*	...	...	...	**+(112.2)**	+(64.6)	...	...
Aerobacter punctat NCIB 640	+	...	...	...	...	...	...	...
Alcaligenes faecalis NCTC 415	+	...	...	...	...	+	...	...
Bacillus subtilis NCTC 3610	+(100.0)	+(26.9)	+	...	...	...	...	...
Escherichia coli	+(100)	...	+(96.0)	...	...	**+(77.0)**	...	...
Flavobacterium sp.	+	...	+	...	...	...	+	...
Lactobacillus plantarum NCDO 343	+(100)	...	+(100.0)	...	...	...	...	**+(100.0)**
Microbacterium thermosphactum	+(100)	...	...	**+(100)**	...	...	...	...
Micrococcus lacticum NCDO 748	+(100)	+(100)	...	...	...	...	+(100.0)	+(100.0)
Pediococcus cervisiae NCDO 813	+(100)	...	+(100.0)	...	...	...	+(100.0)	**+(100.0)**
Proteus vulgaris	+	+	+	...	...	+	...	...
Pseudomonas aeruginosa NCIB	+(100.0)	...	+	...	+(69.0)	+(10.0)	+	...
Salmonella	+	...	+	...	...	+	...	...
Sarcina sp.	+	+	...	...	...	▬	...	...
Staphylococcus aureus NCTC 8532	+	+	...	...	...	+	...	...
Streptococcus sp.	+(100.0)	...	...	...	...	+(46.0)	+	**+(110.0)**
Yeasts	+	...	+	...	+	...	...	...

Bold figure indicates growth on media by bacteria which media designed to select; + = Growth from streak of loopful of an 18 hr broth culture; * (100.0) = Figures in brackets indicate colony counts on selective media expressed as a percentage of number of colonies of same bacterium on plate count agar; ... = No growth from streak.

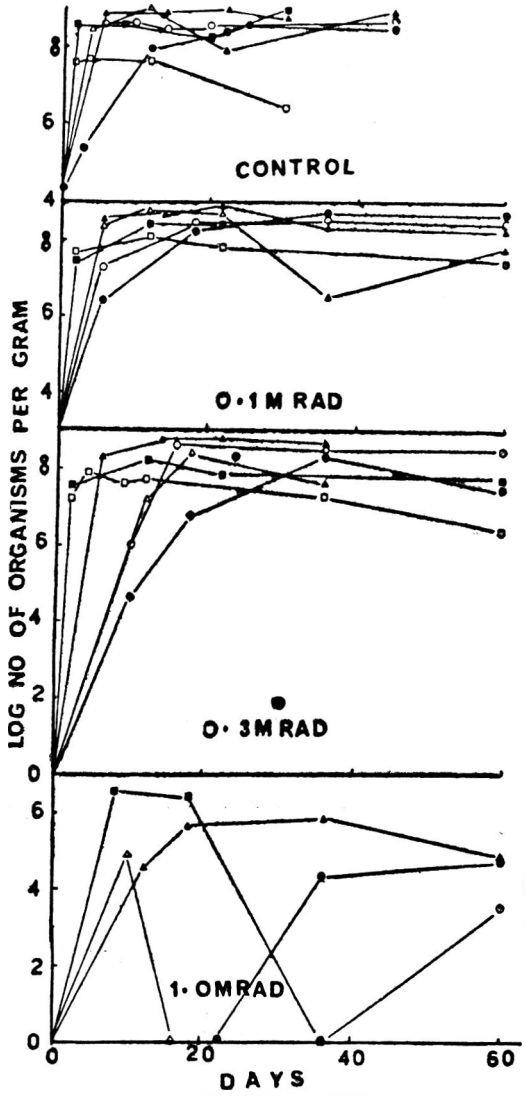


FIG. 1. Log numbers of bacteria developing on plate-count agar (Oxoid) (total counts) after various storage periods temperatures and irradiation doses.
●—● 1°C; ○—○ 5°C; ▲—▲ 15°C, △—△ 25°C;
■—■ 30°C; □—□ 37°C.

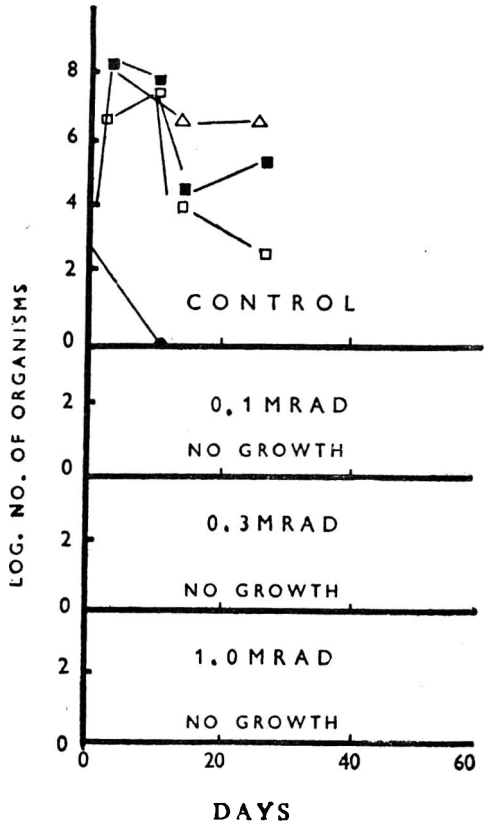


FIG. 2. Log numbers of organisms developing on the agar of Masurovsky *et al.*
●—● 1°C; ○—○ 5°C; ▲—▲ 15°C, △—△ 25°C;
■—■ 30°C; □—□ 37°C.

Total counts increased with increasing temperature of storage of the meat packs for temperatures up to 30°C; at 37°C, however, total counts tended to fall. Although the sampling times had been staggered a trend was clearly evident that the higher the temperature, the shorter was the period of incubation elapsing before the attainment of the highest bacterial numbers in the meat packs. With respect to the individual bacterial groups high storage temperatures (25-37°C) seemed to favour the growth of organisms developing on the medium of Masurovsky (Fig. 2) and Barnes' Tetrazolium Agar (Fig. 3) in the unirradiated meat packs. On the other hand, similar temperatures appeared to discourage the development of bacteria selected by Gardner's medium (Fig. 4) which grew better between 10°C and 15°C.

The lowest irradiation dose (0.1 Mrad) reduced numbers of organisms developing on the media of Gardner and Masurovsky *et al.*, as well as those developing on violet red bile agar, (Fig. 5) (although the extent in this case depended on the storage temperature). On the other hand, 0.1 Mrad did not much affect numbers of organisms developing on Rogosa agar (Fig. 6) on Mannitol-Salt agar (Fig. 7) and yeasts (Fig. 8).

At the higher irradiation doses (0.3 and 1.0 Mrads) no organism developed on Gardner's medium and very few bacteria developed on Masurovsky's medium. At 1.0 Mrad very little growth occurred on Barnes' Tetrazolium Agar and none occurred at all on Mannitol-Salt Agar.

The post-irradiation storage temperatures seemed to influence the viability of micro-organisms in the meat packs. For example, after irradiation at 0.1 Mrad no organisms were isolated on Barnes' Tetrazolium Agar in packs incubated at 5°C. In packs

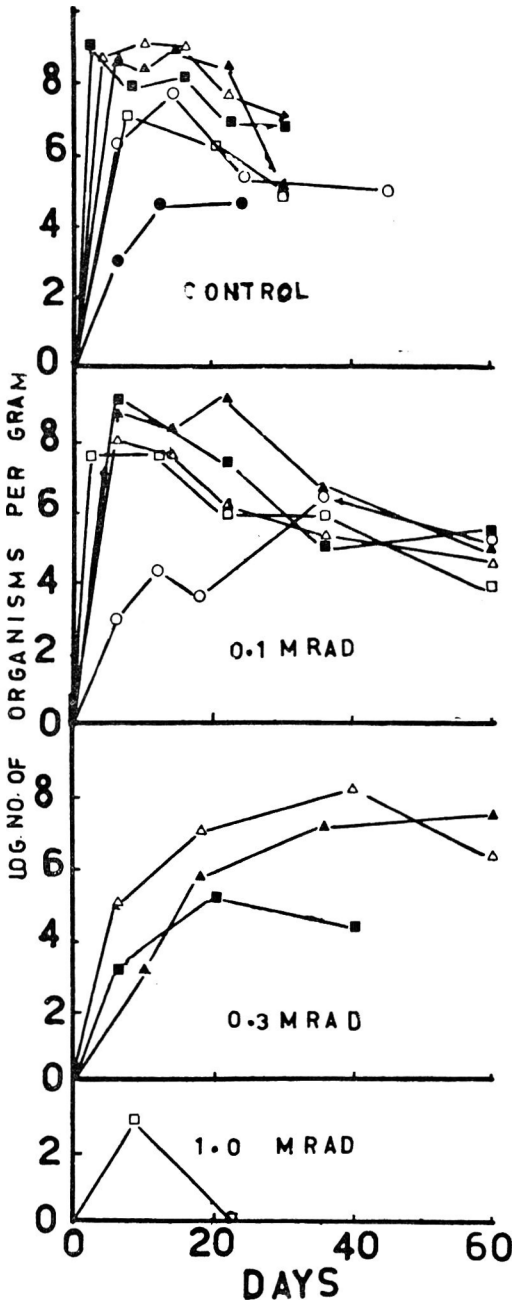


FIG. 3. Log numbers of organisms developing on Barnes Tetrazolium Agar (BBL) (*Streptococci*) after various storage periods, temperatures and irradiation doses.
●–● 1°C; ○–○ 5°C; ▲–▲ 15°C; △–△ 25°C; ■–■ 30°C; □–□ 37°C

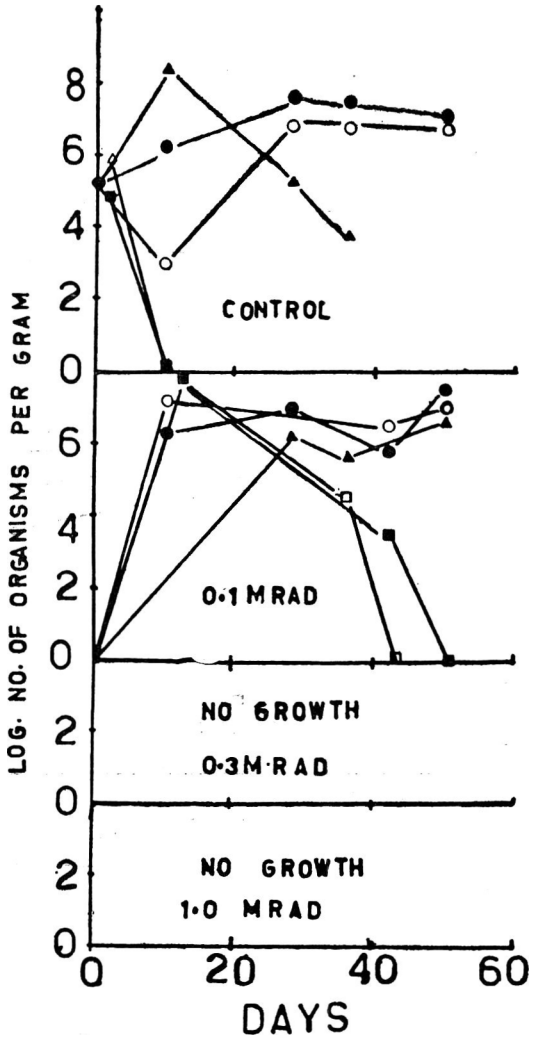


FIG. 4. Log numbers of organisms developing on Gardner's medium (*Microbacterium*) after various storage periods, temperatures and irradiation doses.
●–● 1°C; ○–○ 5°C; ▲–▲ 15°C; △–△ 25°C; ■–■ 30°C; □–□ 37°C.

irradiated at 0.3 Mrad, growth occurred in those incubated at 15-30°C, whereas after irradiation at 1.0 Mrad the only pack which yielded growth was that incubated at 37°C. Similarly, after irradiation at 1.0 Mrad bacteria were isolated on Barnes' medium only from packs incubated at 15°C. On the other hand, counts made on Rogosa agar in packs incubated at 30 and 37°C progressively dropped with increasing length of storage after irradiation at 0.1 and 0.3 Mrad. At 1.0 Mrad, no bacteria were recovered in most packs incubated at 1, 5 and 15°C. Similarly, after irradiation at 1.0 Mrad yeasts were recovered only in packs incubated at 1-25°C.

Gram-negative bacteria of the genus *Pseudomonas* and to a smaller extent *Acinetobacter*, *Alcaligenes* (i.e. the *Pseudomonas-Achromobacter* group) as well as *Microbacterium* are the major meat spoilers at chill temperatures and aerobic conditions[1,5-8]. In vacuum-packed meats *Pseudomonas* are suppressed while the growth of *Lactobacilli* is favoured[9,10]. The result of this experiment confirms these findings. The observation that *Pseudomonas* grow equally in the meat

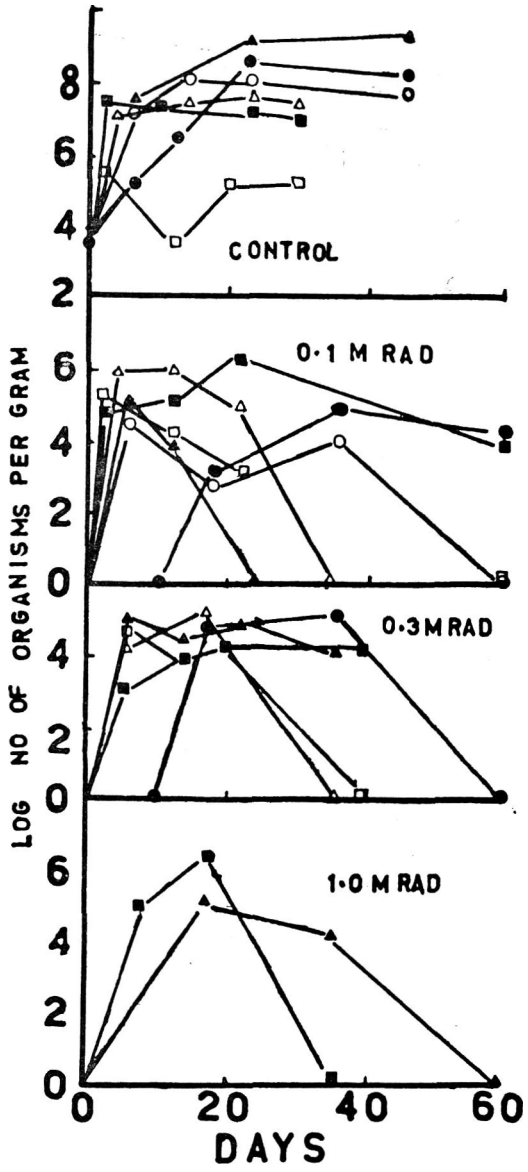


FIG. 5. Log numbers of bacteria developing on Violet Red Bile Agar (Oxoid) (*Coliforms*) after various storage periods, temperatures and irradiation doses
●—● 1°C; ○—○ 5°C; ▲—▲ 15°C; △—△ 25°C;
■—■ 30°C; □—□ 37°C.

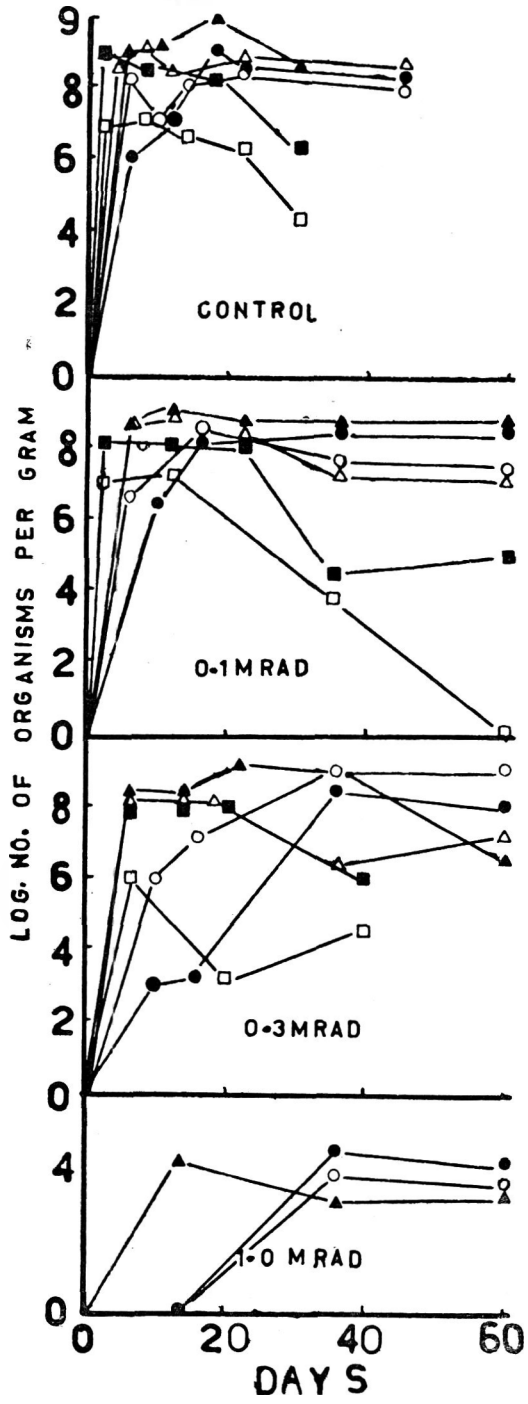


FIG. 6. Log numbers of organisms developing on Rogosa Agar (Oxoid) (*Lactobacilli*) after various storage periods, temperatures and irradiation doses.
●—● 1°C; ○—○ 5°C; ▲—▲ 15°C; △—△ 25°C;
■—■ 30°C; □—□ 37°C.

stored at higher as at the lower temperatures is indeed to be expected; meat storage studies have usually concentrated on chill temperatures. *Microbacterium* numbers declined as expected at storage temperatures of 1 and 5°C[10]; the disappearance however appeared temperature dependent, the rate being higher at higher temperature.

At the irradiation dose of 0.1 Mrad organisms destroyed were mainly the *Pseudomonas* group whereas at 0.3 Mrad or higher the bulk of the surviving organisms included those developing on Mannitol-Salt agar, (*Micrococci*) Rogosa agar (*Lactobacilli*), and yeasts and to a small extent on VRB agar (coliforms). These results agree with those of previous workers [9-13].

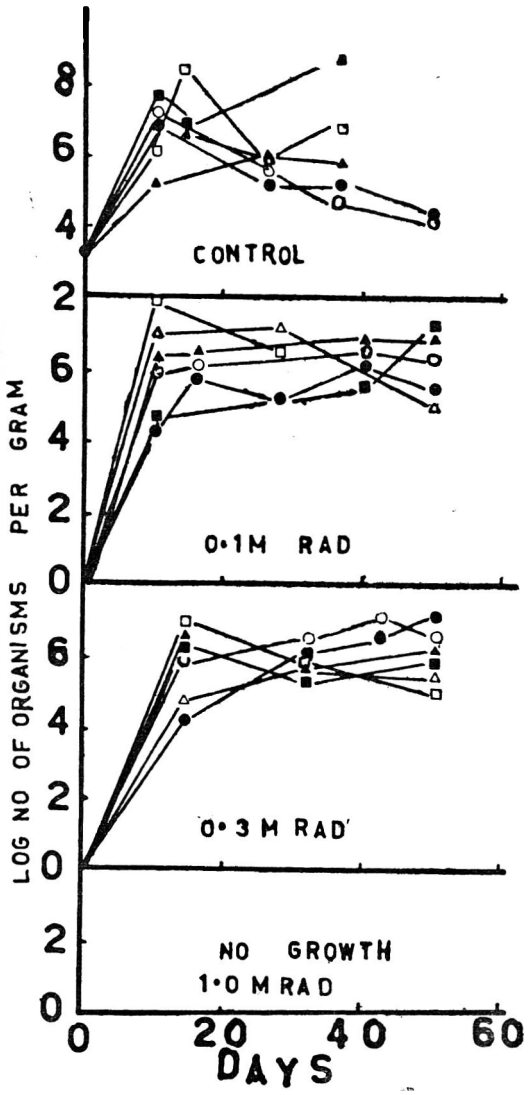


FIG. 7. Log numbers of bacteria developing on Mannitol Salt Agar (Oxoid) (*Micrococci*) after various storage periods, temperatures and irradiation doses.
●–● 1°C; ○–○ 5°C; ▲–▲ 15°C; △–△ 25°C; ■–■ 30°C; □–□ 37°C.

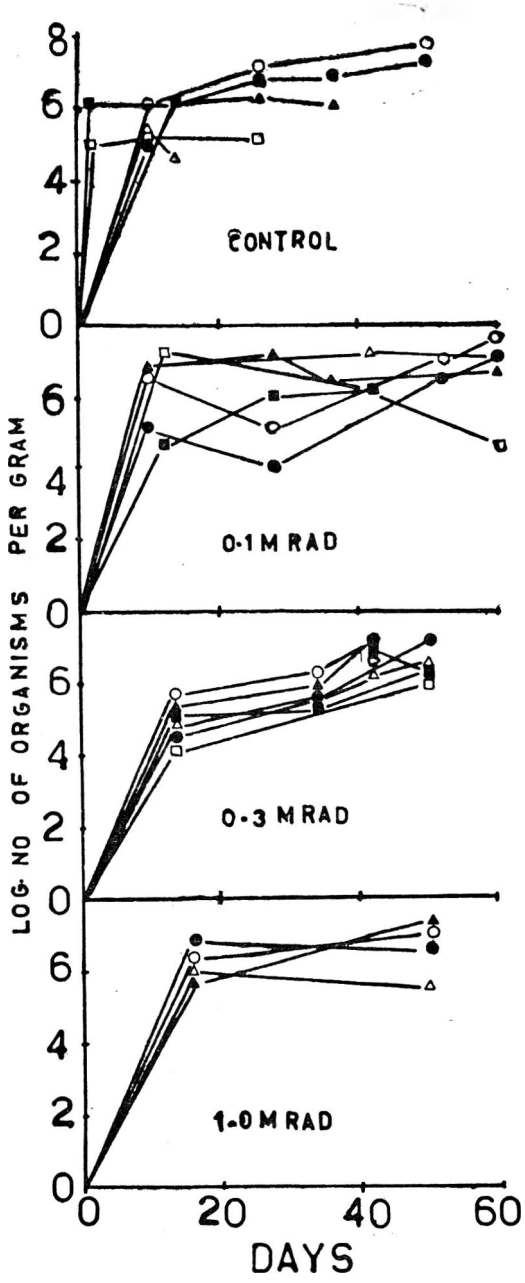


FIG. 8. Log numbers of yeasts developing on malt-yeast extract agar after various storage periods, temperatures and irradiation doses.
●–● 1°C; ○–○ 5°C; ▲–▲ 15°C; △–△ 25°C; ■–■ 30°C; □–□ 37°C.

It would appear that high storage or ambient temperatures could encourage coliforms (including pathogenic forms) to develop on storage subsequent to irradiation at 0.3 Mrad. No coagulase-positive *Staphylococci* were isolated. *Clostridia* were not found at irradiation doses higher than 0.1 Mrad and *Salmonella* was isolated from one unirradiated pack. From the public health point of view, these findings could be of significance.

An irradiation dose of 1.0 Mrad would appear to be required to eliminate most of the micro-organisms present in meat similar in all respects to that used here. It was observed, however, that at 1.0 Mrad many meat packs developed a 'burnt-meat' odour, which might render them less acceptable for public consumption[14]. A compromise dose might be chosen for irradiation-pasteurization[15,16], which would reduce the microbial load while retaining an acceptable flavour.

The organisms developing on meat in this work have been assessed by growing them on selective media, a few of which were not very efficient. One possible alternative to the use of selective media would be to

isolate all or some of the organisms developing on the plate count (total) agar and identify them. The labour and cost would far outweigh any advantages. Ingram[8] has recently discussed some of the problems encountered in enumerating organisms spoiling meat.

Acknowledgement

The author wishes to thank the Royal Society which enabled him to visit England on an award of Royal Society and Nuffield Foundation Commonwealth Bursary; he also thanks the Director of the former Low Temperature Research Station, Cambridge, England, for laboratory facilities.

References

1. Ingram, M. and Dainty, R. H., *J. appl. Bacteriol.*, 1971, **34**, 21.
2. Cruickshank, R., *Medical Microbiology*, Livingstone, Publishing Co., Pa, U.S.A. 1965.
3. Masurovsky, E. M., Goldblith, S. A. and Voss, J., *J. Bacteriol.*, 1963, **85**, 722.
4. Gardner, G. A., *J. appl. Bacteriol.*, 1966, **29**, 455.
5. Ayres, J. C., *J. appl., Bacteriol.*, 1960, **23**, 471.
6. Gardner, G. A., *J. appl. Bacteriol.*, 1965, **28**, 252.
7. Ingram, M. and Shewan, J. M., *J. appl. Bacteriol.*, 1960, **23**, 373.
8. Ingram, M., *J. appl. Bacteriol.*, 1971, **34**, 1.
9. Jaye, M., Kittaka, R. S. and Ordal, Z. J., *Fd Technol.*, 1962, **16**, 95.
10. Cavett, J. J., *J. appl. Bacteriol.*, 1962, **25**, 282.
11. Abrahamson, K., De Silva, N. M. and Molin, N., *Can. J. Microbiol.*, 1965, **11**, 523.
12. Pierson, M. D. Collins-Thompson, D. L. and Ordal, J. D., *Fd Technol.*, 1970, **24**, 1171.
13. Thernley, M. J., Ingram, M. and Barnes, E. M., *J. appl. Bacteriol.*, 1960, **23**, 487.
14. Weidmann, J. F., *J. appl. Bacteriol.*, 1965, **28**, 365.
15. Savagon, K. A., Venugopal, V., Kamat, S. V., Kumta, U.S., and Sreenivasan, A., *J. Fd Sci.*, 1972, **37**, 148.
16. Rhodes, D. N. and Shepherd, H. J., *J. Sci. Fd Agric.*, 1966, **17**, 287.

Packaging Studies on Spray Dried Whole Egg Powder in Pouches of Flexible Films and Laminates

S. S. LANGAR, B. ANANDASWAMY AND N. BALASUBRAHMANYAM
Central Food Technological Research Institute, Mysore

Manuscript Received: 18 October 1972

To develop a suitable consumer package for spray dried whole egg powder, moisture sorption behaviour of the products under different relative humidities, changes in the solubility characteristics of the equilibrated samples at different periods of storage and the behaviour of the fresh product in pouches of different flexible packaging materials during storage have been studied. Sorption studies have indicated that a moisture content of about 6 per cent in the product is critical as judged by physico-chemical properties. Temperature has pronounced effect on the solubility of the product with higher moisture content. The consumer size pouches made of a laminate of paper/aluminium foil of 0.009 mm/150 gauge polyethylene and 300 gauge high density polyethylene would provide a shelf life of about 6 months and 3 months respectively under normal storage conditions.

A process for the manufacture of spray dried whole egg powder from chicken eggs has been standardized at CFTRI[1]. The spray dried egg powder being highly hygroscopic, its shelf life during distribution and storage is influenced considerably by packing materials, method of packing and storage conditions. In commerce, the product is generally bulk packed in quantities of 14 lb in polyethylene bags and packed in an outer sealed fibre board shipping container. For distribution in the regions of high humidities and temperatures, it is gas packed in tins of 2 lb capacity[2]. This method of bulk and unit packaging however restricts the use of the product mostly to institutional use. With an object of making this available to a large number of families and individuals in smaller lots of 50-100 g of single service unit, a study was undertaken to design and develop a suitable consumer size flexible package which would give a shelf life of about 3-4 months for the product. The moisture sorption characteristics of the product and its shelf life in consumer size pouches of different types of thermoplastic films and aluminium foil laminate under

different conditions of storage are reported in this communication.

Materials and Methods

The spray dried egg powder prepared from chicken whole egg, desugared by yeast according to the process standardized by CFTRI[1] was used in the present investigation. The product as prepared was hygroscopic, low in moisture content and was susceptible to oxidative changes. The solubility characteristics of the egg powder is one of the important criteria considered for assessing its initial quality and also during storage and this is influenced by moisture content, storage conditions and method of packaging[6,10,11]. This necessitates the selection of packaging material having low permeability to water vapour and oxygen. The flexible packaging materials used in the investigation were (*i*) high density polyethylene film (HDPE) of 300 gauge; (*ii*) Polycell (a laminate of MSAT 300 cellulose film/150 gauge polyethylene); (*iii*) saranex (a commercial film of a copolymer of PVC and PVDC) of 300 gauge; and (*iv*) a laminate of paper 60 gsm/ aluminium foil of 0.009 mm thick/polyethylene of 150 gauge. The water vapour transmission rate of these packaging materials was determined according to standard ISI method[3] and it was 1.8, 11.2, 3.12 g and almost negligible per sq m/24 hr under a gradient of 90 per cent RH at 38°C in HDPE, polycell, saranex and aluminium foil laminate respectively.

Sorption characteristics of the spray dried whole egg powder: The humidity moisture relationship study of the egg powder which had an initial moisture content of 2.58 per cent was studied at 27 and 38°C. Small quantities of the product were exposed to different relative humidities ranging from 11 to 92 per cent built up in separate desiccators using appropriate saturated salt solutions[4]. They were weighed periodically till they attained constant weight or the content in the dishes showed signs of mould growth whichever was noticed earlier. At the end of equilibration the moisture content of the product at different relative humidities was determined by drying a known weight of the sample at 100±5°C for 18 hr. The results are presented in Table 1.

Studies on the effect of moisture, storage temperature and period on the solubility characteristics of spray dried egg powder: The product with different initial moisture contents obtained by exposing the sample to various relative humidities were packed in glass bottles and were exposed to the storage temperatures of 27 and 38° C for different durations. The solubility of the product at different intervals of storage was determined by the procedure of Haenni as described by Hawthorne[5]. The results are presented in Table 2.

Packaging and storage studies: The egg powder in lots of 50 to 60 g was packed in pouches of 11 cm×10 cm size made from packaging materials described earlier. The filled pouches were closed by heat seal, weighed individually and stored at (*i*) 38°C and 90±2 per cent RH (accelerated storage condition) and (*ii*) 27°C and 65±2 per cent RH (average atmospheric condition prevailing in India).

The individual packages were weighed periodically during storage and the moisture content and solubility of the product were determined. The results are presented in Table 3. The sample kept in glass bottles under the above storage conditions served as control.

Results and Discussion

The sorption studies of the egg powder at 27 and 38°C have indicated that the product is highly hygroscopic in character and with an initial moisture content of 2.65 per cent on dry weight basis would equilibrate to RH of about 9 and 11 per cent at 27 and 38°C respectively. The sorption isotherms obtained at both temperatures were of typical sigmoid type and exhibited steep rise above 44 per cent RH. It is recognised, generally, that the beginning of the rapid rise in sorption isotherm is an indication of the onset

TABLE 1. EQUILIBRIUM MOISTURE CONTENT (EMC) OF SPRAY DRIED WHOLE EGG POWDER AT DIFFERENT RH AND TEMPERATURES

R.H. %	% E M C at indicated temperatures			
	As is basis		Dry wt basis	
	27°C	38°C	27°C	38°C
5	2.36	...	2.42	...
11	2.77	2.77	2.84	2.84
22	3.89	3.32	4.00	3.41
32	4.96	4.26	5.09	4.37
44	6.16	5.43	6.32	5.57
52	7.27	6.74	7.46	6.91
64	9.74	8.78	10.00	9.01
75	13.39	12.39	13.74	12.80
86	17.34	17.17	17.79	17.62

Initial moisture content: 2.58% on as is basis; 2.65% on dry weight basis.

The product with initial moisture content of 2.58% equilibrates to about 9%RH.

of rapid physico-chemical changes in the product. The product with moisture content of about 6 per cent would equilibrate to 44 per cent RH and this could be taken as critical from the point of rapid deterioration in physical and chemical characteristics of the product. The sorption isotherm obtained both at 27 and 38°C were almost parallel except at low and very high ranges of relative humidities.

The vapour pressure isotherms for dried egg powder determined at various temperatures by Gane[6], Makowar[7] and Bumazhnow[8] have all indicated that the rate of deterioration increases with increase in moisture content. Further it is also reported that to maintain quality, dried eggs should not contain more than 5 per cent moisture[9]. Based on the present sorption studies and also on the basis of literature values, it can be inferred that a moisture level above 6 per cent is critical for the keeping quality of the product.

Solubility characteristics of the product: Table 2 presents data on the influence of moisture, temperature and storage period on the solubility of the product. In general, as these factors increased the solubility decreased. It can be seen that the decrease in solubility is considerable in the samples equilibrated to higher moisture level indicating thereby that the solubility of the product is greatly influenced by the moisture content. Further, the results suggest that a moisture level above 6 per cent is critical as the solubility decrease is rapid above this limit. This result is in accordance with the studies of Hawthorne[5] who observed that chemical changes in spray dried egg stored at 20-27°C in sealed tins is slow when the moisture content is below 5 per cent, but considerable loss in solubility occurs after several weeks, particularly at high temperatures. Similarly rapid increase in the liberation of free fatty acids in egg powder containing more than 5 per cent of water is reported by Brooks[10]. A fall in average flavour score during storage in the spray dried egg powder containing 4-5 per cent moisture is reported by Bate-Smith *et al.*[11]

Packaging and storage studies: The changes in moisture content and in solubility of the egg powder in different packages under two storage conditions are presented in Table 3.

TABLE 2. CHANGE IN SOLUBILITY OF WHOLE EGG POWDER WITH DIFFERENT MOISTURE CONTENTS UNDER DIFFERENT CONDITIONS OF STORAGE

Storage at 27°C and 65± 2% RH equilibrated				Storage at 38°C and 90 ± 2% RH equilibrated		
Solubility after					Solubility after	
Moisture %	12 days	52 days	75 days	Moisture %	12 days	52 days
2.84	94.40	92.50	91.67	2.84	95.29	91.67
4.00	93.52	91.20	90.00	3.41	94.40	90.00
5.09	91.67	88.36	86.66	4.37	92.60	87.72
6.32	91.67	87.60	85.60	5.57	91.67	84.50
7.46	90.00	85.58	83.38	6.91	90.83	81.03
10.00	87.72	76.00	70.11	9.01	83.31	78.54
13.74	85.60	70.80	63.42*	12.80	78.54	70.11

* Became moldy after 42 days

TABLE 3. CHANGE IN PER CENT SOLUBILITY OF THE WHOLE EGG POWDER IN DIFFERENT PACKAGES DURING STORAGE

Description of the packages	Solubility when stored at 38°C and 90 ± 2% RH and at indicated periods					Solubility when stored at 27°C and 65 ± 2% RH and at indicated periods				
	20 days	35 days	50 days	65 days	90 days	25 days	40 days	55 days	70 days	90 days
Aluminium foil laminate pouches	95.29 (2.66)	95.29 (2.72)	95.29 (2.78)	93.52 (2.84)	95.29 (2.94)	95.29 (2.63)	95.29 (2.65)	95.29 (2.75)	95.29 (2.85)	94.40 (2.90)
300 gauge HDPE pouches	95.29 (4.23)	91.67 (4.56)	90.00 (4.92)	84.49 (6.0)	77.22 (7.10)	93.52 (3.08)	93.52 (3.17)	93.52 (3.58)	92.59 (3.85)	91.67 (4.09)
Saranex pouches	91.67 (4.45)	90.83 (5.18)	87.72 (6.10)	81.03 (6.71)	71.61 (7.90)	94.40 (3.35)	93.52 (3.39)	92.59 (3.88)	91.67 (4.05)	88.86 (4.41)
Polycell pouches	87.72 (7.13)	82.38 (8.60)	71.61 (9.93)	65.15 (11.65)	55.50 (12.63)	91.67 (4.75)	90.83 (5.25)	88.86 (6.30)	86.66 (6.79)	83.38 (7.51)
Glass bottles	95.29	95.29	95.29	94.40	93.52	95.29	95.29	95.29	95.29	95.29

Initial moisture content of the product, 2.58%; initial solubility of the product, 95.29%
Figures in the brackets indicate moisture content %

Under storage conditions of 38°C and 92±2 per cent RH, no appreciable change both in moisture content and in the solubility of the product was noticed in aluminium foil laminate pouches at the end of 90 days storage. The results were comparable with control sample kept in airtight glass bottle stored under the same conditions. As against this, the moisture content had increased from 2.58 to 7.1, 7.9 and 12.9 per cent and the solubility had decreased from 95.3 to 77.2, 71.6, 55.5 per cent in 300 gauge HDPE film, saranex and polycell pouches respectively at the end of 90 days storage.

By extrapolating the results of storage studies with the sorption isotherm studies it could be seen that the egg powder with an initial moisture content of 2.58 per cent would attain a critical moisture content of about 6 per cent in 65, 50 and 15 days in pouches of 300 gauge HDPE film, saranex, and in polycell respectively under accelerated storage condition.

Under the storage conditions of 27°C and 65±2 per cent RH, it was observed that the moisture content of the product had increased from 2.58 to 2.9, 4.1, 4.4 and 7.5 per cent and the solubility had decreased from 95.3 to 94.4, 91.7, 88.9 and 83.4 per cent at the end of 90 days of storage in aluminium foil laminate, 300 gauge high density polyethylene film, saranex and polycell pouches respectively. As in the previous case during storage not much change was observed in moisture content and solubility of the sample packed in aluminium foil laminate pouch and in control sample in glass bottle. The loss of solubility in samples stored at 38°C was more than the samples stored at 27°C. It can also be seen from Table 3 that with an increase in moisture pick-up in 300 gauge HDPE, saranex and polycell, there is rapid decrease in the solubility of the product at 38°C and it is not much pronounced at 27°C. From the data obtained, it can be inferred that the loss in solubility of the product during storage is greatly influenced by both moisture and temperature. From the above storage studies it is evident that of the different flexible packaging materials used, aluminium foil laminate pouches would provide a shelf-life of more than 3 months under accelerated condition of storage. However, according to Paine's correlation[12] a shelf life of more than 6 months for this product in the above pouch could be expected under average conditions of storage. Thus the spray dried egg powder with an initial moisture content of 2.58 per cent and solubility of 95 per cent would be expected to have a shelf-life of more than six months in aluminium foil laminate pouches under normal atmospheric conditions in the country. Similarly the product packed in the consumer size pack of HDPE film of 300 gauge would be expected to have a shelf life of about three months. High density polyethylene pouch with its varied functional properties appears to be a suitable alternative for the aluminium foil laminate.

Acknowledgement

The authors wish to express their gratitude to Dr H. A. B. Parpia and Dr B. L. Amla of Central Food Technological Research Institute for their keen interest in the investigation.

References

1. Iyengar, J. R., Sripathy, N. V. and Suryanarayana Rao, S. V., *J. Fd Sci. Technol.*, 1969, **6**, 89, 123, 184.
2. Knowles, N. R., *Process Biochem.*, 1970, **5**, 13.
3. *Methods of Sampling and Test for Paper and Allied Products*, I.S.: 1060 (Part II)—1960, Indian Standards Institution, New Delhi.
4. Funk, W. A., *Mod. Packag.*, 1946-47, **20** (Part II), 135.
5. Hawthorne, J. R., *J. Soc. chem. Ind. Lond.*, 1943, **62**, 133, and 1944, **63**, 6.
6. Gane, R. J., *Soc. chem. Ind. Lond.*, 1943, **62**, 185.
7. Makowar, B., *Industr. Engng Chem.* (*Industr.*), 1945, **37**, 1018.
8. Bumazhnow, A. D., *U.S. Egg Poult. Mag.*, 1944, **59**, 198.
9. White, W. H. and Thistle, M. W., *Can. J. Res.*, 1943, **21D**, 194.
10. Brooks, J., *J. Soc. chem. Ind. Lond.*, 1943, **62**, 137.
11. Bate-Smith, E. C., Brooke, J. and Hawthorne, J. R., *J. Soc. chem. Ind. Lond.*, 1943, **62**, 97.
12. Paine, F. A., *Food*, 1955, **24**, 360.

Development and Application of Fungistatic Wrappers in Food Preservation. Part I. Wrappers Obtained by Impregnation Method

K. G. Ghosh, A. N. Srivatsava, N. Nirmala and T. R. Sharma

Defence Food Research Laboratory, Mysore

Manuscript Received: 18 October 1972

Sorbic acid treated crepe paper was found to be an effective fungistatic wrapper for bread. It was however necessary to heat the wrapped bread at 95-100°C for a period of ½ to 1 hr. Incorporation of an antioxidant like Embanox—6 in the treated wrapper and also use of an odour adsorbent like coconut charcoal inside the bread packs minimised off-flavour development. Sliced bread was found organoleptically acceptable upto 1 month and as sandwich, upto 3 months. Sorbic acid treated wrapper could not be used for the preservation of *chapati*, *parotta* and cheese because of the production of bitterness or browning.

The use of fungistatic wrappers for preservation of food against mould attack has been advocated for well over two decades[1-4]. The foods that are stated to have been preserved by such methods are mostly dairy products such as cheese, margarine, butter, etc. Literature survey however, does not reveal that this method has been adopted anywhere on a large scale. No precise information is available regarding the shelf-life of foods like bread and cheese preserved under ambient conditions. The work reported here was confined to the use of sorbic acid or its salt only, since it is now permitted in this country to the extent of 0.1 per cent and is also known to have been previously used in making fungistatic wrappers. It was the aim of this work not only to produce the most effective fungistatic wrappers for different types of foods but also to work out conditions under which such wrappers could be used most effectively and without having any adverse effect on the foods preserved.

There are two ways of using sorbic acid or its salts in a wrapping paper, viz., (*a*) by impregnating the paper with a solution of the active ingredient, or (*b*) by coating its surface with a composition which has this active ingredient in a finely dispersed state in a suitable binder medium, the role of the binder being to keep the former firmly anchored to the paper. Both these methods have been studied with respect to specific food items. The present communication forming the first part of the work, relates to studies carried out with wrappers impregnated with sorbic acid or its salts.

Materials and Methods

Wrapping papers: The following types of papers with characteristics as given in Table 1 were used.

(*a*) Grease proof paper; (*b*) tissue paper; (*c*) crepe paper.

Sorbic acid solution: Sorbic acid, (E. Merck of 99 per cent purity) was dissolved in industrial alcohol (95 per cent) to give alcoholic solution of the acid.

Method of treatment and estimation of sorbic acid content: The wrapping paper was dipped in the solution of sorbic acid for 15 to 20 sec and then taken out and passed through mangle where the uptake could be adjusted. A weight increase of 150 per cent was generally allowed in these experiments. After soaking, the paper was dried at 45 to 50°C in a cross flow air drier for 15 to 20 min. The sorbic acid content was estimated in the treated paper by the method of Schmidt[5].

Large scale treatment of paper with sorbic acid solution in a continuous operation was carried out as illustrated in Fig. 1. For convenient laboratory work a treatment vessel of 42.5 cm × 16 cm × 31 cm dimensions made of mild steel suitably painted externally and internally and fitted with ebonite mangles was used. The sorbic acid treated wrapper thus produced was stored in closed metal containers or in a sealed foil laminated pouch and periodically examined for colour and concentration of sorbic acid in it.

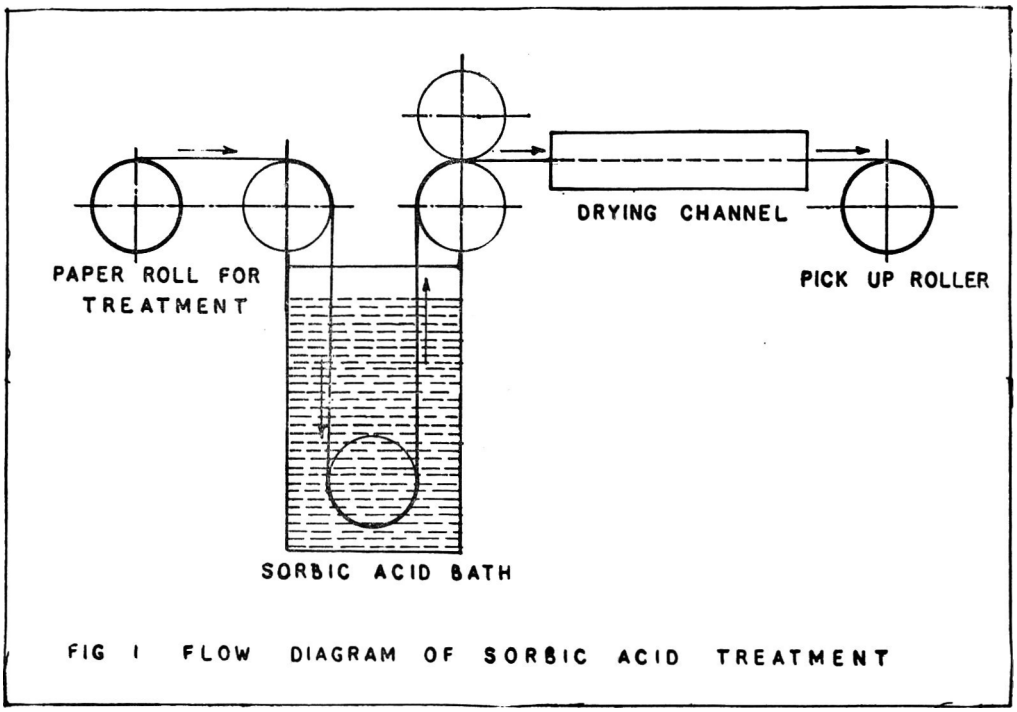


FIG 1 FLOW DIAGRAM OF SORBIC ACID TREATMENT

Breads used: Whole breads, each weighing 400 g and measuring 19 cm×8 cm×8.5 cm made either in closed mould or open top mould were used. Though mostly Modern Bakery breads with a pH of 5.5 and in both sliced and unsliced forms were used in these experiments, breads obtained from various local bakeries with pH varying from 4.2 to 5.0 and in unsliced form were also used.

Method of packaging: The breads were wrapped with sorbic acid treated wrapper using single layer wrapping as far as possible. The breads thus wrapped were repacked in Kraft paper/polythene (150 gauge) bags as tightly as practicable.

Post packaging, processing and storage: The packaged breads were heated at 90-98°C for ½ hr in case of unsliced breads and 1 hour in case of sliced breads. Heating for ½ hr with sorbic acid wrapper was generally followed in all other experiments described below unless otherwise stated. The heat processed breads were then allowed to cool down and were repacked in convenient numbers in waxed corrugated cartons.

Optimum concentration of sorbic acid: Crepe paper was treated with solutions of different concentrations (0.5 to 5 per cent) of sorbic acid and the resulting paper containing 0.6 to 2.0 g/sq m of sorbic acid was used as wrapper. From the performance of the stored bread using these wrappers the optimum concentration of sorbic acid in the wrapper which will prevent mould attack on bread for more than 1 month was determined.

Measures to counteract the effect of sorbic acid on bread flavour: To counteract the development of off-flavour in bread preserved with sorbic acid treated wrapper, 'Embanox—6' (antioxidant) was added (0.08/100 ml) in the sorbic acid solution for treating the wrapping paper. As a further measure to remove any disagreeable stale odour adsorbents such as coconut charcoal wrapped in grease proof paper was kept inside the waxed carton containing the preserved bread or inside the bread packs.

Cheese: Small blocks of processed cheese (4.5 cm ×2.75 cm×1.75 cm) each of 25 g were wrapped with crepe paper containing 2 g/sq m of sorbic acid along with antioxidant 'Embanox-6' and packed in kraft paper/polythene laminate pouches. The packaged cheese after heating to 80-90°C for half an hour was cooled and stored in waxed carton at 37°C.

Chapaties: *Chapaties* each 15-16 cm in diameter and about 40 g in weight made by the usual process and containing 35 per cent moisture, 5 per cent fat and 1 per cent salt were wrapped with crepe paper containing 2g/sq.m of sorbic acid antioxidant 'Embanox -6' and then packed in paper/foil/polythene laminate pouches. Each wrapping and package contained one *chapati*. The packaged *chapaties* were heat processed for storage studies as in case of unsliced breads.

Parottas: These were also packaged with sorbic acid wrapper and processed as in case of the *chapaties* and subjected to periodic examination on storage in the same manner. The *parottas* used were almost of same size and weight as the *chapaties* and had 22.24 per cent moisture; 20 per cent fat and 1.7 per cent salt.

Results and Discussion

Choice of a wrapping paper and method of treatment: A wrapping paper for non-sticky food such as bread should be light, reasonably strong and free from odour contaminants which could migrate into the food materials. Its suitability for treatment with sorbic acid or sorbate solution and subsequent use as a preservative wrapper, however, will be determined by its ability to pickup the active compound and hold the same within its structure when dry. Results presented in Table 1 indicate that of the three types of paper tried, crepe paper is the most suitable evidently because of its porous nature. For the medium of treatment, alcoholic solution was preferred since crepe paper does not lose its strength in alcoholic solution as it does in aqueous medium. Aqueous alcohol could also be used to the extent of about 50 per cent by volume of water in the mixture but the presence of water in the solution to any marked extent was found to result in the formation of big sized crystals of sorbic acid on drying, which was definitely a disadvantage since their physical retention in the paper became increasingly difficult. Table 1 also shows that the dosage of sorbic acid in the treated paper could be conveniently varied by varying its concentration in the treatment bath.

For varying the dosage of sorbic acid in the treated paper, the most convenient method was to vary the concentration of the sorbic acid solution in the treatment bath while keeping the weight increase of the soaked paper constant. Results (Table 1) show that by this method the dosage could be varied from as low as 0.6 to 3 g/sq m or more.

Preservation of bread with the fungistatic wrapper: It is well known that the normal commercial bread cannot keep against mould attack for more than 4-5 days under ambient conditions. It was found in the course of the experiment, that if the breads are packaged in flexible pouches and then heated to high temperature (100°C or more) they keep longer but an uncertain proportion of them get spoiled after 2 to 3 weeks. In one particular study for example, breads were enclosed in paper/.02 mm aluminium foil/polythene (150 gauge) laminate pouches with a small opening at the seam plugged with cotton and then heated to 120°C for 70 min followed by heat-sealing of the pouches below the cotton plug. The breads were subjected to normal handling and rail/road transport. After about a month spoilage by mould attack was observed in about 20 per cent of the breads. The mechanism of this spoilage was not established but some of the bread pouches did show pinholes at corners. Similarly the control samples (not wrapped with sorbic acid treated crepe paper) (Table 2) also showed heavy spoilage. The inpackage heating method was tried in view of the success claimed where Nylon 11 is used as the packaging material and infrared heating is resorted to[6]. It was observed that if the breads are first wrapped with sorbic acid treated wrapper and then heat processed suitably in sealed bags they keep mould free for over 6 months. If the packaged breads with sorbic acid wrapper are stored as such without the heat processing then also mould attack takes place (Table 2). This could be explained by the fact that an intimate contact between the wrapper and all parts of the bread surface is not possible and

TABLE 1. CHARACTERISTICS OF WRAPPING PAPERS USED

Type of paper	Substance g/sq.m*	Breaking strength kg/cm*	Odour contamination test†	Sorbic acid pickup (g/sq.m.) from alcoholic solutions of below noted concentration				Nature of the deposit of sorbic acid in paper
				1%	2%	3%	5%	
Crepe paper, white	34.2	0.2	—ve	0.62	1.10	2.10	3.1	Deposits are somewhat firmly held within the structure of the paper
Tissue paper, white	17.8	0.2	,,	0.10	Not determined as the crystals fall off easily			The crystalline deposits are loosely held on the surface
Grease proof paper, white	40.7	1.6	,,	0.18	,,			,,

* These tests were done as per IS: 1060 (P-I)—1966 † This was done as per BS 3755—1964

so heating which causes the sorbic acid to volatilise and spread all over the bread surface is necessary. But heating as a method of reducing the microbiological count of the bread as a whole to a safe level appears also necessary, since, the same heat processing is not found to be applicable to breads of different sizes (thickness) and to sliced breads also even though they are wrapped by the same sorbic acid wrapper. Table 2 for example gives the heat processing condition for sliced and unsliced breads of the same size. The role of the fungistatic paper inside a sealed pouch containing the bread appears to be to prevent external contamination through chance pinholes or damages in the pouch after the bread has been brought to a safe microbiological status by heat treatment. Table 3 gives microbiological data on breads from

TABLE 2. EFFECT OF PROCESSING CONDITION ON KEEPING QUALITY OF BREADS

Description of breads used	Type of wrapper used	Post packaging treatment	Spoilage period	Organoleptic quality of stored bread
Modern Bakery bread, 400 g unsliced	No wrapper	Heated at 95°-100°C for ½ hr	Spoiled within 10 days	...
,,	Crepe paper containing sorbic acid upto 1 g/sqm	,,	Spoiled within 6 weeks	...
,,	Crepe paper containing 2g/sqm of sorbic acid	,,	No spoilage upto 6 months	After 2 weeks intense rancid and off odour develops; wrapping paper discoloured*
,,	Crepe paper containing 2 g/sqm of sorbic acid and oxidant 'Embanox-6'	,,	,,	No marked off flavour; breads acceptable within 4 weeks; upto 8 weeks acceptable with butter, jam, etc. or after toasting. No discolouration of the wrapping paper†.
Modern Bakery breads, 400 g sliced	,,	,,	About 20% spoilage after 3 weeks	...
,,	,,	Heated at 95°-100°C for 1 hr	No spoilage upto 6 months	Bread was acceptable upto 4 weeks and thereafter with butter and jam or after toasting upto 12 weeks‡

Remarks:

* If after wrapping with the sorbic acid paper without subjecting to heat processing then spoilage by mould takes place within 3 weeks.

† Some disagreeable smell is developed after 4 weeks. This is mostly volatile and disappears after exposure for a few minutes. No failure was observed in a batch of 200 nos. of bread loaves when this method of processing was followed. The method was found applicable also to other bakery breads of same size.

‡ To minimise the instant off-flavour experienced on opening the pack an odour adsorbent such as coconut charcoal was used either inside the paper/poly pouch containing the bread or the waxed carton.

TABLE 3. MICROBIOLOGICAL DATA ON VARIOUS BREADS INITIALLY AND AFTER PACKAGING AND HEAT TREATMENT

Bread type	Initial			After packaging and heat treatment			After 2 months storage		
	Total count (No/g) at		Yeast and mould at	Total count (No/g) at		Yeast and mould at	Total count (No/g) at		Yeast and mould at
	37°C	55°C	32°C	37°C	55°C	32°C	37°C	55°C	32°C
A	100	0-100	3200	100-150	Nil	Nil to 10	Nil	Nil	Nil
B	400	300-400	10-20	200-300	100	Nil	120	20	Nil
C	100	Nil	10-20	Nil	Nil	Nil	50	Nil	Nil
D	100-200	0-100	50-100	Nil	Nil	Nil	...	...	...

Note: Breads A, B, C and D are from 4 different bakeries and they are all unsliced 400 g and of normal size.

different bakeries as determined (*a*) initially on receiving, (*b*) after packaging and heat processing (½ hr at 95°C), and (*c*) after subsequent storage for 2 months under ambient temperature (22-29°C). Heat penetration studies with thermocouple probes showed that the centre of the bread reached a temperature of 65-68°C after half an hour's heating at 95°C when the 400 g unsliced bread was used.

Beside heat processing, another factor which determines whether the breads will keep mould-free or not is the sorbic acid content of the wrapper. Table 2 shows that concentration of about 2 g sorbic acid per square meter of the crepe paper is necessary for keeping the breads mould-free for a longer period. A study was made to ascertain the fate of the sorbic acid after processing. The following figures indicate that approximately 50 per cent of the total sorbic acid of the wrapper is lost during processing (95°C; ½ hour) by decomposition and/or volatilisation and escapes through packaging material:

Amount of sorbic acid present in the wrapper before heat processing (mg)	621
Amount estimated to be present in the wrapper after heat processing (mg)	66
Amount found in the paper/poly pouch (mg)	31
Amount found in the outer layer (about ½ cm thick scrapped off from the bread) (mg)	176
Amount in the layer (½ cm thick) next to the outer layer (mg)	56

It will appear that the amount of sorbic acid left in the wrapper after heat processing is just 0.33 g/sq m and the amount present in bread calculated on its total weight is only 0.06 per cent.

While the use of sorbic acid in the bread wrapper prevents mould growth it has adverse effect on its organoleptic quality as is seen from results in Table 2. The offensive smell given out by the stored bread is similar to the rancid odour of fatty oils. It had been observed earlier that sorbic acid accelerates the oxidative changes in edible oils considerably[7]. To counteract this effect therefore, an antioxidant 'Embanox-6' was used in the wrapper. This had a very marked effect (Table 2) on reducing the off-flavour produced in the stored bread processed with sorbic wrapper. No discolouration was also found to have developed in the wrapper. However, changes such as staling sets in even after 3 days and onwards as could be seen in Table 4. Besides, some off-flavour also develops after 1 month which continues growing in intensity with storage period.

It has been found by user trials that organoleptically the sliced breads are acceptable as such upto one month only and thereafter as sandwiches with jam, butter, etc., or after toasting upto 3 months. The off-odour developed inside the packs is volatile and mostly disappears on keeping the bread exposed for some time or by keeping an adsorbant like coconut shell charcoal wrapped in paper either inside the paper/polythene bags containing the wrapped breads or in the carton containing them. If the bread packs are stored in waxed cartons it is found that moisture loss is only 2 per cent after 6 weeks and 4 per cent after 12 weeks under ambient conditions of Mysore.

TABLE 4. DEVELOPMENT OF STALING IN STORED BREAD

Period of storage days	Crumbliness[9] %	Springiness[10]
Initial	14	1.0
1	18	0.8
3	19	0.7
75	29	0.3

Preservation of other processed food materials with the fungistatic wrapper: The use of sorbic acid wrapper was tried on other food materials such as cheese, *chapaties* and *parottas*, up to 10 weeks of observation no mould growth was observed in any of them but the sorbic acid was found to affect the foods adversely. Cheese showed surface browning while *chapaties* and *parottas* developed somewhat bitter taste. A bitter taste was only slightly perceptible in bread after 2 months.

Production of fungistatic paper in large quantity: The production of sorbic acid treated paper on a large scale presents little difficulty when alcoholic medium of treatment is used. The drying of the soaked paper has to be carried out at a comparatively low temperature of 50°C because of the volatility of sorbic acid at higher temperatures. Also since sorbic acid is liable to oxidation[8] it should better be kept in closed container. It was observed by periodic estimations that upto 2 months there is no significant change in the sorbic acid content of the wrapper when kept in closed containers.

The above studies have indicated that for long keeping bread meant for use as such, beyond one month, it is necessary to develop the suitable recipe and that preservation method alone cannot keep them in acceptable form. The latter work is being pursued in this laboratory.

Acknowledgement

Thanks are due to Dr H. Nath, Director, Shri B. S. Bhatia and Shri G. K. Rao for their interest in the

work and to Shri K. C. Eapen and Dr (Mrs) R. Shankaran for their help in the microbiological studies.

References

1. Smith, D. P. and Rollin, N. J., *Fd Res.*, 1954, **19**, 59.
2. Chintesin, G., Rosu, D. and Lefter, D., *Industr. Aliment Bue.*, 1965, **16**, 251.
3. Fotonhi, D. and Buttiau, R., *Revue Francaise des Corp. Gras*, 1971, **18** (2), 63.
4. *Sorbic Acid Aimed Food Preservation*, Information pamphlet No. 2, Farbwerke Hoechst A.G.
5. Schmidt, H., *Z. Anal. Chem.*, 1960, **178**, 173 (Chemical Abstract, 1962, **56**, 13302).
6. Anon, *Food Engng*, 1969, **41**, 161.
7. Ghosh, K. G., Srivatsava, A. N. and Nirmala, N., Unpublished, Defence Food Research Laboratory, Mysore, India.
8. Melnick, D., Luckmann, F. H. and Gooding, C. M., *Fd Res.*, 1954, **19**, 33.
9. Swanson, E. C., *Cereal Laboratory Methods*, American Association of Cereal Chemists Inc., Minnesota, 1957, 353.
10. Brennan, J. G., Jowitt, R. and Mughsi, O. A., *J. Texture Stud.*, 1970, **1**, 167.

Comparative Assessment of Quality of *Khoa* and Their Products from Homogenised and Unhomogenised Milk*

C. A. MULAY AND B. G. LADKANI
National Dairy Research Institute, Karnal, India

Manuscript Received: 7 November 1972

***Khoa* made from homogenised milk, both cow and buffalo, was softer and light brown in colour as compared to those prepared from unhomogenised milk. Homogenised cow and buffalo milk *khoa* could not be patted together unlike the unhomogenised milk *khoa*. Fat leakage was higher in unhomogenised cow and buffalo milk as compared to corresponding lots of unhomogenised milk *khoa*. *Peras* prepared from homogenised cow and buffalo milk were distinctly softer but more sticky than those prepared from corresponding lots of unhomogenised milk *khoa*.**

Homogenisation is an asset to the dairy industry so far as the improvements are concerned in the quality of milk and milk products and no wonder, now the homogenisers find their right place in the modern dairies of the leading countries[1]. Amongst the Indian milk products, *Khoa* is commonly used in preparation of sweets like *Peras* and *Gulabjamuns*. *Khoa* is commonly made by concentrating milk approximately to 5:1 ratio in *Karahi* or in jacketed vats heated with steam[2]. Such a product is conducive to excess of fat leakage which is associated with lower keeping quality and defective body. Peters *et al.*,[3] observed lower fat leakage in cheese prepared from homogenised milk as compared to one from unhomogenised milk. They also reported improvements in body and texture of cheese made from homogenised milk. We therefore, thought of studying the effect of homogenisation of milk on the quality of *Khoa* and *Gulabjamuns* and *Peras* made therefrom.

Materials and Methods

Raw materials: Cow and buffalo milk produced at the National Dairy Research Institute, Karnal farm was used for *Khoa* making.

Khoa was prepared from milk by the method recommended by De and Ray[2] using 5 litres of milk at a time in a steam jacketed vessel. The bulk cow and buffalo milk was used as such, separately for *Khoa* making. In other lots, the same cow and buffalo milk was homogenised at 60°C at 200 kg/sq cm pressure with Rannie homogeniser prior to preparation of *Khoa*.

Gulabjamuns and *Peras* were prepared by the method commonly adopted by the *Halwais*.

Cow milk and buffalo milk: Fat and total solids (T.S) were determined with Gerber and density hydrometers respectively as per ISI methods[4].

Khoa: Fat and total solids were determined by Majonnier gravimetric method[5].

Fat leakage: The method recommended by Peters *et al*[3]., for cheese was adopted with little modification as given below. In this, *Khoa* was weighed in 5 g quantities and transferred to cream butyrometers. Sufficient quantity of distilled water at room temperature containing formaldehyde (500:1) was added to

* NDRI Publication No. 72-97.

TABLE 1. QUALITY OF KHOA FROM HOMOGENISED AND UNHOMOGENISED COW AND BUFFALO MILK (SIX TRIALS)

	Cow milk *khoa*		Buffalo milk *khoa*	
	Unhomogenised milk	Homogenised milk	Unhomogenised milk	Homogenised milk
1. Colour	Brownish yellow†	Brownish yellow	Slightly brownish white †	Slightly brownish white *
2. Body and texture	Appearance of oiling off fat *	Soft without appearance of free fat	Appearance of oiling off fat †	Soft without appearance of free fat
3. Patting quality	Good	Unsatisfactory with breaking of granules	Good	Unsatisfactory with breaking of granules

* Denotes slight intensity † Denotes increasing intensity

fill up the lower bulbs of the cream butyrometers. Two drops of annatto colour (fat soluble) were also added to the contents and shaken. The butyrometers were then incubated at 37°C for 24 hr. This was followed by addition of warm water at 37°C to raise the fat column in the stems of the butyrometers. Butyrometers were then centrifuged in Gerber centrifuge for 5 min and held in water bath at 60°C for 5 min before noting the readings.

Judging of *Khoa*, *Gulabjamuns* and *Peras* was done by a Panel of six members drawn from different technical cadres of the Dairy Technology staff of National Dairy Research Institute. Judging was confined to colour, body and texture observations and patting qualities of *khoa;* body and texture and sugar retention in *Gulabjamuns* and body and texture of *Peras*.

Results and Discussion

It can be seen from Table 1 that the brownish colour intensity was less in homogenised milk *khoa* than in case of unhomogenised milk *khoa* both from cow and buffalo milk and that the cow milk *khoa* had more brownish yellow intensity than buffalo milk *khoa*. Homogenised buffalo milk *khoa* was softer than the one made from cow milk. Homogenised cow and buffalo milk *khoa* was softer than the lots prepared from unhomogenised cow and buffalo milk. Homogenised cow and buffalo milk *khoa* had practically no oiling off of fat and had very poor patting qualities than the corresponding lots prepared from unhomogenised cow and buffalo milk.

Quality of Gulabjamuns *and* Peras: *Gulabjamuns* prepared from homogenised cow and buffalo milk *khoa* were distinctly harder and the sugar syrup retention was poorer as compared to those prepared from unhomogenised cow and buffalo milk *khoa*. The judges showed their preference to *Gulabjamans* made from unhomogenised milk *khoa* because of their characteristic spongy softness with better sugar syrup retention (no comparative study was carried out on the quality of *Gulabjamuns* from cow and buffalo milk).

TABLE 2. OBSERVATIONS ON FAT LEAKAGE IN KHOA MADE FROM HOMOGENISED AND UNHOMOGENISED COW AND BUFFALO MILK (4 BATCHES)

Trial No.	Cow milk *khoa*		Buffalo milk *khoa*	
	Unhomogenised (fat leakage %)	Homogenised (fat leakage %)	Unhomogenised (fat leakage %)	Homogenised (fat leakage %)
1	18	2	32	2
2	20	4	23	5
3	17	2	24	2
4	22	4	27	6

Most of the judges showed their preference to *peras* prepared from homogenised cow and buffalo milk. No comparative study was made between cow and buffalo milk *peras*.

Fat leakage: Khoa made from homogenised cow and buffalo milk showed lower fat leakage from the corresponding one made from unhomogenised milk (Table 2). This is in agreement with the work of Peters *et al.*,[3] on cheese.

Acknowledgement

The authors wish to thank Shri M. R. Srinivasan, National Dairy Research Institute, Karnal, for his help and guidance.

References

1. Trout, G. M., *Homogenised Milk—A Review and Guide*, Michigan State College Press, East Lansing, 1950.
2. De S., and Ray, S. C., *Indian J. Dairy Sci.*, 1952, **5**, 147; 1953, **6**, 47.
3. Peters, I. I., Mulay, C. A. and Dalton, G. L., *Milk Producer J.*, 1958, **49**, 13.
4. *Determination of Fat in Whole Milk, Evaporated (Unsweetened Milk, Separated Milk, Skim Milk, Butter Milk, and Cream by the Gerber Method*, ISI, New Delhi, 1958.
5. *Laboratory Manual, Methods of Analysis of Milk and its Products*, Milk Industry Foundation 1145. Washington, D.C. 1964, 264, 276.

Studies on the Keeping Quality of Whole Egg Powder in Light-weight Flexible Packaging

M. P. Srivastava, N. Nirmala and B. S. Bhatia
Defence Food Research Laboratory, Mysore

Manuscript Received : 29 December 1972

Foam-mat dried egg powder compressed into block and wrapped in cellophane before finally packing and sealing in paper foil poly laminate has been found to remain acceptable for one year when stored at 37°C. Accelerated freeze dried egg powder in the same type of packing keeps well for one year at ambient room temperature (20-30°C) and eight months at 37°C. Spray dried egg powder in the same packing remains acceptable for four months when stored at 37°C.

Hen egg is an important culinary article of diet for the Defence Forces in India. There is considerable loss of eggs mainly due to breakage during transport, specially during transportation to troops operating in extreme conditions of forward areas of high altitude and difficult mountain terrain. An adequate solution to obviate this loss is to supply the egg contents in dried form as a powder.

The egg powder is usually supplied in tin cans packed under an inert gas like nitrogen. Changes during storage in tin cans under nitrogen have been studied by many workers,[1-14] but no information is available on the changes with regard to the acceptability of egg powder stored in indigenously available flexible packaging materials which are considerably lighter than the tin container and, therefore, more convenient for use.

Due to shortage of tin in the country and the logistic requirements, the present work was undertaken to develop a light-weight flexible packaging for egg powder with a minimum shelf-life of one year.

Materials and Methods

Egg powder prepared by foam-mat drying, accelerated freeze drying and spray drying was packed in the following containers :

1. MST cellophane 300 grade conforming to IS: 5012-1968[15].
2. 60 g Brown casing (BC) paper/0.04 mm aluminium foil/polyethylene 150 gauge, adhesive (sodium silicate).
3. 60 g Brown casing (BC) paper/0.02 mm aluminium foil/polyethylene 150 gauge, adhesive (sodium silicate).
4. 202×307 plain sanitary cans having 1 lb tin per base box of 217.78 sq ft of sheet.

Packaging of foam-mat dried egg powder: The following packs for storage study were made from foam-mat dried egg powder prepared after desugaring by glucose oxidase.

1. Egg powder was placed inside MST cellophane 300 grade pouch with an opening in one corner. This was placed inside 60 g BC paper/0.04 mm Al. foil/polyethylene 150 gauge pouch which was sealed after flushing with nitrogen. This foil laminate was used for this purpose as it has been found to be gas proof by Ghosh *et al.*[16]

2. Egg powder blocks or tablets were made by compressing the egg powder at ambient temperature into blocks of 4 cm×4 cm size. Various combinations of pressure/dwell were tried using a 12 ton Carver laboratory press and an iron mould to find out the lowest pressure dwell combination to produce a satisfactory cohesive block. The blocks were finally made at a pressure of 400 psi/10 sec using 30 g of egg powder. Each tablet, immediately after removing from the mould, was heat sealed first in an inner wrap of MST cellophane 300 grade and then in an outer pouch of 60 g BC paper/0.02 mm Al. foil/polyethylene 150 gauge laminate.

3. Oil hydro equal to 5 per cent by weight of egg powder was mixed with it and placed inside MST cellophane 300 grade pouch which was then placed inside another pouch of 60 g BC paper/0.02 mm Al. foil/polyethylene 150 gauge and then heat-sealed.

4. Thirty grams of egg powder was packed in 202×307 plain sanitary cans under nitrogen gas. The cans were kept inside a vacuum desiccator, 28″ vacuum was created, held for 2 min and then nitrogen was flushed to a positive pressure of 1 lb/sq. in. This procedure was repeated once again. The head space was one centimeter.

Packaging of accelerated freeze dried egg powder: Four types of packs similar to those used for foam-mat dried egg powder were also used for accelerated freeze dried egg powder prepared without desugaring.

Packaging of spray dried egg powder: In the case of spray dried egg powder prepared after desugaring by yeast, it was not possible to make a block or tablet by compression at a pressure of 400 psi/10 sec but satisfactory blocks were prepared at minimum pressure of 1500 psi/10 sec.

Three types of packs were made e.g. (*i*) egg powder tablet, (*ii*) egg powder mixed with 5 per cent oil hydro, and (*iii*) egg powder in can under nitrogen.

The different types of packs made from the three types of egg powder were stored at 37°C, at ambient room temperature (20-30°C), and at 0-4°C. Samples were drawn and examined for moisture, pH, solubility and palatability. The egg powder packed in can under nitrogen was used as control.

Moisture, pH and solubility, were estimated as per ISI specification[15]. Haenni's[10] method for estimation of solubility of egg powder was adhered to. For palatability evaluation the method developed by Wilson and Slosberg[17] was adopted with a panel of five experienced tasters who normally consume eggs. The rating was from 1 to 10 and the score sheet is as follows:

Score	Quality
10	Excellent
9	Very good
8	Good
7	Slight storage flavour
6	Storage flavour
5	Slight off flavour
4	Definite off flavour
3	Old and unpleasant flavour
2	Very old and unpleasant flavour
1	In-edible.

Results and Discussion

Spray dried egg powder could be compressed into blocks at the minimum pressure of 1500 psi/10 sec whereas the accelerated freeze dried egg powder could be compressed into a block at the pressure of 400 psi/10 sec only. This may be due to the difference in the structure of the two powders. Folger and Kleinschmidt[18] described the spray dried whole egg powder particles to be hollow spheres, whereas Reeve[19] observed minute fat globules dispersed throughout the films. Shaw *et al.*,[20] estimated the specific surface areas of several spray dried and freeze dried powders, and found them when expressed as sq.m/g powder, to range from 0.11-0.41 and 0.48-0.83 respectively. Powders produced by drying from the frozen state appeared sponge-like under the microscope. Presumably the texture of foam-mat dried egg powder is also sponge-like as it could also be compressed into a block at 400 psi/10 sec like the freeze dried egg powder. The thickness of the compressed block obtained from the spray dried egg powder was about 1 to 2 mm more than that obtained from foam-mat dried or accelerated freeze dried egg powder.

The pH of the foam-mat dried egg powder when stored at 0-4°C for nine months showed a difference of 0.5 units (7.0 to 7.5). When stored at ambient room temperature for the same period, the difference was of the order of 0.6 units whereas when stored at 37°C for four months the difference was found to be of the order of 0.3 units. In case of spray-dried egg powder the initial pH was 7.2 and after nine months storage at room temperature the difference was of the order of 0.1 unit. No suitable relation could be established between pH changes and solubility or palatability. Thistle *et al.*,[21] found only slight correlation between pH and solubility, and poor correlation between pH and palatability.

The initial moisture content in the foam-mat dried egg powder was 1.3 per cent but during storage the moisture varied from 2.1 to 2.9 per cent. In spray dried egg powder the initial moisture content was 2.1 per cent but in the packed material during storage period it varied from 2.3 to 2.9 per cent. This might be due to the absorption of moisture from the atmosphere during preparation of the different packs. In the accelerated freeze dried egg powder the initial moisture content was found to be 0.7 per cent only.

The solubility of foam-mat dried egg powder samples on storage, when estimated by ISI[15] method decreased in all cases upto six months but after nine months storage it was found to have increased in all cases. This was contrary to the findings of earlier workers[10, 12, 22]. However, on estimation by Haenni's method, the solubility figures obtained on the same samples were higher and hence it was adopted[23].

The loss in solubility is more in samples stored at 37°C than at lower temperatures (Table 1). At 0-4°C the loss in solubility is much less. The loss in solubility is more in case of AFD egg powder than in the case of foam-mat dried egg powder. This may be due to the fact that AFD egg powder was not desugared. The samples stored under nitrogen show less loss in solubility.

Results of palatability score on the three types of egg powder are shown in Fig. 1, 2 and 3. Throughout the storage period of one year, the foam-mat dried egg

TABLE 1. SOLUBILITY (PER CENT) OF EGG POWDER BY HAENNI'S METHOD ON STORAGE

Type of egg powder and packaging	Solubility at indicated periods of storage and temperature (months and °C)									
	0	8		9		10		12		
	20–30°C	37°C	20–30°C	37°C	0–4°C	37°C	20–30°C	37°C	20–30°C	0–4°C
Accelerated freeze dried	97	...	...	...	...	...	...	...	...	...
(*a*) Tablet in flexible pack	...	68.5	75.9	...	...	68.5	75.9	63.4	73.1	...
(*b*) 5% oil hydro in flexible pack	...	...	...	...	...	55.5	73.1	53.3	70.1	...
(*c*) Can under N_2	...	...	...	...	...	...	...	...	...	92
(*d*) Flexible pack under N_2	...	...	...	...	...	...	81.0	...	78.5	...
Foam-mat dried	92	...	...	...	...	...	...	...	...	...
(*a*) Tablet in flexible pack	...	...	...	75.9	...	...	...	73.1	...	...
(*b*) 5% oil hydro in flexible pack	...	...	...	75.9	90.7	...	...	73.1	...	88.7
(*c*) Can under N_2	...	...	...	78.6	...	...	...	73.1	...	...
Spray dried	94	...	...	...	...	...	...	...	...	...
(*a*) Tablet in flexible pack	...	...	...	88.7	...	...	...	...	...	...
(*b*) 5% oil hydro in flexible pack	...	...	...	84.5	...	...	...	...	...	...
(*c*) Can under N_2	...	...	...	...	92.0	...	...	...	...	...

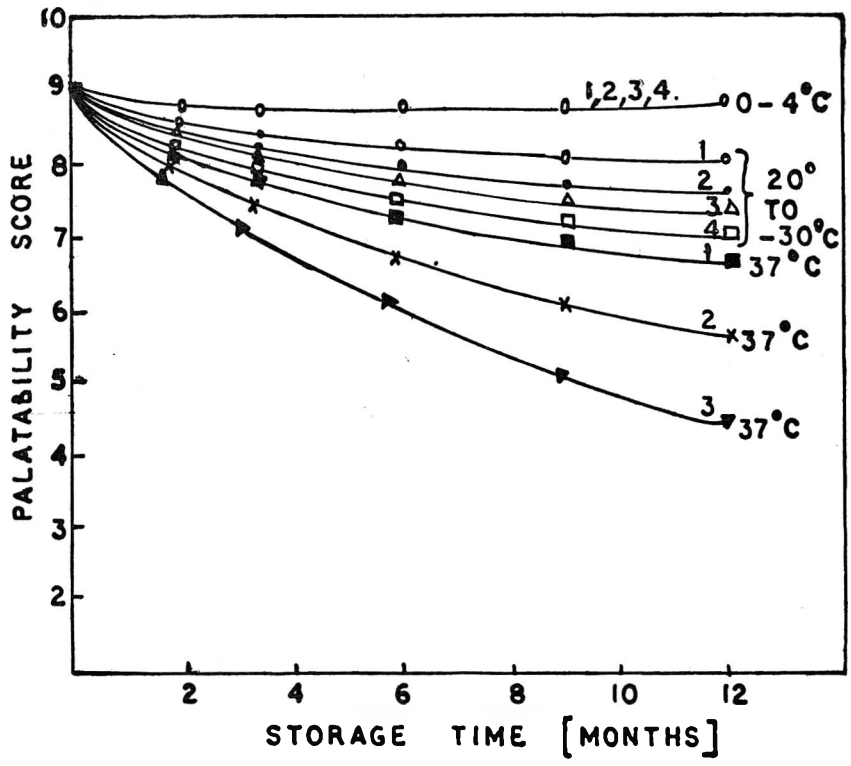


Fig. 1. Relation of storage temperature to palatability during storage of foam-mat dried egg powder.

(1) Foam-mat dried egg powder tablet in paper foil (0.02 mm) poly laminate. (2) Foam-mat dried egg powder with 5 per cent oil hydro in paper foil (0.04 mm) poly laminate. (3) Foam-mat dried egg powder in tin can under nitrogen. (4) Foam-mat dried egg powder in paper foil (0.04 mm) poly laminate under nitrogen.

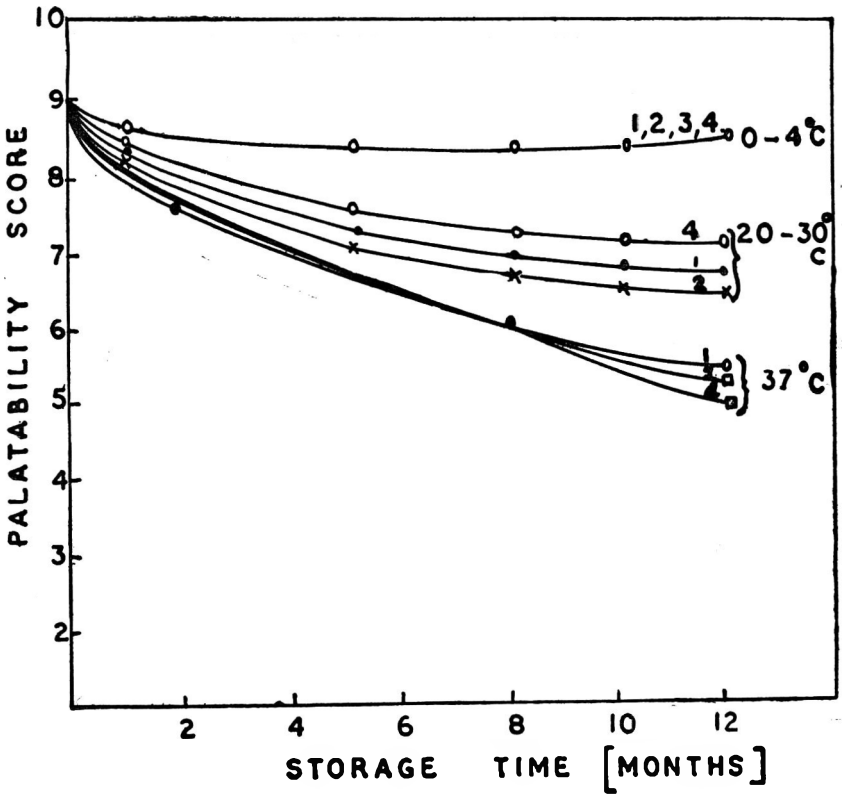


Fig. 2. Relation of storage temperature to palatability during storage of accelerated freeze dried egg powder.

(1) AFD egg powder tablet in paper foil (0.02 mm) poly laminate. (2) AFD egg powder with 5 per cent oil hydro in paper foil (0.02 mm) poly laminate. (3) AFD egg powder in tin can under nitrogen. (4) AFD egg powder in paper foil (0.04 mm) poly laminate under nitrogen.

powder compressed into a block and stored at 37°C, was found acceptable as regards flavour, texture and colour. It was superior to the other two types of egg powders which developed off-flavours within one year of storage at 37°C. The compressed block of AFD egg powder was, however, acceptable after one year of storage at room temperature and after eight months of storage at 37°C whereas the spray dried egg powder compressed in the form of block was acceptable upto four months storage at 37°C. When tasted after nine months storage it was disliked by all the judges on account of off-flavour.

Foam-mat dried egg powder, with 5 per cent oil hydro as stabilizer, when stored at 37°C was acceptable after nine months storage but developed slight off-flavour after storage of one year at 37°C and was not acceptable. Foam-mat dried egg powder packed in can under nitrogen developed some metallic taste and very slight off-flavour after six months storage at 37°C and was not acceptable. However, it was acceptable upto one year when stored at ambient room temperature.

AFD egg powder with 5 per cent oil hydro as stabilizer when stored at 37°C was acceptable upto eight months but developed off-flavour and considerable brown colour after 12 months storage and was not acceptable. This browning may be attributed to the fact that desugaring was not done during its preparation. Hawthorne and Brooks[24] found that removal of the sugar resulted in storage improvement and lowered rate of browning. However, it was acceptable after 12 months storage at ambient room temperature. Spray dried egg powder with 5 per cent oil hydro was found to have developed off-flavour when examined after nine months storage at 37°C and was not acceptable. It was, however, acceptable upto four months. AFD

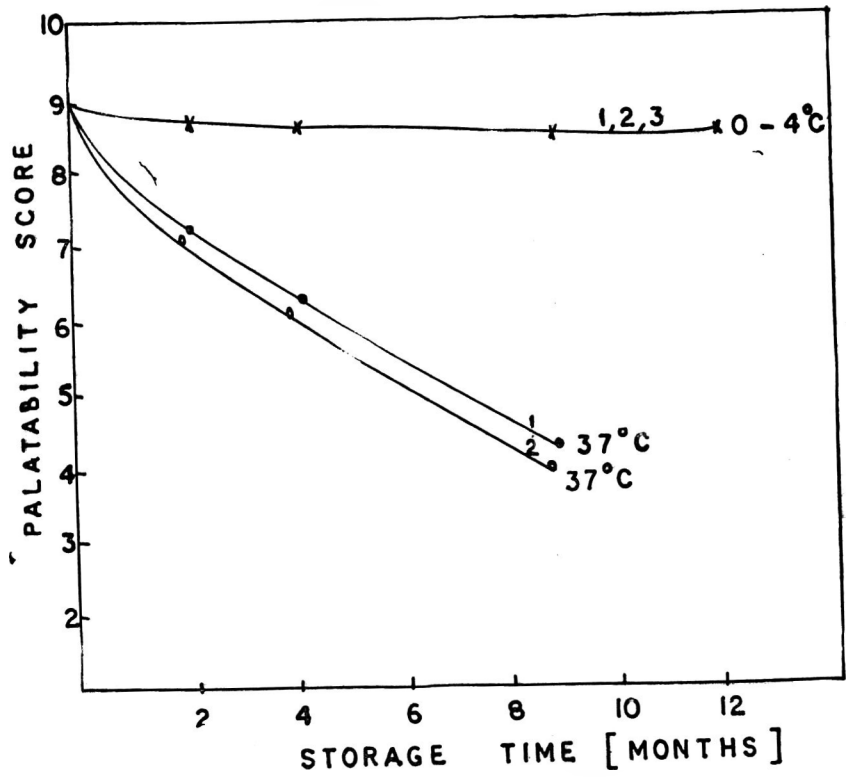


Fig. 3. Relation of storage temperature to palatability during storage of spray dried egg powder.

(1) Spray dried egg powder tablet in paper foil (0.02 mm) poly laminate. (2) Spray dried egg powder with 5 per cent oil hydro in paper foil (0.02 mm) poly laminate. (3) Spray dried egg powder in tin can under nitrogen.

egg powder packed under nitrogen in flexible packaging and stored at 37°C was acceptable upto eight months but developed off-flavour after 12 months storage and was not acceptable. When stored at ambient room temperature it was acceptable for one year. Foam-mat dried egg powder packed under nitrogen in flexible packaging and stored at room temperature was also acceptable after 12 months storage.

All the three types of egg powders when stored at 0-4°C were acceptable after 12 months storage irrespective of any of the above types of packaging used.

Economy in space during storage and transport is of paramount importance for providing rations to troops. Compressing the egg powder into blocks results in considerable saving of space. According to Morris[25] there was saving in weight and bulk of eggs by dehydration and compressing into blocks.

Compression into blocks also eliminated the necessity of packing under nitrogen which is essential while packing the egg powder in cans. The air and consequently oxygen in between the particles of the egg powder gets excluded on compression. Immediate wrapping in cellophane 300 grade after taking out from the mould and then heat sealing it in paper foil poly laminate further prevents the egg powder from coming in contact with atmospheric air or oxygen which is one of the deteriorating factor during storage.

Since the egg powder is largely consumed in the military as scrambled egg specially during emergency, the flavour was considered as a major quality criterion during the study. Bate-Smith[26] held the view that only true criterion was the appreciation by the consumer, because, after all, the purpose of the producer and marketer was to satisfy the requirements of the consumer. According to him mere recital of physical

quantities was meaningless except in relation to a population of consumers and a body of appreciation.

The study has revealed that glucose oxidase desugared foam-mat dried egg powder compressed in the form of block or tablets at 400 psi/10 sec and packed in flexible packaging, remains acceptable after one year of storage at 37°C. Accelerated freeze-dried egg powder prepared without desugaring under the same conditions is acceptable upto eight months only but when stored at ambient room temperature, it remains acceptable for one year. The spray dried egg powder desugared by yeast can be compressed into a block at 1500 psi/10 sec and when packed in flexible packaging, remains acceptable when stored at 37°C for four months only. When stored at 0-4°C, all the three types of egg powders remain acceptable for one year. Thus it has been confirmed that a low storage temperature is necessary besides low moisture if the egg powder is to retain its initial properties for long periods, since deterioration increases rapidly with rise in temperature and this type of deterioration cannot be prevented by gas packing. Access of air leads to deterioration in flavour[27].

Acknowledgement

The authors express their grateful thanks to Dr H. Nath, Director of the Laboratory for his keen interest in this work and to Sri N. L. Jain of A.F.D. Unit, Delhi for supplying the accelerated freeze dried egg powder.

References

1. Pearce, J. A. and Thistle, M. W., *Can. J. Res.*, 1942, D 20, 276.
2. Brooks, J., *J. Soc. chem. Ind., Lond.*, 1943, **62**, 137.
3. Gibbons, N. E. and Fulton, C. O., *Can. J. Res.*, 1943, D21, 332.
4. Thistle, M. W., White, W. H., Reid, M. and Woodcock, A. H., *Can. J. Res.*, 1944, F **22**, 80.
5. Boggs, M. M. and Fevold, H. L., *Industr. Engng Chem.*, 1946, **38**, 1075.
6. Dawson, E. H., Shank, D. E., Lyun, J. M. and Wood, E. A., *U.S. Egg Poult. Mag.*, 1945, **51**, 154.
7. White, W. H. and Thistle, M. W., *Can. J. Res.*, 1943, **D 21**, 211.
8. Stuart, L. S., Grewe, E. and Dicks, E. E., *U.S. Egg Poult. Mag.*, 1942, **48**, 498.
9. Stewart, G. F., Best, L. R. and Lowe, B., *Proc. Inst. Fd Technol.*, U.S.A., 1943, 77.
10. Hawthorne, J. R., *J. Soc. chem. Ind., Lond.*, 1943, **62**, 135.
11. White, W. H., Thistle, M. W. and Reid, M., *Can. J. Res.*, 1943, **D 21**, 271.
12. Iyengar, J. R., Sripathy, N. V. and Suryanarayana Rao, R., *J. Fd Sci. Technol.*, 1969, **6**, 123; 1969, **6**, 184.
13. Stuart, L. S., Hall, H. H. and Dicks, E. E., *U.S. Egg Poult. Mag.*, 1942, **48**, 629, 658.
14. Bate-Smith, E. C., Brooks, J. and Hawthorne, J. E., *J. Soc. chem. Ind., Lond.*, 1943, **62**, 97.
15. *Specification for Egg Powder*, IS:4723, Indian Standards Institution, New Delhi, 1968.
16. Ghosh, K. G., Sripatiachar, K., Srivastava, A. N., Ramanujam, S., Kameshwara Rao, G. and Vijayaraghavan, P. K., *J. Fd Sci. Technol.*, 1968, **5**, 12.
17. Wilson, R. V. and Slosberg, H. H., *U.S. Egg Poult. Mag.*, 1943, **49**, 21.
18. Folger, B. B. and Kleinschmidt, R. V., *Ind. Engng Chem.*, 1938, **30**, 1372.
19. Reeve, R. M., *Adv. Fd Res.*, 1948, **1**, 156.
20. Shaw, T. M., Vorkoeper, A. R. and Dyche, J. K., *Fd Res.*, 1946, **11**, 187.
21. Thistle, M. W., Pearce, J. A. and Gibbons, N. E., *Can. J. Res.*, 1943, **D21**, 1.
22. Bate-Smith, E. C. and Hawthorne, J. R., *J. Soc. chem. Ind. Lond.*, 1945, **64**, 297.
23. Srivastava, M. P. and Bhatia, B. S., *An Improved Method for Determining Solubility of Egg Powder* (under publication).
24. Hawthorne, J. R. and Brooks, J., *J. Soc. chem. Ind., Lond.*, 1944, **63**, 232.
25. Morris, T. N., *Food Science*, The Cambridge University Press, Lond., 1952, 276.
26. Bate-Smith, E. C., *Food Science*, The Cambridge University Press, Lond., 1952, 154.
27. *Food Industries Manual*, Leonard Hill (Books) Limited, London, 18th Ed., 1957, 542.

Comparative Studies on Microbial Milk Clotting Enzymes

T. S. KRISHNAMURTHY, S. S. SANNABHADTI AND R. A. SRINIVASAN
National Dairy Research Institute, Karnal, India

Manuscript Received: 7 November 1972

Six microbial milk clotting enzymes obtained from *B. subtilis* K-26, *B. cereus* BC-1 and FR-86, *B. megaterium* K-40, *Streptococcus liquefaciens* S—108 and *Aspergillus nidulans* LC-1 were compared with Hansen's rennet in respect of some of their properties. The microbial enzymes were found quite stable when dissolved in calcium chloride solution (30 mg per cent). Both microbial and animal rennet showed considerable loss in activity when dissolved in distilled water or in 15-20 mg per cent $CaCl_2$ solution or in 2.5-5.0 per cent NaCl solutions. Enzymes of *B. subtilis* K-26 and *A. nidulans* Lc-1 formed firm coagulums which were comparable to that formed by animal rennets. Increase in concentrations of calcium chloride had pronounced influence on the clotting activity of animal rennet, but not so on microbial rennets. While addition of 1 per cent starter to milk showed no need for ripening and for accelerating effect on the clotting activity of animal rennet, the microbial enzymes required the addition of 3 per cent starter and a ripening period of 30 min for showing similar accelerated activity. Proteolytic activities of these enzymes, protein and fat loss in whey and yield of cheese curd have also been compared and tabulated.

Considerable interest is being evinced in the use of rennet substitutes obtained from vegetable sources like *Withania coagulans*[1], *Ficus carica*[2,3], *Cucurbita pepo*[4], *Ricinus communis*[5], and microbial sources like *Bacillus subtilis*, *B. brevis*, *B. fusiformis*, *B. mesentericus* *B. cereus*,[6-8] *Streptococcus liquefaciens*[9], *Mucor pussilus* Lindt[10,11] *Endothia parasitica*[12], *Aspergillus candidus*[13], and *Fomitopsis pinicola*[14] in cheese manufacture. Several bacterial and fungal strains capable of producing milk clotting enzymes have been isolated in our laboratory. Some of the properties like pH and temperature optimum for the enzyme produced by some bacterial isolates have been reported[9,15]. Properties like stability of the enzymes in solution, ability to form firm coagulum, influence of calcium chloride and starter cultures on clotting activity, and behaviour during cheese making exhibited by the enzymes of some selected strains are presented in this paper.

Materials and Methods

Enzyme sources: *Streptococcus liquefaciens* 108; *Bacillus cereus* BC-1 and FR-86; *B. megaterium* K-40; *B. subtilis* K-26; *Aspergillus nidulans* LC-1 and animal rennet (Hansen's powder rennet).

Enzyme assay: Milk clotting activity was determined by using reconstituted skim milk (spray dried) fortified with 0.1 per cent calcium chloride as the substrate. Ten ml of the substrate and one ml of the enzyme solution were mixed at 30°C and the time required to bring about a clot was noted. One unit of enzyme was considered to be capable of clotting 10 ml of milk at 30°C in 10 min.

Proteolytic activity was determined according to the method of Hull[16] and lipolytic activity according to Yachino and Umamoto[17].

Stability of enzyme: 100 mg of each enzyme was dissolved separately in distilled water, 0.5, 1.0 and 2.5 per cent sodium chloride and 15 and 30 mg per cent calcium chloride solutions. They were stored for 6 hr at 25°C and for 24 hr at 4°C and then tested for milk clotting activity.

Firmness of coagulum: This was determined according to the method of Chandrasekhara *et al*[18].

Cheese preparation: Cheddar cheese (upto green cheese stage) was prepared in the laboratory according to Kosikowski[19].

Results and Discussion

The enzyme of *Aspergillus nidulans* LC-1 showed remarkable stability in all the solvents (Table 1). The other microbial enzymes were stable in either 30 mg per cent calcium chloride solution or 0.5 per cent sodium chloride solution. There was considerable loss in the

• NDRI Publication No. 72-94.

TABLE 1. STABILITY OF MILK CLOTTING ENZYME SOLUTIONS STORED AT 25°C FOR 6 HR•

Solvent	Milk clotting activity (units/ml) of enzymes													
	A.R.		S-108		BC-1		FR-86		K-40		K-26		LC-1	
	I	F	I	F	I	F	I	F	I	F	I	F	I	F
Distilled water	10.0	8.5	0.9	0.8	8.5	8.0	1.7	1.5	3.6	3.3	20.0	17.0	1.7	1.7
$CaCl_2$ solution (mg %)														
15	10.0	8.5	0.9	0.8	8.5	8.0	1.7	1.5	3.6	3.3	20.0	17.0	1.7	1.7
30	10.0	10.0	0.9	0.9	8.5	8.5	1.7	1.7	3.6	3.3	20.0	20.0	1.7	1.7
NaCl solution %														
0.5	8.0	8.0	0.9	0.8	7.5	7.5	1.7	1.7	3.6	3.6	20.0	17.0	1.7	1.7
1.0	8.0	8.0	0.8	0.8	7.5	7.5	1.2	1.2	3.6	3.6	17.0	17.0	1.7	1.7
2.5	5.7	5.7	0.8	0.8	5.7	5.7	1.0	1.0	3.0	3.0	13.3	13.3	1.7	1.7

• Similar results were obtained when the enzyme was stored at 4°C for 24 hr

AR=Animal rennet; S-108=*S. liquefaciens*; BC-1=*B. cereus*; FR-86=*B. cereus*; K-40=*B. megaterium*; K-26=*B. subtilis* and LC-1=*Aspergillus nidulans*.

I=Initial activity; F=Final activity after 6 hr storage.

activity of all the enzymes, except that of *A. nidulans* when dissolved in distilled water, 15 mg per cent calcium chloride solution or 1.0 and 2.5 per cent sodium chloride solution. When dissolved in sodium chloride solution animal rennet, and enzymes of *S. liquefaciens*, *B. cereus* BC-1 and FR-86 showed considerable decrease in the initial activity itself, but on subsequent storage further decrease in the activity was not noticed.

Similar observations regarding the stability of mould enzymes have been made in respect of *Mucor pussilus* Lindt by Richardson *et al*[11] and Alais and Novak[20]. Addition of smaller concentrations of sodium chloride, viz., 0.2 to 0.3 per cent, however, was found to reduce the clotting time of liquid rennet of *Mucor miehei*, *Endothia parasitica*, *Mucor pussilus* Lindt and animal rennet by 87 per cent[21].

Firmness of coagulum: Enzymes of *Aspergillus nidulans* and *B. subtilis* K-26 formed relatively more firm coagulum than other microbial enzymes and showed curd tension values closer to but slightly lower than animal rennet (Table 2). Enzymes of *B. megaterium* formed a very soft coagulum followed by *S. liquefaciens*. Kikuchi *et al.*,[22] similarly reported that the curd formed by enzymes of *Mucor pussilus* Lindt showed a lower curd tension than animal rennet, but pasteurisation and subsequent addition of $CaCl_2$ to milk gave a curd similar to animal rennet curd. Mold enzyme obtained from *Aspergillus candidus* II was found to give a more firm curd than the enzyme of *B. mesentericus*[13].

Influence of starter cultures on milk clotting activity: Milk ripened with starter cultures showed relatively more rapid clotting than unripened milk (Table 2). The influence of starters was highest in the case of animal rennet. Ripening of milk with starters even

TABLE 2. FIRMNESS OF COAGULUMS FORMED AND INFLUENCE OF STARTER CULTURES ON CLOTTING ACTIVITY

Enzyme source	Curd tension (g)•	Concentration of starter culture (%)					
		1	2	3	1	2	3
		Unripened			Ripened for 30 min		
		(Clotting time in min) †					
S. liquefaciens 108	4.00	8.3	8.0	8.0	7.0	7.00	6.30
B. cereus FR-86	4.20	10.0	10.0	10.0	10.0	8.30	7.30
B. cereus BC-1	4.66	8.0	8.0	8.0	8.0	7.30	7.30
B. megaterium K-40	3.67	10.0	9.3	9.0	8.0	8.00	8.00
B. subtilis K-26	5.11	9.3	8.0	8.0	8.3	8.00	8.00
A. nidulans LC-1	5.18	10.0	10.0	9.0	10.0	9.00	7.00
Animal rennet	6.83	9.0	8.0	7.0	5.0	4.35	4.00

† Concentration of enzymes adjusted to bring about clotting of milk at 30°C in 10 min.

• Curd tension measured 30 min after addition of the enzyme. 50 ml of milk used as substrate.

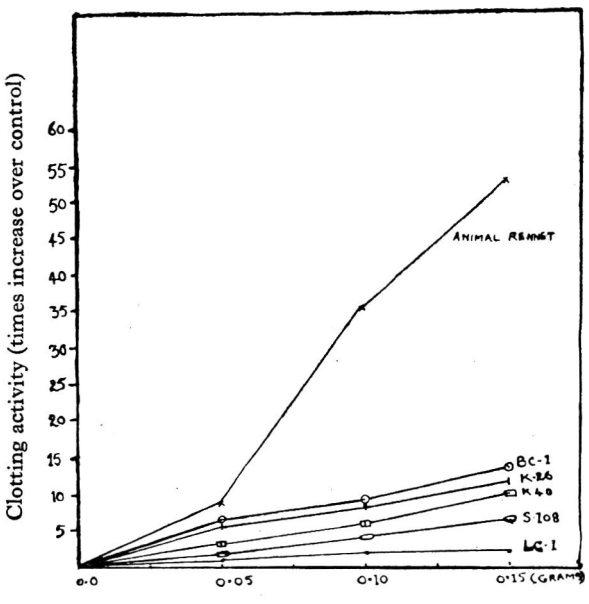
at 1 per cent level of inoculum increased the activity of animal rennet by nearly 1.8 times the original activity by decreasing the clotting time from 9 to 5 min. Among the microbial enzymes, the enzymes of *S. liquefaciens* 108 and *B. megaterium* K-40 were considerably influenced by the ripening process. With 3 per cent starter and with ripening, the clotting time of all the microbial enzymes were found to be reduced by 60 per cent. The results indicate that microbial rennet preparations are less pH dependent than animal rennet. Similar observations have been made by Behuke[23] in regard to pH dependence of microbial and animal rennets.

Influence of calcium chloride on milk clotting activity: The milk clotting activity of all the enzymes increased

with an increase in the concentration of calcium chloride in the substrate (Fig. 1). The influence was highest in the case of animal rennet. On addition of 0.15 per cent $CaCl_2$ to milk the clotting activity of animal rennet increased by 54 times over the original activity. But the maximum increases were only 13, 12, 10, 6, 4 and 2 times respectively in the case of enzymes of *B. cereus* BC-1, *B. subtilis* K-26, *B. megaterium* K-40, *S. liquefaciens* 108, *B. cereus* FR-86 and *Aspergillus nidulans* LC-1. Alais and Novak[20] observed that the enzyme powder of *Endothia parasitica* was less sensitive to Ca^{++} concentration as compared to animal rennet. On the other hand the coagulation of milk by the enzyme of *Mucor pussilus* Lindt was more affected by Ca^{++} than veal rennet according to Richardson *et al*[11].

Among bacterial rennets, the clotting activities of the enzymes of *B. cereus*[24] and *B. subtilis* were found to be influenced by Ca^{++} ions but this influence was lower than that of animal rennet[25, 26].

Protein degradation: The enzyme of *Aspergillus nidulans* showed highest proteolytic activity followed by the enzyme of *B. cereus* FR-86 and *S. liquefaciens* 108 (Table 3). Under the conditions of testing enzymes of *B. cereus* BC-1 and *B. megaterium* K-40 did not show any protein degraded product. The lipolytic activity shown by the enzymes of *B. subtilis*



$CaCl_2$ added to milk%

FIG. 1. Influence of $CaCl_2$ on the clotting activity of different milk clotting enzymes.

BC-1: *Bacillus cereus;* K 26: *Bacillus subtilis.*
K-40: *Bacillus megaterium;* S-108: *Streptococcus liquefaciens.*
LC-1: *Aspergillus nidulans.*

TABLE 3. PROTEOLYTIC AND LIPOLYTIC ACTIVITIES SHOWN BY MILK CLOTTING ENZYMES AT 32°C

Enzyme source	Proteolytic activity * Clotting time (min)	Proteolytic activity * Tyrosine equivalent (mg)	Lipolytic activity† Units per 2 mg of enzyme
S. liquefaciens 108	10	0.080	0
B. cereus FR-86	10	0.090	0
B. cereus BC-1	10	0.000	0
B. subtilis K-26	10	0.035	2
B. megaterium K-40	10	0.000	0
A. nidulans LC-1	10	0.260	2
Animal rennet	10	0.075	0

† Lipolytic activity: one unit=0.01μ M of free fatty acid liberated.

* Proteolytic activity: Determined 20 min after formation of clot.

K-26 and *A. nidulans* was 2 units/2 mg of lipase activity while its presence was not detected in other enzymes.

Fungal rennet of *Mucor pussilus* Lindt was reported to show greater increase of non-protein nitrogen in casein solutions and in cheese than pepsin or rennet[11]. Higher lipase activity was also reported to occur in this fungal enzyme[27]. The authors suggest its advantages in cheese ripening. Maubois and Mocquot[28] observed that the enzyme of *Endothia parasitica,* produced higher total nitrogen content in the whey than that of animal rennet when used for the preparation of camembert cheese. Puhan and Steffen[29] observed greater proteolytic activity in *B. subtilis* rennet than animal rennet.

Yield of curd and protein and fat loss in whey: Laboratory trials were conducted to determine the yield of curd and loss of protein and fat in whey during the preparation of cheddar cheese curd, adopting the regular schedule for cheese making. The quantity of enzyme to bring about clotting of milk in 30 min varied widely depending upon the potency of the enzyme (Table 4). Lower yields of cheese curd was obtained with the enzymes of *S. liquefaciens* 108 and *Aspergillus nidulans* LC-1 as compared to animal rennet. These enzymes also brought about greater digestion of proteins which was lost in the whey. *Aspergillus nidulans* enzyme also caused greater expulsion of whey as well as higher loss of fat in whey than animal rennet (0.1 per cent more).

Increased protein losses in cheese whey was found to occur by Chebotarey *et al.*,[13] when the enzyme of *A.*

TABLE 4. PROTEIN AND FAT LOSS IN WHEY AND YIELD OF CURD IN LABORATORY TRIALS OF CHEESE MAKING

Enzyme source	Enzyme added* (mg)	Yield of cheese curd (g)	Whey expelled (ml)	Protein loss in whey (Tyrosine equivalent in mg)	Fat loss in whey (%)
S. liquefaciens 108	1270	99.5	887	0.590	0.3
Animal rennet	40	105.5	892	0.155	0.3
B. cereus FR-86	70	106.0	897	0.255	0.3
Animal rennet	40	105.0	907	0.155	0.3
B. cereus BC-1	500	103.5	878	0.220	0.3
Animal rennet	40	103.8	878	0.145	0.3
B. subtilis K-26	35	113.0	873	0.130	0.4
Animal rennet	40	110.0	886	0.195	0.4
B. megaterium K-40	190	104.5	878	0.285	0.3
Animal rennet	40	105.0	898	0.180	0.3
A. nidulans LC-1	370	102.5	890	0.575	0.5
Animal rennet	40	110.0	878	0.180	0.4

* (i) Enzyme concentrations adjusted to give a clot in 30 minutes.

(ii) 1000 ml whole milk, standardised to give a protein fat ratio of 1:0.7; pasteurised and cooled to 30°C was used.

(iii) One per cent starter consisting of a single strain of *S. lactis* C-10 with an acidity of 0.7-0.8% lactic acid was used.

The condition of green cheese was normal in all cases.

candidus II was used for cheese making. The authors, however, claimed the superiority of fungal rennet to trypsin and papin on the basis of proteolysis. Quarne *et al.*,[30] found that the rennet of *Endothia parasitica* caused greater digestion in Pizza cheese than veal rennet.

Development of acidity: In all trials with microbial enzymes, the whey obtained at the stage of cutting exhibited higher acidity as compared to animal rennet whey (Table 5). At the end of cheddaring the acidity was similar to animal rennet cheese whey in the case of enzymes of *B. cereus* BC-1 and FR-86, and *B. subtilis* K-26 whereas whey formed by enzymes of *S. liquefaciens* 108, *B. megaterium* K-40 and *A. nidulans* LC-1 exhibited relatively higher acidity. Whey formed with *A. nidulans* enzyme showed highest acidity of 0.6 per cent lactic acid at the end of cheddaring stage.

Changes in pH: Enzymes of *S. liquefaciens* 108, *B. cereus* FR-86, *B. megaterium* K-40 and *A. nidulans* LC-1 brought down the pH at a faster rate than animal rennet. Enzymes of *B. cereus* BC-1 and *B. subtilis* K-26 were very similar to animal rennet in bringing down the pH, but the final pH however was higher than that with animal rennet.

The above data indicate that the performance of enzymes obtained from *B. subtilis* K-26 and *B. cereus*

TABLE 5. ACID DEVELOPMENT AND CHANGES IN PH DURING CHEDDAR CHEESE PREPARATION ON A LABORATORY SCALE*

Enzyme source	Particulars of test	Milk+ starter	Cutting	Acid and pH at different times (hr—min) of manufacture: Cooking			Cheddaring		
		0-30†	1-00	1-05	1-50	1-55	2-25	2-55	3-25
S. liquefaciens 108	Acid‡	0.18	0.13	0.14	0.15	0.16	0.21	0.30	0.55
	pH	...	6.45	6.45	6.35	6.30	6.10	5.70	...
Animal rennet	Acid	0.18	0.11	0.12	0.13	0.13	0.17	0.25	0.50
	pH	...	6.60	6.60	6.55	6.40	6.25	6.10	...
B. cereus BC-1	Acid	0.17	0.12	0.13	0.14	0.15	0.19	0.35	0.50
	pH	...	6.50	6.50	6.40	6.10	6.00	5.80	...
Animal rennet	Acid	0.17	0.11	0.12	0.13	0.14	0.19	0.40	0.50
	pH	...	6.55	6.55	6.40	6.10	5.80	5.30	...
B. cereus FR-86	Acid	0.17	0.13	0.14	0.15	0.15	0.20	0.40	0.50
	pH	...	6.35	6.25	6.20	6.10	6.00	5.40	...
Animal rennet	Acid	0.17	0.11	0.12	0.13	0.13	0.18	0.40	0.50
	pH	...	6.40	6.35	6.25	6.25	6.10	5.30	...
B. megaterium K-40	Acid	0.18	0.13	0.14	0.15	0.15	0.20	0.30	0.50
	pH	...	6.45	6.40	6.40	6.20	5.90	5.65	...
Animal rennet	Acid	0.18	0.11	0.12	0.13	0.13	0.18	0.25	0.47
	pH	...	6.35	6.25	6.20	6.10	6.00	5.40	...
B. subtilis K-26	Acid	0.18	0.12	0.13	0.14	0.14	0.17	0.30	0.47
	pH	...	6.50	6.50	6.40	6.40	6.40	6.00	...
Animal rennet	Acid	0.18	0.12	0.13	0.14	0.14	0.16	0.30	0.47
	pH	...	6.5	6.5	6.4	6.4	6.2	5.7	...
A. nidulans LC-1	Acid	0.17	0.13	0.14	0.16	0.20	0.25	0.40	0.60
	pH	...	6.45	6.40	6.20	6.10	6.00	5.40	...
Animal rennet	Acid	0.17	0.11	0.12	0.13	0.13	0.17	0.28	0.49
	pH	...	6.55	6.45	6.40	6.30	6.15	5.70	...

* Details as given under Table 4. † 30 min. after addition of starter to milks. ‡ Acid as per cent lactic acid

BC-1 are quite satisfactory and could be utilized for cheese making. A few cheese making trials conducted on a semicommercial scale using these enzymes have also yielded good quality cheese.

References

1. Kothavalla, Z. R. and Khubchandani, P. G., *Indian J. vet. Sci. Anim. Husb.*, 1940, **10**, 284.
2. Krishnaswamy, M. A., Johar, D. S., Subrahmanyan, V. and Thomas, S. P., *Fd Technol., Champaign*, 1961, **15**, 482.
3. Zuckerman-Stark, S. and Leibowitz, J., *Enzymologia*, 1963, **25**, 252.
4. Zuckerman-Stark, S. R. and Leibowitz, J., *Enzymologia*, 1963, **25**, 257.
5. Zuckerman-Stark, S. and Leibowitz, J., *Enzymologia*, 1964, **26**, 294.
6. Shimwell, J. L. and Evans, J. E., **British Patent, 1944, 565, 788.**
7. Emanuiloff, I., *XIV Internat. Dairy Congr.*, 1956, **2**, 200.
8. Srinivasan, R. A., Anantharamiah, S. N., Keshavamurthy, N., Anantakrishnan, C. P. and Iya, K. K., *XVI Internat. Dairy Congr.*, 1962, **1**, 506.
9. Srinivasan, R. A., Anantharamiah, S. N. and Anantakrishnan, C. P., *Indian J. Dairy Sci.*, 1968, **22**, 149.
10. Robertson, P. S. and Gillies, J., *J. Dairy Technol.*, 1966, **1**, 91.
11. Richardson, G. H., Nelson, J. H., Lubnow, R. E. and Schwerberg, R. L., *J. Dairy Sci.*, 1967, **50**, 1066.
12. Bolliger, O. and Schilt, P., *Schweiz Milchztg.*, 1969, **95**, 1029. *Dairy Sci. Abstr.*, 1969, **31** (10), 552.
13. Chebotarey, A. I., Durova, E. I., Petina, T. A. and Mosichev, M. S., *Appl. Biochem. Microbial.*, 1966, **2**, 437.
14. Kawai, M. and Mukai, N., *Agric. biol. Chem.*, 1970, **34**, 159.
15. Final Report on Microbial Rennet. PL-480 Project 1962-67, *Natl. Dairy Res. Inst., Karnal.*
16. Hull, M. E., *J. Dairy Sci.*, 1947, **30**, 881.
17. Yaichiro Umemoto, Hiromitsu Umeda and Yashshi Sato, *Agric. biol. Chem.*, 1968, **32**, 1311.
18. Chandrashekhara, M. R., Swaminathan, M., Bhatia, D. S. and Subrahmanyan, V., *Fd Sci.*, 1957, **6**, 226.
19. Kosikowski, F., *Cheese and Fermented Milk Foods*, Edwards Brothers Int. Ann Arbor, Michigan, 1970.
20. Alais, C. and Novak, G., *Lait*, 1968, **48**, 393.
21. Hamdy, A. and Edelstein, D., *Milchwissenschaft*, 1970, **25**, 450.
22. Kikuchi, T. Toyoda, S., Suzuki, Y. and Takafuji, S., *Dairy Sci. Abst.* 1968, **31** (6), 305.
23. Behuke, V., *Milchwissenschaft*, 1967, **22**, 563.
24. Oosthuisen, J. C., *J. Dairy Res.*, 1962, **29**, 297.
25. Puhan, Z., *Dairy Sci. Abstr.*, 1966, **29**, 157.
26. Puhan, Z., *J. Dairy Sci.*, 1969, **52**, 289.
27. Babel, F. J. and Somkuti, G. A., *J. Dairy Sci.*, 1968, **51**, 937.
28. Maubois, J. L. and Mocquot, G., *Dairy Sci. Abstr.*, 1962, **32** (2), 135.
29. Puhan, Z. and Steffen, C., *Dairy Sci. Abstr.*, 1967, **29**, 544.
30. Quarne, E. L., Larson, W. A. and Olson, N. F., *J. Dairy Sci.*, 1968, **51**, 848.

The Quality of Soft-Serve Ice Cream as Influenced by the Levels of Fat, Emulsifier, Sucrose Substitutes and Processing Conditions*

GYANENDRA KUMAR GOYAL AND M. R. SRINIVASAN
National Dairy Research Institute, Karnal, India

Manuscript Received: 12 December 1972

A study of the effect of 7, 10 and 14 per cent fat levels on the final quality of the soft-serve ice cream indicated that the product made from 7 per cent fat and 12 per cent milk solids not fat (MSNF) was highly acceptable to taste, with normal melting rate, and lowest pH.
The use of 0.2 per cent glycerol mono-stearate (GMS) in the mix produced soft ice cream with highly desirable qualities. Replacement of 35 per cent of added sugar with regular conversion corn syrup produced soft ice cream of best quality followed by dextrose (25 per cent sucrose substitution). The soft ice cream served at—6.4 to—5.3°C with 50—60 per cent overrun was most acceptable.

Soft ice cream is a semi-frozen mixture of milk products such as cream, milk, dried milk and condensed milk with the addition of non milk products for sweetening, flavouring, stabilising and emulsifying. This is largely marketed in a soft form immediately after withdrawl from the freezer. In India this product is of recent origin. A study on the manufacturing techniques along with standardization of composition and serving temperature of soft-serve ice cream under Indian conditions will provide basic technological information for boosting up its production and sale in our country.

* N.D.R.I. Publication No. 73-38.

Sheuring and Rossi[1] produced an excellent product from a mix containing 6 per cent or above fat, 9 per cent milk solids not fat, 0.15 per cent emulsifier and 0.4 per cent stabilizer. A drawing temperature of 20°F gave the best results. Savinovsaki[2] observed that at a product temperature of —6 to 6.3°C, the consistency and structure of ice cream were satisfactory and its removal from the freezer was comparatively easy. Crowhurst[3] recommended that 7 per cent fat mixtures with fairly high total solids were most suitable. Arbuckle[4] has observed that if the fat content is low (less than 4 per cent) the product tends to be coarse, weak and icy. If the fat is high (above 12 per cent) the product may be too rich and less palatable in addition to presenting freezing difficulties involving possible fat separation during the freezing process. The use of emulsifiers in soft ice cream has been recommended by various workers[3, 5] for obtaining a product of 'dry' appearance, required stiffness, stand-up quality and melt resistance.

Leeder[5] discussed the proper use of corn sweeteners in ice cream. The object of this study was to try three fat levels i.e., low, medium and high in soft-serve ice cream and also to find out the effect of emulsifier on the quality of final product. In addition to this, the present study also included the standardization of overrun in the product and determination of most suitable serving temperature.

Materials and Methods

The following base formulae having low, medium and high fat were prepared and processed for the study.

	Mix No. 1	Mix No. 2	Mix No. 3
Fat %	7.0	10.0	14.0
MSNF%	12.0	11.5	10.0
Sucrose%	15.0	15.0	15.0
Stabilizer%	0.3	0.3	0.3
Total solids%	34.3	36.8	39.3

Fresh cow milk was drawn from the NDRI. The cream was obtained by separating cow milk by De-laval tri-process machine. The spray dried skim milk was obtained from the experimental dairy. Sodium alginate was used as stabilizer.

The mixes were heated to 65.5°C and homogenized at first and second stage pressures of 2500 and 500 psig respectively. The mixes were pasteurized at 71°C for 30 min, and subsequently cooled to 20°C by first dipping the cans containing mixes in tap water and then immersing the cans in chilled water. The mixes were frozen in a batch type, ice cream freezer. Four kilogram mix was used for each batch. The pH of the freshly prepared soft-serve mixes having different levels of emulsifier glycerol monostearate (GMS) and corn syrup/dextrose were determined immediately after processing and cooling to 20°C. The viscosity of the soft-serve mixes were measured with Stromer's viscometer immediately after cooling the mixes to 20°C. The time taken for 100 revolutions of blades was noted in each type of mix. The surface tensions of the soft-serve mixes at 20°C were determined using DU-Nouy tensiometer. The effect of emulsifier GMS was studied at 0.1, 0.2 and 0.3 per cent (GMS) levels in the Mix No. 1. The other study consisted of replacing 25 per cent of added sucrose with dextrose and 35 per cent of added sucrose with corn syrup in the Mix No. 1 containing 0.2 per cent GMS.

Product evaluation: Three trials for each type of mix were conducted and average scores for attributes of different soft-serve samples were noted. An expert panel of 3 independent judges evaluated the product for flavour, body, texture and taste. Marks were awarded to each sample out of a maximum of 10. Each judge was provided with all the 3 samples under different code numbers without disclosing the identity of the samples. The samples of the soft ice cream provided to judges for overrun and serving temperature evaluation had 30, 50, 60 and 90 per cent overrun and —8.0, —6.4, —5.3 and —3.4°C average drawing temperatures. The effect of emulsifier level and that of replacement of added sucrose with corn syrup/dextrose were tested in samples having 60 per cent overrun and —6.1°C drawing temperature by serving to judges.

Results and Discussion

Table 1 shows that the viscosity of the soft-serve mix increased slightly with increased quantity of GMS in the mix. The surface tension of the mix with the addition of GMS decreased apparently due to the concentration of the emulsifier in the interface between the fat and the plasma. The addition of emulsifier, however, had no effect on the pH of the mix. The observations in Table 2 indicate that the addition of corn syrup/dextrose had no effect on pH of the mix, but the viscosity of the mix was slightly increased. The increase in viscosity may be due to the increase in total solids. The surface tension of soft-serve mix having corn syrup/dextrose also increased. The effect of dextrose on surface tension of the mix was more than the corn syrup.

TABLE 1. EFFECT OF THE USE OF DIFFERENT PROPORTIONS OF GMS ON MIX PROPERTIES

Mix property	Control	GMS level (%)		
		0.1	0.2	0.3
Viscosity (sec).	34.6	34.9	35.5	35.9
Surface tension (dynes/cm²)	52.3	49.7	48 9	46.6
pH	6.1	6.1	6.1	6.1

TABLE 2. EFFECT OF REPLACEMENT OF PART OF ADDED SUGAR WITH CORN SYRUP/DEXTROSE ON MIX PROPERTIES

Property	Control	Corn syrup to replace 35% sucrose	Dextrose to replace 25% sucrose
pH	6.1	6.1	6.1
Viscosity (sec)	35.5	36.0	35.7
Surface tension (dynes/cm²)	49.1	51.4	53.0

TABLE 3. EFFECT OF FAT LEVEL ON THE PROPERTIES OF SOFT-SERVE ICE CREAM

Mix No. 1	Flavour	Body and texture	Melting quality	Average score out of 10
1	Good	Excellent	Good	8.6
2	Good	Very good	Good	7.0
3	Good	Good	Slow melt	6.2

TABLE 4. EFFECT OF EMULSIFIER LEVEL ON THE PROPERTIES OF SOFT-SERVE MIX

Sample GMS level %	Body and texture	Melt down rate (%)	Average score out of 10
Control	Good	33.4	6.5
0.1	Good	31.1	7.0
0.2	Excellent	28.1	7.8
0.3	Good	24.6	7.3

TABLE 5. EFFECT OF REPLACEMENT OF PART OF ADDED SUGAR WITH CORN SYRUP/DEXTROSE ON THE PROPERTIES OF SOFT ICE CREAM

Sample	Flavour	Body and texture	Melt down rate	Average score out of 10
Control (All sucrose)	Good	Good	35.8	8.0
Corn syrup (35% sucrose substitution)	Good	Excellent	27.2	9.0
Dextrose (25% sucrose substitution)	Good	Very good	32.8	8.5

TABLE 6. EFFECT OF OVERRUN LEVEL ON THE PROPERTIES OF SOFT ICE CREAM

Overrun %	Serving temp. °C	Body, texture and taste	Melt down (%)	Average score out of 10
30	-8.0	Soggy and cold	32.8	7.3
50	-6.4	Very good	37.4	8.9
60	-5.3	Excellent	39.4	9.1
90	-3.4	Fluffy and warm	41.5	7.0

Low fat soft ice cream (7 per cent fat) was found to be most acceptable followed by soft ice cream having 10 and 14 per cent fat (Table 3). The 14 per cent soft ice cream showed slow melt down while soft ice cream having 7 and 10 per cent fat melted at normal rate. It is clear from Table 4 that the soft ice cream having 0.2 per cent GMS scored highest for body and texture and the increasing use of emulsifier decreased the melt-down rate of soft ice cream. The soft ice cream with corn syrup scored highest for body and texture and melted last as compared to soft ice cream having dextrose and all sucrose (Table 5). The observations in Table 6 indicate that the soft ice cream served at -8.0°C with 30 per cent overrun was rated as soggy and cold and the soft ice cream served at -3.4°C and 90 per cent overrun was recognised as warm and fluffy, while the soft ice cream served at -6.4 to-5.3°C and having 50-60 per cent overrun was liked most.

Acknowledgement

The authors are grateful to Mr R. Balachandran, Assistant Research Officer, of the Institute for his help during the investigation.

References

1. Sheuring, J. J. and Rossi, P. F., *Ice Cream Tr. J.*, 1951, **47**, 74.
2. Savinovski, N., *Dairy Sci. Abstr.*, 1959, **21**, 109.
3. Crowhurst, B., *Ice Cream Industr.*, July 1961, **49**, 53.
4. Arbuckle, W. S., *Ice Cream*, The AVI Publishing Co. Inc., Conn. U.S.A., 1966.
5. Leeder, J. G., *Am. Dairy Rev.*, 1971, **33**, 28.
6. Leeder, J. G., *Am. Dairy Rev.*, 1971, **33**, 44.

CHEMICAL COMPOSITION OF TENDER SHOOTS AND LEAVES OF *RAYA (BRASSICA JUNCEA)* MUTANTS

Raya mutants were found to be good sources of dietary protein

Tender leaves and shoots of rape is one of the most popular green pot herbs consumed as a vegetable (*Sarson ka sag*) during winter. The tender green leaves are rich source of protein and minerals and are considered to be easily digestible. Leaves and tender shoots of *raya* are also being exported after dehydration. A study was, therefore, conducted to find out some strains of *raya* superior in chemical composition to the traditional *raya* L-18 and brown *sarson*.

Seventeen different *raya* mutants morphologically suitable for *Sag* purposes were selected from the second generation of irradiated material (M_2 population) from 2,00,000 rontgens of γ-rays treatment in 1970-71. These seventeen *raya* mutants along with *raya* L-18 and brown *sarson* were sown in a test plot at Punjab Agricultural University, Ludhiana, during rabi 1971-72. In the third generation of irradiated material (M_3) all these lines were uniform in growth and morphological characters. Samples of green leaves and tender shoots were taken after 50 days from the date of sowing. Nitrogen was determined in the oven dried samples by Microkjeldahl method of McKenzie and Wallace[1] while crude fibre, ether extract, total minerals and nitrogen free extract (NFE) were estimated according to AOAC methods[2].

The chemical analysis of tender shoots and leaves of different mutants along with the standard *raya* L-18 and brown *sarson* are given in Table 1.

TABLE 1. PER CENT CHEMICAL COMPOSITION OF TENDER SHOOTS AND LEAVES OF VARIOUS RAYA MUTANTS

Mutant No.	Dry matter S.E.± 0.57	Protein* S.E.± 0.51	Crude fat*	Crude fibre*	Mineral matter*	Nitrogen free extract (by difference)
RLM 245-3	8.86	29.25	5.00	12.10	13.05	40.60
RLM 249-4	9.28	30.00	5.45	7.25	11.12	46.18
RLM 245-1	9.60	32.37	3.95	13.87	10.62	39.79
RLM 247-5	9.90	31.25	3.68	13.52	14.20	37.25
RLM 242-2	9.42	32.12	4.20	9.20	12.18	42.30
RLM 242-4	8.92	28.31	6.53	8.28	12.60	44.27
RLM 236-4	10.90	30.00	6.90	7.88	9.65	44.57
RLM 233-5	10.48	32.68	5.05	8.92	11.82	41.53
RLM 247-2	9.22	30.94	5.80	8.32	11.08	43.86
RLM 246-3	8.54	31.94	4.70	7.52	9.42	46.42
RLM 244-2	10.44	31.75	5.12	6.90	10.84	45.39
RLM 249-2	10.56	30.50	4.25	8.15	9.50	47.60
RLM 241-3	10.88	30.44	5.84	7.28	8.48	47.96
RLM 249-1	10.36	34.13	5.90	11.18	11.92	36.87
RLM 240	11.68	37.38	4.75	8.90	9.25	39.72
RLM 246-4	9.76	32.81	4.80	12.17	9.62	40.60
RLM 218	9.24	31.50	5.50	9.30	10.15	43.55
RL 18	10.36	31.94	4.65	8.82	9.42	45.17
Brown sarson	7.76	38.88	5.18	7.62	16.25	34.81

RLM—Raya, Ludhiana mutants; R L.—Raya, Lyallpur mutant; * Results are on dry matter basis.

The dry matter varied from 7.76 per cent in case of brown *sarson* to 11.68 per cent in RLM 240. Out of the 17 *raya* mutants, RLM 240 gave the highest value. All the mutants registered higher dry matter content than the brown *sarson* and in ten of them the difference was significant.

Ether extractives in the samples ranged from 3.68 to 6.9 per cent and crude fibre from 7.25 to 13.87 per cent. Similar variations in crude fibre content with leafy vegetables have been reported[3]. Though some amount of crude fibre in the diet is beneficial, very high content makes the vegetables unacceptable for human consumption[4].

Protein content (N×6.25) of the different mutants ranged from 28.31 to 37.38 per cent. Six mutants recorded more protein content than *raya* L-18. Brown *sarson* gave the highest value of 38.88 per cent and among the mutants RLM 240 was the best with a protein content of 37.38 per cent.

The mineral matter content of the mutants ranged from 8.48 to 14.20 per cent as against 9.42 per cent in *raya* L-18 and 16.25 per cent in brown *sarson*. The nitrogen free extract ranged from 34.48 to 47.96 per cent. Since green foliage of plants are the main sites of protein synthesis and are generally good source of all the essential amino acids, *sag* of *raya* mutants in general and RLM 240 in particular could form a valuable supplement to Indian diets which are predominantly based on cereals. The results also indicate that the specific mutants can serve a better source of germ plasm for improving the nutritive value in specific direction of otherwise well adapted varieties of *raya* through cross breeding.

Punjab Agricultural University, Ludhiana
18 September 1972

K. S. LOBANA
J. S. GARCHA
M. L. GUPTA
B. N. SHARMA

References

1. McKenzie, H. A. and Wallace, H. S., *Aust. J. Chem.*, 1954, 7, 55.
2. *Official Methods of Analysis*, Assoc. Off. Agric. Chemists, Washington, D.C., 1965.
3. Aykroyd, W. R., *Nutritive Value of Indian Foods*, Ind. Counc. Med. Res., New Delhi, 6th Ed. 1965.
4. Sosulski, F. W. and Bakal, A., *Can. Inst. Fd Sci., Technol. J.*, 1969, 2, 28.

COLORIMETRIC ESTIMATION OF DICHLORVOS (DDVP)

A rapid and accurate method for the quantitative estimation of 0,0—dimethyl 2,2—dichlorovinyl phosphate (DDVP) in formulations by hydrolysing with alkali is described. The colour produced by the residual alkali with carbon disulphide and ethyl alcohol is measured quantitatively in a colorimeter.

The insecticide 2, 2-dichlorovinyl dimethyl phosphate has been extensively tested for use in baits, space spray, aerosols and possibly as a fumigant and animal spray. The principal constituents of DDVP after hydrolysis in aqueous solution are dimethyl phosphoric acid and dichloroacetaldehyde[1].

Estimation of DDVP has been done by a number of workers. The observation that dichloroacetaldehyde forms a derivative with 2,4-dinitrophenyl hydrazine, which yields an intense blue colour on the addition of alkali has made possible its determination by a modification of the method used for triose phosphates[2,3]. There are also methods of estimation by Hodgson and Casida[4] and Hughes[5]. There are also some other methods for its determination[6-8]. Visweswariah *et al.*,[9] estimated DDVP using monoethanolamine hydrolysis.

The measurement of the colour produced by ethyl alcohol and carbon disulphide with the excess alkali after hydrolysis of DDVP is reported. The chemicals used are: (*i*) Dichlorvos (DDVP) (analytical grade); (*ii*) Ethyl alcohol (96 per cent); (*iii*) Caustic soda solution (5 per cent NaOH in distilled water); (*iv*) Carbon-disulphide, (analytical grade,); and (*v*) Carbon tetrachloride, (analytical grade).

DDVP (0.1 per cent) in acetone is prepared and used as standard solution. Different amounts (10, 20, 30, 40 μg) of this solution are taken in four test tubes. Then to each test tube 1 ml of 5 per cent NaOH is added. A blank is prepared by adding only 1 ml alkali solution in a test tube. All the test tubes are kept immersed in ice bath for 30 minutes. The hydrolysed solution is then taken in four separating funnels (250 ml). To each of them, 25 ml carbon tetrachloride and 15 ml alcohol are added. After proper shaking for 3 min, 25 ml distilled water and 5 ml carbon di sulphide are added and shaken. The CCl_4 layer is discarded. The intensity of colour of the aqueous layer is estimated in a colorimeter within 15 min. The reading of the blank gives highest reading and as the concentration of DDVP increases, the intensity of the colour decreases. The standard graph is prepared by plotting concentration of DDVP against the colorimetric reading obtained by subtracting sample reading from the blank.

The method is very accurate and simple. The sensitivity is as low as 1 μg.

The colour formation is probably due to the formation of complex sodium xanthate (CH_3CH_2O-CSSNa)[10] produced by carbon disulphide, ethyl alcohol and alkali.

Here, DDVP is hydrolysed by alkali and the residual alkali is used for colour formation. As the amount of alkali is fixed in all cases but amount of DDVP is varying, so amount of residual alkali is varying which is responsible for colour formation. As a result, the intensity of colour is different for different amounts of DDVP. Adopting this procedure DDVP can be estimated easily.

Central Food Laboratory
Calcutta
25 November 1972

G. MUKHERJEE
T. S. BANERJEE
A. K. MUKHERJEE
T. V. MATHEW

References

1. Jandrof, B. J., *J. Agric. Fd Chem.*, 1956, 4, 853.
2. Beck, W. S., *Meth. Enzym.*, 1956, 3, 201.
3. Lowry, O. H., Robert, N. R., Wu, M. L., Hixon, W. S. and Crawford, E. J., *J. biol. Chem.*, 1954, 19, 207.
4. Hodgson, E. and Casida, J. E., *J. Agric. Fd Chem.*, 1962, 10, 208.
5. Hughes, J. J., *Analyst, Lond.*, 1963, 88, 318.
6. Geiger, M. and Furer, R., *Anal. Chem.*, 1960, 174, 401.
7. Kadkol, S. B., *J. Fd Sci. Technol.*, 1967, 4, 123.
8. Lippin Gerald, R. and Cark Leland, C., *Anal. Chem.*, 1951, 23, 241.
9. Visweswariah, K., Jayaram, M. and Majumder, S. K., *Res. Ind.*, 1971, 16, 45.
10. Norris, M. V., Easter, E. W., Fuller, L. T. and Kuchar, E. J., *J. Agric. Fd Chem.*, 1958, 6, 111.

SUGGESTED MODIFICATION ON PFA SPECIFICATION IN CASE OF CORIANDER (*DHANIA*)

An important constituent of a spice is the volatile or essential oil to which its aroma is due. In the Prevention of Food Adulteration Rules 1955[1], specification have been laid down for the total ash and ash insoluble in dilute HCl for spices. The present study was

undertaken to see whether the existing requirements are adequate to ensure a quality material and more particularly to check admixture with spice from which the volatile oil has already been extracted.

The present investigation was restricted to coriander (*Coriandrum sativus* L) or *Dhania*, one of the most widely used spices. Thirty samples were collected from the local market, crushed in the laboratory and the following estimations done: moisture, total ash, ash insoluble in dilute HCl, volatile oil[2] and cold water extract[3]. In addition, after the volatile oil extraction, the residue was spread in open air to let it regain its original consistency, and the same estimations were repeated.

The distilling solvent used in case of volatile oil estimation was distilled water, as mixed solvents have no particular advantages over the former[4]. The volatile oil of coriander has a sp gr of 0.870 to 0.885 and is therefore to be collected over water column without the help of xylene. The results are tabulated below:

TABLE 1. RESULTS OF ANALYSIS OF THIRTY SAMPLES OF CORIANDER (DHANIA)

	Moisture %	Total ash %	Ash insoluble in dil. HCl %	Volatile oil %	Cold water extract %
Max.	11.0	7.7	0.9	0.45	16.4
Min.	7.5	5.7	0.2	0.20	7.5
Av.	9.2	6.2	0.4	0.33	12.2

TABLE 2. SPREAD OF VALUES

Moisture %	Total ash %	Ash insoluble in dil. HCl %	Volatile oil %	Cold water extract %
7.5—8.5 (8)	5.7—6.2 (20)	0.2—0.3 (18)	0.2—0.25 (10)	7.5—8.0 (4)
9.0—9.5 (14)	6.5—6.9 (8)	0.4—0.5 (6)	0.3—0.4 (16)	8.7—10.8 (6)
10.0—10.5 (6)	7.1—7.7 (2)	0.7—0.9 (6)	0.45 (4)	11.6—13.4 (8)
11.0 (2)				14.0—16.4 (12)

There are generally two types of coriander, one is bigger, slightly ovoid in shape and straw-yellow in colour, the other is smaller, subglobular and brownish yellow to dark brown in colour. The latter variety, due to the size and colour of fruits is particularly susceptible to admixture with dirt, stones and foreign seeds. The analytical figures for these two varieties are somewhat different from each other. We can mention here that the higher percentage of total ash (6.5-7.7 per cent) and lower percentage of volatile oil (0.2-0.25 per cent) and cold water extract (7.5-10.8 per cent) are due to these dark brown varieties.

Two of the dark brown varieties have exceeded the limit of total ash prescribed in the PFA rules[1] presumably because of the heavy amount of extraneous matter they contain. The maximum value obtained for ash insoluble in dilute HCl is nearly 1.0 per cent (including those that contain dirt and foreign seeds) and so with a little allowance the upper limit may reasonably be fixed at 1.25 per cent. Regarding volatile oil, we have to fix a lower limit of 0.2 per cent due to those dark brown varieties, though according to authorities[5-7] it should be much higher. The cold water extract varies widely from 7.5-16.4 per cent and considering the spread of values a lower limit of 8.5 per cent seems reasonable as more than 85 per cent of the results are above this.

Experiments were also carried out on the exhausted stuff from which the volatile oil has been totally removed. It was observed that though they are devoid of any volatile oil and contain much less cold water extract (ranging from 1.5-4.1 showing a loss of 70 to 85 per cent of the actual values) the total ash and ash insoluble in dilute HCl are within the prescribed limit[1]. Without any restriction for those two chemical constituents viz., volatile oil and cold water extract, the Public Analysts have to classify them as genuine, according to the present standard.

Central Food Laboratory,
Calcutta.
10 November 1972

A. R. SEN
P. K. SARDAR
S. SIL
T. V. MATHEW

References

1. *The Prevention of Food Adulteration Rules, 1955*, Govt. of India, Ministry of Health, Appendix B, item. A050801.
2. British Pharmacopoeia 1968, 1275.
3. *Methods of Sampling and Test for Spices and Condiments*, IS: 1797-1961, Indian Standards Institution, New Delhi-1,
4. Mitra, S. N. and Roy, S. C., *J. Indian chem. Soc.*, 1956, 19, 113.
5. Mukherjee, B., *Indian Pharmaceutical Codex Vol. I*, Council of Scientific and Industrial Research, New Delhi, 1953, 81.
6. *The Wealth of India, Raw Materials*, Vol. 11, Council of Scientific and Industrial Research, New Delhi, 1950, 349.
7. Watt, G., *Economic Products of India, Vol. II*, Govt. of India, Calcutta, 1889, 568.

STUDIES ON BACTERIAL LOAD OF RAW MEAT

Unwholesome meat has been held responsible for causing a number of cases of food poisoning and also speeding the spoilage of meat under market storage conditions. Besides the presence of pathogens, different types of other bacteria and their heavy load may be present in the raw meat as a result of faulty handling procedures followed in the abattoirs. The present study was therefore, taken up to ascertain the level of microbial population for assessing hygienic status of meat production under routine abattoir procedures.

Meat samples from goat carcasses were collected from three different abattoirs viz., Pantnagar, Haldwani and Bareilly. Samples including a piece of liver from hilar region weighing about 300-400 g, one kidney including pelvis region and a muscle piece from the thigh region weighing about 300-400 g, were collected in sterilized wide mouth specimen jars immediately after skinning and evisceration of the carcass by the butchers. The carcass was not washed after dressing.

Total viable bacterial counts were made after 3-5 hr of sample collection. About 6-8 g of tissue was collected from each organ removing thinnest possible slice of the surface material according to Evans and Diebel[4]. It was then homogenized and its ten fold dilutions were prepared according to Peltier *et al*[5]. Pour plates were prepared by inoculating 1 ml of suitable dilution in 10-12 ml of Bacto nutrient agar. The plates were incubated at 37°C for 24 ±2 hr (WHO)[7]. Bacterial colonies were counted with the help of Quebec's colony counter and the average count of the two plates was reported as total viable count (TVC) per gram of the meat sample.

In all 75 samples including 25 each of liver, kidney and muscle were analysed. The TVC was recorded as high as 35×10^7/g in liver and the maximal average TVC was recorded to be 10^8/g (Table I). The average TVC recorded in each organ was found to be higher than the suggested limits of total viable aerobes (10^5-10^7/ g) in raw meat[3]. In most of the cases the average TVC were found to be lowest in the samples taken from Pantnagar (Table 2). The variation in counts suggested that there were differences in the environmental conditions of the abattoirs and slaughtering practices being followed at these three places. Since tissues of the live healthy animals are considered to be sterile, such heavy contamination of the carcasses were due to wrong handling methods being followed. Ayres[1], Borgstrom[2] and Thornton[6] have attributed dirty knives, other cutting tools, handler's hands, unwashed hides and skins, polluted water and faulty slaughtering procedures as potential means of contamination of the carcasses. In underdeveloped areas of the world such infected raw meats are good source of infection to man (WHO)[7].

TABLE 1. RANGE AND AVERAGE OF TOTAL VIABLE COUNTS PER GRAM OF MEAT SAMPLES

Organ	No. of samples	Range	*Average
Liver	25	$110\text{–}35\times10^4$	10^5
Kidney	25	$30\text{–}35\times10^4$	81×10^3
Muscle	25	$90\text{–}35\times10^4$	73.5×10^3

* Average of 25 samples.

TABLE 2. SOURCE WISE AVERAGE TOTAL VIABLE COUNT PER GRAM OF MEAT SAMPLE

Source	No. of samples	Liver	Kidney	Muscle
Pantnagar	9	3.46×10^3	4.39×10^3	5.37×10^3
Haldwani	7	1.78×10^4	1.5×10^4	1.15×10^4
Bareilly	9	2.6×10^5	2×10^5	19×10^4

Indian Veterinary Research Institute, Izatnagar (U. P.).
V. N. BACHHIL
S. S. AHLUWALIA
10 October 1972

References

1. Ayres, J. C., *Adv. Fd Res.*, 1955, **6**, 109.
2. Borgstrom, G., *Adv. Fd Res.*, 1955, **6**, 163.
3. Elliott, H. P. and Michener, H. D., *Appl. Microbiol.*, 1961, **9**, 452.
4. Evans, J. B. and Diebel, R. H., in *The Science of Meat and Meat Products*, Reinhold Publishing Corporation, New York, 1960.
5. Peltier, G. L., George, C. E. and Lindgren, L. F., *Laboratory Manual for General Bacteriology*, John Wiley & Sons, Inc., New York, London, Sydney, 1959.
6. Thornton, H., *Text Book of Meat Inspection*, Bailliere, Tindall and Cox. London, 5th Ed. 1968.
7. *Meat Hygiene*, Monograph Series No. 33, WHO, Rome Geneva, 1957.

FREE FATTY ACID CONTENT OF MUSTARD OIL

Rancidity is usually accompanied by free fatty acid formation and so the determination is often used as a general indication of the condition and quality of oils. The rate of hydrolysis in the presence of moisture alone being negligible[1] and the quantity of enzymes present in oils being small, the proportion of free

fatty acids found in edible oils is not very considerable[2]. Pearson[3] has said that acidity begins to be noticeable to the palate when the free fatty acids as oleic acid is about 0.5 to 1.5 per cent. According to Eckey[4] the acid value of mustard oil should be 0.6. Yet the PFA Rules 1955[5] has specified the limit as high as 3.0 per cent.

Here we have restricted our investigation only to mustard oil and furnish data of the free fatty acid content of some 373 samples. AOAC[6] and AOCS[7] recommend ethanol alone as the titration medium but we prefer the method specified in I UPAC[8] as the mixed solvents do not require any heating or vigorous shaking. Also, there is no rigidity about the quantity to be taken.

As it is not possible to present the detailed results of analysis of 373 samples, summary results are tabulated in Tables 1 and 2.

TABLE 1. FREE FATTY ACID PERCENTAGE IN 20 SAMPLES OF MUSTARD OIL

Storage period		
6 months	8 months	10 months
0.23–0.96 (16)	0.45–0.96 (13)	0.62–0.96 (10)
		1.13–1.18 (5)
1.01–1.07 (2)	1.01–1.13 (5)	
		1.24–1.98 (4)
1.19–1.35 (2)	1.24–1.75 (2)	
		2.88 (1)
12 months	18 months	24 months
0.79 to 0.96 (5)	0.86 to 0.91 (2)	0.68 (1)
1.24 to 1.96 (7)	1.24 to 1.92 (9)	1.24 to 1.92 (7)
2.03 to 2.43 (5)	2.14 to 2.93 (5)	2.03 to 2.88 (5)
3.27 to 3.61 (3)	3.61 to 3.90 (2)	3.05 to 3.38 (4)
		4.00 to 6.15 (3)

Figures in the parenthesis indicate number of samples

TABLE 2. FREE FATTY ACID (FFA) CONTENT OF 353 SAMPLES OF OIL (PER CENT)

6 to 9 months storage FFA	No. of samples	10 to 26 months storage FFA	No. of samples
Below 1	43	Below 1	110
,, 2	19	,, 2	108
,, 3	1	,, 3	45
Above 3	1	Above 3	26

The frequency distribution of the samples representing different ranges is evident from the tables. From the spread values of our findings it is seen that free fatty acid content does not generally exceed 2.0 per cent within 9 months. Only in two out of 84 samples examined the value exceeds 2.0 per cent and in one it is only upto 2.17 and in the other the initial reading is as high as 1.01 per cent. Even the figures within 10 to 26 months show that the maximum limit fixed in the PFA is too high and not fully justified. The results prove that the maximum limit of the value should not be more than 2.0 per cent.

Thanks are due to Shri T. V. Mathew, Director, Central Food Laboratory, for his keen interest in this study.

Central Food Laboratory, Calcutta
A. R. SEN
P. SENGUPTA (MRS)

10 November 1972

References

1. Fox, B. A. and Cameron, A. G., *Food Science—A Chemical Approach*, University of London Press Ltd., 2nd Edition, 1970, 102.
2. Lewkowitch, J., *Chemical Technology and Analysis of Oils, Fats and Waxes Vol. I*, Macmillan & Co., Ltd. London, 5th Edn., 1913, 51.
3. Pearson, D., *The Chemical Analysis of Foods*, J. A. Churchill, London, 6th Ed., 1970, 514.
4. Eckey, E. W., *Vegetables, Fats and Oils*, Reinhold Publishing Corp, New York, 1954, 438.
5. *The Prevention of Food Adulteration Rules, 1955*, Government of India, Ministry of Health Publications, Appendix B, Item A 17.06.
6. *Official Methods of Analysis*, Assoc. Off. Analyt. Chemists, Washington, 11th Ed., 1970, 446.
7. *Official and Tentative Methods*, American Oil Chemists Society, Chicago, Illinois, 2nd Ed., 1950.
8. *Standard Methods of the Oils and Fats Division*, I.U.P.A.C., Butterworths, London, 5th Ed., 1964, P II DI.

DETECTION OF CORN PRODUCTS IN FLOURS OF PEA, BENGAL GRAM AND WHEAT PRODUCTS BY THE USE OF FREE PROLINE CONTENT OF CORN

The admixture of maize or Indian corn (*Zea mays*) in flours of pea (*Pisum sativum*), Bengalgram (*Cicer arietinum*) and wheat (*Triticum aestivum*) or corn soji in wheat soji is one of the means of adulteration in vogue. Microscopical examination of starches[1], biuret test[2], spotting the ethanol extracts of the flours on a filter paper and observing under woods light[3], are the methods reported for the identification of corn flour. However they have their own limitations.

During the course of our study on free amino acids in the flours of corn, pea, Bengal gram and wheat, it

was observed that corn contains very high concentration of proline (as free amino acid) when compared to other flours under study. Although proline as free amino acid has been reported to be present in corn[4], pea[5], Bengal gram[6] and wheat[7], quantitative data have not been reported. As such a study was undertaken to determine the content of proline in these flours and using these data a paper chromatographic method has been devised for detecting the admixture of corn flour with other flours.

The test: A few local varieties of corn, pea, Bengal gram and wheat were purchased from Government Agencies, freed from foreign matter, powdered separately in a grinder attachment of a waring blender, sieved and the fine powder was defatted with petroleum ether in a soxhlet apparatus.

Twenty grammes each of the defatted flours were extracted with 100 ml of 70 per cent ethanol in a conical flask overnight. The filtered extracts were concentrated to dryness on a steam bath and, after petroleum ether treatment to remove traces of fats, the residue was taken in 5 ml of 10 per cent isopropanol and centrifuged. Ten microlitres of each of the clear extracts was chromatographed on a Whatman No. 1 filter paper by descending technique using *n*-butanol: acetic acid: water (12:3:5) as developing solvent. The paper after air drying was sprayed with 0.2 per cent ninhydrin in acetone and heated in a hot air oven at 100°C for 2 min. Proline was observed as a yellow spot at an Rf value of 0.47 in maize flour and was not identified in the flours of pea, Bengal gram, and wheat even at higher concentrations. The presence of proline was confirmed by co-chromatography using an authentic sample of proline.

Estimation of proline in flours: The isopropanol extracts were used for estimating the concentration of proline in the respective grains by the paper chromatographic method[8] using isatin reagent[9].

Table 1. PROLINE CONTENT IN CORN, PEA, BENGAL GRAM AND WHEAT

Flour	Proline content (mg/100g)
Corn	15.78
Pea	1.14
Bengal gram	1.96
Wheat	1.29

No significant variation in the concentration of proline was observed among different varieties of the materials. The average concentration of proline from three determinations in each of the flours of corn, pea, Bengal gram and wheat is given in Table 1.

From Table 1 it is clear that corn flour contains very high concentrations of proline as compared to other flours. This difference can conveniently be used as a basis for the detection of corn in other flours.

Food and Water Analysis Laboratory, Bangalore
C. P. HARTMAN
SAROJA PICHAMUTHU
N. G. DIVAKAR
U. N. NAGARAJA RAO

14 November 1972

References

1. A. T. Czeja, *Anal. Abstr.*, 1965, **12**, 3519.
2. W. S. Smirnow, *Chem. Abstr.*, 1932, **26**, 6027.
3. Jean Kiger, *Chem. Abstr.*, 1951, **45**, 6763.
4. Godishnik Khim, *Chem. Abstr.*, 1965, **62**, 819b.
5. Radha Pant and Ashok S. Kapur, *Z. Physiol. Chem.*, 1964, **338** (1-3), 39.
6. Radhakrishnan, A. N., Vaidyanathan, C. S. and Giri, K. V., *J. Indian Inst. Sci.*, 1955, **37A**, 178.
7. Betty Sullivan and Payne, W. E., *Cereal Chem.*, 1951, **28**, 340.
8. Eva Hrabetova and Jaroslav Tupy, *J. Chromatog.*, 1960, **3**, 199.
9. Barrollier, J., Heilman, J. and Watzke, E., *Z. Physiol. Chem.*, 1956, **304**, 21.

BOOK REVIEWS

Bakery Technology and Engineering: by SAMUEL A. MATZ, The AVI Publishing Company, Inc., USA, 1972, pp. 598. Price: $30.

Since the publication of the first edition in 1960, the field of bakery science, technology and engineering has advanced considerably. It is but natural that the AVI Publishing Company has brought out the second edition, in which the author has rearranged the old topics and in addition included new chapters. The book is conveniently divided into four sections dealing with raw material requirements of the baking industry, the different formulations and procedures for bakery products, processing operations and equipment and management aspects.

The first section on materials of baking discusses in 10 different chapters the raw materials for baking industry such as flour, water, leavening agents, sweeteners, shortenings, emulsifiers and antioxidants, milk products, eggs, fruits and nuts, flavours and colours and minor ingredients.

In chapter 1, flour—the main ingredient of bakery products is discussed. Aspects relating to milling, grading, constituents, testing in respect of baking quality of wheat and other flours are also covered. The relevant details of different chemical leavening agents and yeast are given in chapter 3. Chapter 4 deals with the basic information on the types and desired quantity of sweeteners commonly used, as they not only affect the taste, but also the texture and appearance of the baked products. The functional properties of natural fats and oils, modified shortenings, emulsifiers and antioxidants used in bakery products are covered in chapter 5. Chapter 7 relates to different aspects of uses of eggs mainly used in cake formulations for getting the desired colour, flavour and texture as a result of their emulsifying, leavening, tenderising and binding actions. Utilisation of fruits in pie fillings and of nuts in sweet goods is discussed in Chapter 8. The discussion in Chapter 9 covers natural flavours and colouring agents added in relatively small amounts primarily for their flavour modifying functions. In view of their significant contribution to sensory qualities and physical characteristics of the product, the minor ingredients (which are often quite important) like malt products, enzyme preparations, inhibitors of microbiological spoilage, dough improvers and yeast foods, etc., form the contents of chapter 10.

Coming to Section 2, formulations for (*a*) air-leavened, steam-leavened and unleavened products like cakes, pie crust, puff pastry, air-leavened breads, cookies, etc. and (*b*) chemically leavened products are given along with the procedures in chapters 11 and 12. The consequent reactions occurring in fermenting and baking doughs, the function of important ingredients and processing steps, recipes and preparation methods as well as the common difficulties encountered are discussed in the chapter 13 on yeast leavened baked foods. Chapter 14 gives the basic information on recipe and procedural aspects of adjuncts like icings, fillings, frostings, toppings, sauces, creams, marsh mellow, jellies, etc., which are commonly used for sweet bakery products.

The equipment commonly used for bulk handling of ingredients in bakeries are given in chapter 15 of Section 3. The equipment required for weighing, measuring and mixing with the relevant operational information is impressively covered in chapters 16 and 17. Adequate schematic diagrams have been used for an easy understanding of different equipment. The makeup equipment consisting of rounders, provers, moulders and forming equipment for different types of bakery products are discussed in chapter 18.

With the advent of modernisation in bakery industry, the continuous processing of bakery products in plants like Baker, Do-Maker, AmFlow and Chorleywood processes has assumed increasing importance. Naturally, chapter 19 discussing formulations and ingredients, equipment and procedures forms interesting and useful reading. The proofing and fermentation operations are exhaustively covered along with the equipment as well as their schematic diagrams in chapter 20. Since baking ovens and the auxiliary equipment like loaders, coolers, depanners, conveyers form dominant equipment with respect to lay out and the product quality, adequate stress has been given in chapter 21 on these equipment in respect of basic information on heat transfer mechanism, different types of ovens, mode of heating the ovens and the auxiliary equipment.

The slicing and packaging equipment along with the packaging materials are covered in chapters 22 and 23. Chapter 24 describes finishing and decorative equipment, special plants and some auxiliary devices, like applicators, sandwitching machines, jelly rolls, chocolate conditioners, etc. The preservation methods

for bakery foods by freezing and other methods like heat treatment in hermetically sealed containers are covered in chapter 25.

In Section 4 on technical functions in bakery operations, the research and development aspects relating to product development, administration, controlling, operation research, product development systems are discussed in chapter 26, while chapter 27 gives the basic concepts of the role of the quality control department in a bakery organisation. The last chapter emphasizes on nutritional considerations to be kept in view while formulating bakery products.

All the 28 chapters have been appended adequately with bibliographies covering mainly the references to recent developments after 1960.

One is likely to be surprised that the Publishing Company of AVI's reputation has overlooked the printing error on the contents page, wherein chapter 15 on bulk handling of ingredients has been wrongly grouped under Section 2 instead of Section 3.

To conclude, the present book forms a short encyclopaedia for all those involved in learning, practising or researching in the field of baking science, technology and engineering and is practically a must, on the book-shelf of all those associated with this branch of food technology.

S. R. SHURPALEKAR

Health Hazards of the Human Environment: World Health Organization (1972), 388 pages. Price: £ 4.40, $ 11.00, Sw.fr. 44. WHO Regional Office, Indraprastha Estate, Ring Road, New Delhi 1.

If allowed to proceed unchecked, environmental degradation may cause serious and sometimes irreversible damage to life on this planet. Much remains to be learned, however, about the complex interrelationships between environmental factors and health. There is consequently a great deal of uncertainty about many issues on which judgements and decisions are required daily. The situation is all the more confused because such decisions are influenced not only by the amount of scientific knowledge available but also by economic, political, cultural, and other considerations.

The World Health Organization has been concerned about these problems throughout the twenty-five years of its existence, and in 1971 the Twenty-fourth World Health Assembly carried out an extensive review of the situation and indicated those areas in which action is particularly needed. Subsequently, the United Nations Conference on the Human Environment, held in Stockholm in July 1972, focused worldwide attention on the environmental hazards to human health. A wide-ranging survey of these hazards, prepared by 100 specialists in 15 countries, has now been published by the World Health Organization. It not only summarizes what is known at present but draws attention to the many gaps in knowledge and suggests measures that can be taken to minimize health hazards. While it is intended mainly for health authorities, it will undoubtedly be of interest to others concerned with environmental problems.

The publication consists of four parts. In Part I environmental hazards are considered in relation both to such physical aspects of the environment as air, water, food, soil, and land and to others less easy to quantify, such as the home and the place of work.

Part II is devoted to a discussion of specific chemical contaminants and physical hazards present in the environment. Mutagens, carcinogens, teratogens, and pesticides are dealt with as groups because of the special problems they pose. Particular attention is paid to the problems involved in interpreting the results of laboratory tests, since these tests form the basis of most decisions to limit or prohibit the use of particular substances.

The development of a world system of surveillance and monitoring of environmental factors affecting health is the subject of Part III of the publication. WHO has for some years carried out surveillance and monitoring in the field of communicable diseases and of adverse drug reactions, but a much broader and better integrated effort is required. The ultimate goal must be a comprehensive health information network linking all countries. Such a network will be able to take advantage of the recent remarkable achievements in methods of accumulating, organizing, and handling data making use of systems theory and electronic computers.

In Part IV environmental health hazards are viewed from the standpoint of the action that can be taken to deal with them. Great importance is attached to the development of criteria and standards that could be generally applied in, for example, air and water pollution and food contamination. Political, economic, and cultural differences make this difficult, but it has proved possible to draw up valuable criteria and standards of this nature in certain instances. Part IV also includes a discussion of the role of basic sanitation in solving many problems in the control of communicable disease, and some indications of the ways in which advanced technology may be used for controlling certain pollutants and nuisances.

Handling, Transportation and Storage of Fruits and Vegetables: Volume I. Vegetables and Melons, by A. LLOYD RYALL AND WERNER J. LIPTON, The AVI Publishing Company Inc., Westport, Connecticut, 1972, pp. 473. Price $20.

In the USA during 1964-67, though 52 per cent of the total vegetable acreage was intended for processing, 71 per cent of the farm value was generated by the remaining 48 per cent of the acreage intended for 'fresh produce trade', thus indicating the importance of 'fresh produce trade' in the agricultural economy of that country. This is also true of many other countries.

Research activities on 'fresh produce trade' have been undertaken in many premier research institutions of the world and considerable amount of data have been collected and published in a number of scientific and professional journals, reports, circulars, etc. In the book under review the authors have ably compiled documentary evidences from different sources on the biological and physiological aspects of marketing of fresh vegetables including potatoes and melons.

The various aspects of fresh produce trade are covered in 22 chapters. The emphasis, however, is laid on practices and techniques followed in horticultural crops grown in the USA.

The first chapter on 'vegetables as living products' briefly deals with some aspects of respiration and transpiration during post-harvest period of the fresh produces, difficulties in considering the rate of respiration as an index of 'storage life' and usefulness of Q_{10} value while calculating refrigeration or ventilation requirement have been well described. Brief mention is also made of chilling injury occurring in the field and during storage, its deleterious effect on the quality and the methods of combating it.

Chapter 2 and 3 deal with 'harvesting practices and equipment' and 'preparation for marketing' respectively. It is interesting to note that harvesting of crops meant for processing is generally mechanised, but not much evidence for fresh produce trade. A very brief description of machinery used is given. The limitations in adapting mechanisation are neatly summed up. In chapter 3, all the operations involved like washing, scrubbing, curing and grading are covered adequately including scientific methods of grading, measurement of quality by texture, sensory evaluation, etc.

The next two chapters deal on 'shipping containers' and 'consumer packages'. Types of shipping containers, methods of filling, legislation in certain States in the U.S.A. with regard to types and size of container have been detailed. The chapter could have been more beneficial by including greater details on materials used in shipping containers, cushioning materials, wrappers, and methods of packing.

Principles and advantages of prepackaging, types of packaging materials and their properties have been given adequate treatment. However, the basis for number and size of ventilation holes in packages is not clearly explained.

In chapters from six to nine on 'commodity requirements', the fresh produces have been divided into (*i*) 'leafy vegetables and flower buds', (*ii*) 'unripe fruits and miscellaneous structures' and their requirements like types of precooling, favourable temperatures and RH, air circulation, packaging criteria, favourable modified atmospheres, precautions in curing, effect of exposure to ethylene, etc., during transit, storage and retail distribution have been discussed in great detail with reference to a number of commodities providing valuable information. However, it could have been more useful if information on (*i*) plastic wraps used for leafy vegetables, (*ii*) packing pattern, (*iii*) arrangement of shipping containers in cold storages were also included.

Chapter 10 dealing with 'treatments prior to shipment or storage' is perhaps one of the best chapters in the book covering different methods of precooling, equipment needed and limitations of each method. The concept of 'half cooling time' and 'half warming time' their practical applications are well brought out by means of nomographs.

In chapter 11 on 'ventilated storage', a method is described in which natural favourable temperature prevailing during certain period of the year is advantageously made use of for storage of certain commodities and storage structure have been described. Careful planning needed in ventilated storage of commodities like potatoes, onions, sweet potatoes, carrots, etc have been well brought out. The chapter on 'refrigerated storage' includes principles of refrigeration, equipment, importance of temperature and RH during storage, commodities which need low and intermediate temperature have been described and a brief mention is also made on 'controlled atmosphere storage' and 'hypobaric storage'.

Chapter 13 and 14 deal with transportation by rail and high way and by air and sea. Efforts to minimise losses by devising different types of rail and road transport systems and improved facilities available in them have been described. Newer development in the transport called 'Tectrol' atmosphere system has been mentioned. Advantages of using aircrafts of the Boeing type are described.

A good coverage has been given on transportation in ships where the losses due to pilferage is estimated to be about 10 per cent. The advantages of refrigerated and ventilated shipholds, their economics, use of pallet bins, unitizing of container against 'break bulk system of loading' are mentioned.

The 'market disorders' have been discussed in chapter 15. The disorders due to unavoidable internal causes such as senescence and the avoidable external causes such as rough physical handling, preharvest or post-harvest freezing, heat injury and injuries caused by light and ultraviolet radiation and disorders due to volatiles have been discussed. In the following chapters 16 to 18, description and the causes of disorders, and methods of prevention with respect to a number of commodities classified under 'leafy vegetables and immature flower heads; "unripe and ripefruits", underground structure' have been systematically described. On the same lines, 'market diseases' of the commodities, causative organisms and various preventive measures like use of chemicals, antibiotics, hot water, etc. find a good coverage in chapters 19 to 21.

The last chapter is on 'protection during wholesale and retail distribution'. All the factors to be taken care of to achieve the desired goal have been dealt with in detail.

The elaborate treatment given to each of the activities involved in the fresh produce trade have been well brought out in this book which will serve as a valuable and useful reference book to researchers, extension workers and teachers, workers and to people concerned in the trade specially in developed countries. At present many of the practices mentioned in the book are not followed in underdeveloped and developing countries for want of facilities and economic reasons. This, however, does not diminish its academic value, and knowledge available in the book would be helpful in planning their future developmental programme.

The book contains good number of tables, charts and nomographs at appropriate places to make the points clear. At the end an appendix covering calculations of temperature, refrigeration requirements and relative humidity, etc. and a glossary to familiarise the readers with scientific and technical terms have all enhanced the value of the book. The printing and get up of the book are attractive.

B. ANANDASWAMY

Rice: Chemistry and Technology: by D. F. HOUSTON, American Association of Cereal Chemists, U.S.A., 1972, pp. 527. Price: $21.50.

The book entitled 'Rice: Chemistry and Technology' published by the American Association of Cereal Chemists fills a long felt need for a comprehensive treatise relating to this important cereal. Books so far available on the subject have emphasised mainly the agricultural, breeding or physiological aspects. The present book written by specialists in diverse fields relating to the chemistry, biochemistry, handling, storage, processing and utilization of rice is the first of its kind and will be welcomed by students, teachers, research workers and technologists.

The initial chapters review adequately the present status of knowledge relating to the histology and chemical composition of the grain and the important enzymes present in it providing the basic chemical and biochemical information which has direct or indirect bearing on the nutritional, processing and storage qualities of the grain. Parameters for judging marketing, consumer and processing qualities are next reviewed. The technology of harvesting, drying and storage of the paddy follows in sequence. Milling technology as practised currently particularly in the U.S. is next described followed by description of the present status of the recently developed technology relating to solvent milling of brown rice. The chapter relating to distribution of nutrients and other chemical constituents within the rice grain and changes taking place during the ageing of rice is highly informative although it could have been presented along with the earlier chapters relating to the chemistry of rice. The problems and prospects relating to speciality flours using rice are described next.

Chapters 11 and 12 relating to chemistry, technology and utilization of the important byproducts of rice milling are extremely informative as they summarise existing information highlighting future avenues for utilization. The details of the currently practised methods for enrichment of milled rice and conservation of nutrients through parboiling are next covered in chapters 13 and 14. Chapter 15 describes the basic principles governing the technology of producing quick cooking rices. Adaptation and simplification of this technology should be useful to all rice consuming countries especially in the matter of producing a quick cooking parboiled or undermilled rice with high nutritive value. Processed rice products produced in advanced countries and the technology of their production along with their nutritional implications are described in the next three articles. The last two

chapters of the book relate to the use of rice and milling byproducts of rice for the manufacture of beer and Sake. Information describing the production of Sake brings out many details which are perhaps not so well known and are practised as an art particularly in Japan.

The various subjects covered in the book have been written by specialists in the respective fields and have been generally well covered both in depth and expanse. As most of them are drawn from the U.S. much of the information is presented in the context of the U.S. situation although the basic information and technology would certainly be useful to the Asian countries. Although the physical properties of rice and its byproducts are given in the text in the relevant context it would be useful, in future editions, to include an exclusive chapter summarising information on the physical properties of paddy, rice and rice byproducts.

H. S. R. DESIKACHAR

Indian Sardines: by R. V. NAIR, Council of Scientific and Industrial Research, New Delhi, 1972. pp. 107. Price: Rs 22, $ 7.00 or £ 2.20.

The 'Indian Sardines' by Dr R. V. Nair of the Central Marine Fisheries Research Institute, Mandapam Camp (Tamil Nadu) is a CSIR Zoological Monograph (pp. 107) No. 2. The subject is of great importance because the clupeoid fishes occupy a unique position in the Indian fisheries as they constitute about one-third of the total marine fish production. Of this Indian oil-sardine (*Clupea longiceps*) is the most important pelagic fish. However, there have been great seasonal and annual fluctuations of this unpredictable fish with the result that it is rather undependable for commercial exploitation. The present monograph contains full details of the fundamental aspects of the biology of the fish i.e., its early life history, food and feeding habits, embryonic and larval development, spawing habits, age and growth, rate, etc. These important data should considerably help research workers in planning and undertaking of research work in areas which require further study and investigation.

Apart from the oil-sardine, the lesser sardines as a valuable source on both the east and west coasts of India, should play equally important role. The results of the investigation on the various aspects such as taxonomy, binomics, etc., on these fish should be of considerable value to the scientists in the field. The biology and fishery of the lesser sardines discussed are *Sardinella gibbosa, albella, fimbriata, sirm, malanura, sindensis, clupeoides*. Other lesser fish taken into consideration are *Sardinella dayi, huseelti, dussumieria acuta* and *Kowala coval.* Data is also presented in the catch of these fish and their utilization.

The results of the investigation carried out during the last two decades are covered by about 150 references nicely documented at the end of the book. It also contains author index, systematic index and subject index. This well illustrated monograph will prove useful to teachers, post-graduate students and pisciculturists.

M. N. MOORJANI

Hygiene in Food Manufacturing and Handling: by BARRY GRAHAM-RACK AND RAYMOND BINSTED, Food Trade Press, London, Second Edition, 1973. pp. 184. Price: £4.00.

Ever since taking sensible care of mankind's food supply became known as food hygiene, a number of authors have attempted to write definitive books on this important subject. Almost without exception they have finally produced books on food-borne disease rather than books of positive advice on food care. One of the notable exceptions was the first edition of 'Hygiene in Food Manufacturing and Handling'. This book did get to grips with the real nub of the matter because the authors appreciated that food hygiene is rather more than the prevention of notifiable food-borne disease, and they did offer direct advice on improving hygiene in food factories and other food premises, in language that had clear meaning.

The second edition of this book stays with these principles and is improved in many aspects regarding the food technology involved. Perhaps the most difficult of all food care problems lies in the rapid changes in food processing and handling techniques. This new edition has been completely revised, enlarged and is profusely illustrated. It deals only in passing with the medical connotations, but concentrates on the effective design of food processing premises and equipment. The effective cleaning and maintenance of these premises and items of equipment thus becomes the paramount factor and it will be found as the central feature of this book.

The explanation of the formulation and application of the products of the industrial chemist, which allow the food handler to work correctly without causing hazard to anyone, is the basis of modern positive food hygiene. This book covers that explanation and gives information on engineering detail relating to food machinery, without which knowledge food hygiene cannot be practised.

To be economically viable, modern food production depends on wide-scale distribution. Wide-scale distribution is not possible if any production method or circumstances or place is unhygienic. Therein lies the value of this publication.

The thirteen chapters are entitled as follows: An Introduction to the Problems of Food Poisoning and Spoilage; Bacteria, Moulds and Yeasts; Digestive System; Bacterial Food Poisoning; Cases of Food Poisoning; Non-Bacterial Food Poisoning; Food Spoilage; Protection of Food; Construction and Layout of Plant and Equipment; Cleaning Methods; Pest Control and Hygiene; Hygiene Contract Services; Statutory Regulations, followed by an appropriate Index.

Composite Flour Technology-Bibliography: by D. A. V. DENDY, A. W. JAMES AND P. A. CLARKE, TPI Report G71, Tropical Products Institute, London, 1972, pp. 10.

The role of composite flours in developing countries for substituting or protein enrichment of bread ingredients is of paramount importance. In addition, other starchy sources like cereals, tubers, etc., and protein sources like edible oilseed meals are covered in this report.

An exhaustive list of 150 references is classified under different headings like (i) general (ii) bread (general, cassava and roots, cereals, protein supplementation and nutritional aspects), (iii) biscuits, (iv) indigenous foods, (v) pasta products, and (vi) grain substitutes. Of these, nearly 100 publications included are those published after 1964 indicating thereby an exhaustive coverage of recent work reported from all over the world. There is no doubt that this bibliography on composite flour technology will be of immense use to food scientists as guidelines for utilising the available information as well as for planning future lines of research work.

S. R. SHURPALEKAR

Cassava Processing: Commercially Available Machinery by JEAN S. INGRAM, TPI Report G75, Tropical Products Institute, 1972, pp. 8.

In this report, the author has given a brief introduction on the present status of cassava (also called manioc, manihot, tapioca, etc.) production, processing and machinery. The machinery manufacturers and suppliers of plants for manufacture of starch, gari, pellet, chips, flour and also for grinding, drying and powdering are enlisted. 28 useful references on experimental machines and techniques used in cassava processing are included at the end. It is needless to emphasise that this TPI report will be of great use for research workers and those interested in the processing and utilisation of cassava.

S. R. SHURPALEKAR

Principles of Package Development: by ROGER C. GRIFFIN, JR. AND STANLEY SACHAROW, The AVI Publishing Co., Inc., Westport, Connecticut, 1972, pp. 327, Price $ 18.

This is the second book by the same authors and is written in logical sequence to the first one entitled 'Food Packaging' to remove 'a glaring gap in the rapidly growing field of packaging viz. principles of package development'.

Packaging development today, as rightly pointed out by the authors, is a multidisciplined profession requiring a knowledge of packaging materials and their conversion; package forming, filling and closing; packaging machinery; package testing; product manufacturing processes; product properties; transport, storage and handling procedures; package economics; commercial art and design; marketing and advertising and legal regulations. Persons who enter this fascinating profession therefore need to develop a wide perspective and gain knowledge of wide range of inter-related matters as indicated above. Books like the one under review will no doubt prove a very valuable asset to all such persons.

Chapter 1 of the book gives a short history of the gradual development of the modern concept of the package and forms an appropriate introduction to the subject matter of the book.

Chapter 2 gives view of various aspects of package development and brings out very clearly the intricacies of the interrelationships among corporate groups in the development of a new package system.

Chapters 3 to 9 deal in detail each one of the various aspects concerning the development of a packaging system. The information given in these chapters are quite extensive and supplemented by well-documented literature. Chapter 10 deals with disposal of waste packaging material. Disposal of solid wastes is one of the pressing problems of advancing society and is engaging the attention of world bodies. Since waste packaging material constitutes 10-20 per cent or more of the total municipal and industrial solid wastes the authors have done well in including this chapter.

It not only deals with the technology of solid waste disposal but gives all related information to the packaging technologists which are aimed at generating an awareness and understanding of the problems so that they could guide themselves in developing packaging in a manner that will best serve the interest of both the industry and the society.

Chapter 11 is of special interest to the developing countries as it deals with packaging development concerning them. Voluminous information is given on various agencies of the United Nations Organisation and bodies in developed countries which have activities aimed at the packaging needs of the developing countries. This will prove useful to the countries concerned.

The binding and printing of the book are good and it contains a large number of excellent illustrations. The book will prove to be a very valuable training aid to people who take to packaging as their career and indeed a useful addition to the libraries of institutions which are engaged in packaging activities.

K. G. GHOSH

Soybeans, Chemistry and Technology: Vol. I, Proteins. Edited by A. K. SMITH AND S. J. CIRCLE, The AVI Publishing Company Inc., Westport, Connecticut, 1972, pp. x + 470, Price: $ 24.

Among the leguminous crops of the world, the soybean is unique on account of its high content of protein of excellent nutritional quality. With about 40 per cent protein and 18 per cent fat, it occupies an intermediate position between the pulses and oilseeds and has been used as human food for centuries in China, Manchuria, Japan and other countries of the Far-East. Nearly 70 per cent of the world's current production of 44 million tonnes per annum comes from the US where it is mainly processed for recovering the edible oil and protein rich meal for livestock feeding. Two detailed and well documented volumes on 'soybeans and soybean products' edited by Markley (1950-51) have been serving as useful reference books on the subject all these years.

A very large amount of work on the basic, technological and utilization aspects of soybean has been in progress in the US and other countries for the past two decades and much valuable data have been reported. The main aim of the present book has been to review these developments particularly on the food uses of soybean protein products. The two editors have themselves done pioneering work and made notable contributions on the processing technology of soy flours and protein products. Four of the 12 chapters in the book have been written by them and the remaining by well known authorities in the respective fields. The chapters are: Historical background; Genetic and other biological characteristic; Chemical composition of the seed; Purification and properties of the proteins; Organic solvent treatment of soybeans and soybean fractions; Biologically active components; Nutritional value of food protein products; Biological processes in stored soybeans; Processing soy flours, protein concentrates and protein isolates; Protein products as food ingredients; Fermented soybean food products; and Marketing of soybeans and their protein products. The appendix contains information on glossary of soybean terms, US standards for soybeans and flours, analytical data on commercial soy protein products and the names of companies marketing such products. The AOCS methods on the nitrogen solubility index (NSI), protein dispersibility index (PDI) and urease activity have also been included.

In the foreword to the book, Dr Max Milner, Executive Secretary of the Protein Advisory Group of the UN refers to the challenge of effectively applying the 'new' technologies to the production of human food from the large resources of oilseed protein in the world and emphasises the fact that success in 'soybean utilization has been achieved only because of the research accomplishments of dedicated human talent and years of steadfast financial and institutional support for its efforts'.

The book has an excellent get up and the figures, flow-sheets and diagrams are clear and informative. The topics covered will be of immense value to food scientists and technologists as well as agronomists, nutritionists, and marketing specialists. The volume can serve as a very useful reference book to all those engaged in research and development on oilseed proteins.

N. SUBRAMANIAN

The Use of Protein-rich Foods for the Relief of Malnutrition in Developing Countries: An Analysis of Experience: by ELIZABETH ORR. TPI Publn. G. 73, Tropical Products Institute, London, 1972, pp. VI+71.

This is a critical report dealing with the major approaches to solving the protein problem in the technologically less advanced countries of the world. The successes and failures of the different protein-rich

food schemes have been dealt with and the reasons thereof analysed. Based on the experience of a number of such programmes it has been found that many of the products have not penetrated to the rural areas to any extent. It is considered unlikely that such foods will play any significant role in reducing malnutrition among the low income groups unless substantial government assistance is provided with regard to finance and marketing. It has been pointed out that there should be a reapprisal of government policies on the use of donated foods as these can be a serious disincentive to the local production of protein rich foods. The report has the following sections: I. Introduction: the protein problem and approaches to it. II. Protein-rich food schemes. III. Some aspects of protein-rich food schemes. IV. Evaluation of the protein-rich food approach. V. Initiation of protein-rich food schemes: guidelines for Government administrators. The final section offers many constructive suggestions and recommendations which will be helpful to the future development of protein-rich foods. The manner in which the governments may provide incentives for participation by private firms has been discussed. The report will be quite useful to all those engaged in the development and promotion of protein foods.

N. SUBRAMANIAN

Tree Fruit Production: by BENJAMIN J. E. TESKEY AND JAMES S. SHOEMAKER, AVI Publishing Company, Inc. Westport, Connecticut, USA. 2nd Edn. 1970, pp. 336. Price $16.

This book is a new, revised edition of 'Tree Fruit Production' published in 1959. The authors have covered important fruit crops cultivated in United States of America and Canada. The fruit crops include apples, pears, dwarfed apples and pears, peaches, cherries, plums, apricots and nectarines which have been discussed in detail in seven chapters covering 327 pages.

Since the first edition was published, considerable information has accumulated on important developments in horticultural science and the authors have ably brought out up to date information on this subject in this new revised edition. This book appears to be an outcome of research in various institutions in U.S.A. and Canada together with practical experience of the authors.

Origin, history, botanical aspects and total production of these temperate fruits in United States and Canada have been ably discussed in each chapter. Orchard operations such as propagation of nursery stock, cultivars, soil management, planting operations, pruning, diseases and pests, low temperature injury, nutritional requirements, prophylactic measures adopted to control diseases and pests have been briefly discussed under each fruit crop. Use of chemical regulators for fruit thinning and colouration have been dealt in greater detail in each chapter. Harvesting and packing operations, maturity indices for harvest, storage under refrigerated and controlled atmosphere conditions, factors affecting storage qualities, storage disorders and diseases are of special significance in each chapter and these aspects have been briefly reviewed under each fruit crop.

The horticultural practices and post harvest technology of these temperate fruits are constantly undergoing changes. Mechanised operations have been introduced in commercial fruit orchards in view of the extreme high cost of labour. This aspect has been summarised by the authors under each fruit crop.

In view of the latest developments in orchard practices involving chemical regulators for thinning of fruits, control of pre-harvest fruit drop, preparation of the fruit for mechanical harvesting and better storage, the science of fruit culture has come to the forefront.

Increasing emphasis is laid on improvement of fruit colour for consumer appeal, efficient pre-cooling techniques for longer storage life after harvesting and integrated approach for control of pests and diseases and these aspects have been brought out by the authors very ably.

Increasing costs of fruit crop management and economic competitions have led to the adoption of labour-saving devices and this has completely changed the orchard management and post-harvest practices. The third chapter is devoted entirely to this subject with special reference to apples and pears. This is a subject of growing importance in developing nations of the world. The authors have discussed current developments in this field comprising of high density orchard planting and new techniques of management and maintenance of fruit orchards.

Each chapter is followed by a bibliography for ready reference and the text is illustrated with photographs and drawings for clear understanding. The detailed index is very useful for quick reference.

This book is useful as a text to the students, a reference for the researchers and as a guide for orchard practice.

H. SUBRAMANYAM

Final Report of the CSIR Scheme on *Stabilisation of Rice Bran in Closed Circiut Fluidised Bed Heat Transfer System:* By B. N. SHRIMANI, 1972, pp. 25.

The report pertains to the work carried out at the Department of Food Technology and Biochemical Engineering, Jadhavpur University, Calcutta on the stabilisation of rice bran by inactivating the lypolytic enzyme in rice bran and hence arrest the rise in the FFA content of the extracted rice bran oil. Thus an edible quality oil can be obtained.

Initial studies were directed on the effect of humidity and humid heating on the growth of micro-organisms.

Inactivation of the enzyme was carried out by heating at 100°, 110° and 120°C for 10, 12, and 20 minutes. Heating period of 20 min was found necessary at 110°-120°C, prolonged heating at high temperature affects the quality of oil and involves fire hazards. Exposure to live steam for a period of 3 minutes will completely destroy the enzyme. Bran needs immediate drying to remove the moisture absorbed during steaming.

A fluidised bed heat transfer system handling ½ ton of bran per day using a 22′ column and heating the bran to 110°C by hot air at 180°C was designed, fabricated and worked out by the author.

Based on the data, the economics of batch and continuous rice bran oil extraction plant for high FFA content and low FFA content has been worked out for a 5 ton of rice bran per day plant. It has been found that stabilisation by the above method yields an edible quality oil with a margin of Rs 450 per ton over high FFA content rice bran oil.

P. N. SREENIVASA RAO

NOTES AND NEWS

Research and Education Trust Created

A Research and Education Trust named after the internationally renowned scientist and standards personality, Dr Lal C. Verman, has been established for the development of standardisation as a new and distinct discipline. The trust will be particularly concerned with research and education in standardisation in all areas of human endeavour including industry, agriculture and administration. The trust will seek to promote these through grants, fellowships, professorships, etc., and appropriate recognition of meritorious contribution to the advancement of the discipline.

Dr Lal C. Verman, formerly founder Director General, Indian Standards Institution, and adviser on standardisation to the Government of India, will be the chairman of the trust. Dr Verman has initially endowed a sum of Rs 25,000 for the establishment of the Trust. He has also assigned to the Trust the copyright and royalties accruing from his Book 'Standardization—A New Discipline' just published as an Archon Book in the United States and soon being published in India by the Affiliated East-West Press, New Delhi. The trust is authorized to receive cash and other contributions from all those interested in its objective.

ISI Certification for Food Colours

The Government of India decided to amend the Prevention of Food Adulteration Rule No. 48A regarding the sale of coaltar food colours by providing that 'the coaltar dyes and their preparations or mixtures permitted for use in certain foods shall be sold under the ISI certification mark'.

This was disclosed by Dr M. S. Swaminathan, Chairman of the Agricultural and Food Products Division Council of the Indian Standards Institution at its annual meeting held recently in New Delhi.

Dr Swaminathan said that ISI certification for food colours and their preparations would come into operation after about one year—the minimum time necessary for exhausting the present stock which do not carry the ISI mark.

Confructa Award in Memorium Z. I. Kertesz 1973

On the occasion of the International Confructa Symposium 1973 in Budapest, Hungarian People's Republic, entitled 'Fundamentals and Applications of Instrumental Colour Measurement of Raw Materials and Products of Industrial Fruit and Vegetable Processing' and organized by the Hungarian Scientific Society for Food Industry, and the Board of Editors of CONFRUCTA, International Journal for Technology of Fruit and Vegetable Processing. Dr Dipl.-Ing. Karoly Kaffka, head of the department for control engineering, Central Food Research Institute, Budapest, has been granted the 'CONFRUCTA AWARD' in memorium Z.I. Kertesz in recognition of his outstanding scientific achievements in the field of technology of fruit and vegetable processing with special regard to the automation of instrumental quality control.

Short Term Course on Poultry Nutrition, Feeding and Feed Processing

A short term course on Poultry Nutrition, Feeding and Feed Processing was held at the Poultry Research Division, I.V.R.I., Izatnagar, from May 14-18, 1973. This course was organised under the auspices of the ICAR and UNDP Centre of Excellence for Advanced Studies in Poultry Production located at the Poultry Research Division, IVRI, Izatnagar, U.P. Dr G. L. Sharma, Principal-cum-Joint Director, IVRI, welcomed the delegates. Dr C. M. Singh, Director IVRI, in his presidential address, laid stress on popularising small-scale poultry farming, which a common man could afford with a limited investment. He requested the delegates to give priority in their discussion to measures to bring down the high cost of poultry feeding and to divert their research to the more practical problems of the day. Dr B. Panda, Head of the Poultry Research Division and Sub-Project Coordinator of the UNDP Centre of Excellence proposed the vote of thanks. While proposing thanks, Dr Panda pointed out that poultry production has become one of the means of fighting poverty, unemployment and malnutrition in India. As such, more attention should be paid for the growth and development of the poultry industry in India.

Chemical Engineering in the Service of Mankind

An international congress of the above title, was organised by the Societe de Chimie Industrielle from 3-9 September 1972 at Ecole Centrale des Arts et

Manufacturers, Chatemay-Malabry (France), as an event of the European Federation of Chemical Engineers.

Prof. H. Brusset, President of the Congress, called upon the participants to find solutions of the problems facing mankind. Fight against hunger, fight against pollution, and fight for protection of environment, were enunciated by him as the three tasks before their deliberations in the following Congress sessions. The ball was set rolling in the paper dissecting the role of UNICEF and the state of food technology and food industries in the developing countries. The fallacy and futility of continuing assistance on a long-term basis were exposed in serving no purpose to lasting solution of the problems. During discussions more information on the bankruptcy of international agencies was presented. Particular reference was made to the UNICEF assistance to India in the form of milk and cheese processing plants, groundnut flour and protein plants, and milk-vending machines. It was pointed out that the benefits of such assistance never reached the vast majority, the supposed targets, with the help of products beyond their purchasing capacity, and that such assistance made any tangible impact on production of raw materials to increase their local availability to the common people.

A programme for manufacture of protein foods and some specific amino acids in developing countries in fight against problems of food and nutrition was outlined in a paper, with Mexico as an example.

In a survey of leaf protein research and perspectives of technology, special attention was focused on the problems in processing and in subsequent handling of different products for satisfactory use, viz., leaf green and decolourised leaf protein concentrate, pressed fibrous residue, and the deproteinised fluid.

There were two papers on fungal proteins. One reported a process for converting the sugars in carob fruit (*Ceratonia siliqua*) to fungal protein. The second paper reported the development of the RHM pilot plant from original laboratory research, as the first commercial continuous in-line sterilization and fermentation production of fungal biomass from waste cheap carbohydrates. New developments from Holland were presented on production of fish protein concentrate around the T.H.E. Solvent extraction process, including desolventisation techniques for improving the wettability of the product.

Genetic and physiological techniques to improve the nutritive value of SCP in yeasts on petroleum hydrocarbons and development of mutant strains yielding biomass with increased methionine levels, were reported in an Yugoslav paper. Progress was reported on the two British Petroleum (BP) 4,000 and 16,000 tons capacity plants, based on paraffin and gas oil hydrocarbon processes respectively, which produced single organisms in sealed, sterile fermentation chambers under strictly controlled conditions of pH, temperature, etc. Results from studies at different centres were presented to show that the BP yeast was a good protein supplement and that it had no toxicity.

In terms of technology *per se*, the wide spectrum of coverage revealed very interesting developments in new processes and new sources of protein foods, ever widening the scope of production.

The 4th International Congress of Food Science and Technology, Madrid, September 22/27, 1974

The organising committee has already determined the contents of the Congress. Firstly special attention has been devoted to the scientific programme, about what we have just received the following information: There will be two different kinds of sessions, those for the presentation of research papers, and round-table discussions.

The final selection of topics are the following for the general paper sessions: 1. Chemistry and Biochemistry of Foods. 2. Physical Properties of Food. 3. Sensory Properties of Foods. 4. Microbiology of Foods. 5. Food Processing. 6. Food Engineering. 7. Food Science and Nutrition. 8. Food Safety and Sanitation. 9. Environmental Pollution.

Similarly, the following themes have been decided for round-table discussions; 1. Current experience of waste treatment in the food industry. 2. Techniques in the forecasting of food research needs. 3. Agricultural pollutants in foods; how to fight them. 4. Education and training in food science and technology. 5. Evaluation of consumer's needs in relation to price and quality. 6. Food science and technology. 7. Need for co-operation between research centres and international agencies for industrial development.

In the near future, the regulations for the submission of papers will be given and the dates fixed.

New Infrared Spectra of Monomers and Polymers Published by Sadtler

Sadtler Research Laboratories, Inc., of Philadelphia, has published 600 new infrared reference spectra of Monomers and Polymers. These two new volumes will supplement the twelve volumes of IR grating spectra which have been previously published in this collection. Included are spectra of commercially available products such as monomers, polymers,

catalysts, antioxidants, modifiers and other additives which are used in polymerization processes.

VI International Congress of Essential Oils

The Scientific Programme Committee of the VI International Congress of Essential Oils calls for scientific papers to be presented at the Congress on 8-12 September 1974, in San Francisco, California, USA.

These papers should report technical and scientific achievements based on original research work in the fields of essential oil technology. All scientists who wish to present a paper should send a letter of intent which should include the title of the paper, the author's name and current address to the Scientific Programme Committee, VIth International Congress of Essential Oils, 60 East 42nd Street, New York, New York 10017, USA. Immediately upon receipt of this letter, an abstract form from the Committee will be forwarded to the author, who must complete it and return it to the Scientific Committee by 1st February 1974. If accepted, the abstract will be published as submitted in the programme.

Journal of Plantation Crops

The Indian Society for Plantation Crops is happy to announce the launching of its official publication THE JOURNAL OF PLANTATION CROPS. The Journal is meant for the speedy publication of original articles and invited reviews on all aspects of all the plantation crops including spices and condiments. The first volume will be published in 1973. One volume will consist of 2 numbers. Each number will have about 125 pages. (Subscription: Rs. 30 in India, US $ 10 or £ 4 elsewhere.)

The Journal welcomes submission of articles for editorial consideration from members. The articles may be on agronomy and soil science, genetics and breeding, physiology and biochemistry, diseases and pests, and processing and marketing. They may be sent to the Editor, JPC, Central Plantation Crops Research Institute, Regional Station, Vittal—574 243, S.K., Karnataka State, India. Authors planning to submit articles may write to the Editor for a copy of the 'Instructions to Authors'.

The membership of the Society is open to all persons interested in plantation crops. The details of membership are available from the Secretary, Indian Society for Plantation Crops, Central Plantation Crops Research Institute, Kasaragod-670 124, Kerala State, India.

The Society is also publishing the proceedings of the first Indian National Symposium on Plantation Crops held at Trivandrum in December, 1972. A total of 48 papers were presented in the six sessions of the Symposium (Genetics and Breeding, Agronomy and Soil Science, Pathology, Entomology, Physiology and Biochemistry, and Technology). Tentative price: Rs. 50 in India. US $ 20 or £ 8 elsewhere.

Indian Standards Institution

The following standards have been published:

IS:2168-1971	Pomfret Canned in Oil	Rs 8.00
IS:6635-1972	Tractor Operated Disc Harrows	Rs 5.50
IS:4366-1972	Agrl. Tillage Discs (Flat Type)	Rs 5.00
IS:6684-1972	Milk Can Trolleys	Rs 3.00
IS:6628-1972	Slide Rails Used in Abattoirs	Rs 5.00
IS:6670-1972	Guide for Storage of Potatoes	Rs 2.50
IS:6663-1972	Method for Determination of Angle of Repose of Grains	Rs 4.00
IS:1705-1972	Alluminium Foil for Milk Bottle Caps	Rs 4.00
IS:6669-1972	Guide for Storage of Apples	Rs 2.50
IS:1517-1972	Tinned Milk Steel Milking Pails (Hooded Type)	Rs 4.00
IS:1516-1972	Milk Strainers	Rs 4.00
IS:1675-1971	Stearic Acid, Technical	Rs 5.50
IS:Draft	Glossory of Terms for Coffee and Its Products	Free

Announcement

The 29th Annual Convention of the Oil Technologists' Association of India and a Symposium on 'Problems and Prospects in Oils and Fats, Surface Coatings and Bleaching Earths and Active Carbons' will be held on Saturday and Sunday, the February 9 and 10, 1974 at the Regional Research Laboratory, Hyderabad-500009. The Symposium will cover discussions on (i) augmentation and better utilization of oils and fats, (ii) recent advances in surface coatings, (iii) bleaching earths and active carbons, and (iv) a panel discussion on collaborative research between Research Institutes, Universities and Industries in the next five years. In addition one session will be devoted to the presentation of research papers in oils and fats and related fields.

Further particulars can be had from: Dr. A. J. Pantulu, Convener, OTAI Symposium, Regional Research Laboratory, Hyderabad-500009.

Seminar on Nutritious Foods for Meeting Social Objectives

A Seminar of the above title was organised by the Food and Nutrition Board, Ministry of Agriculture in collaboration with the Association's Northern Zone and the Oil Technologists Association of India on 12-13 May 1973. The objectives of the Seminar were to discuss the nutrition content, cost, etc., of foods meant for large-scale feeding programmes and explore possibilities of developing indigenous food industry for this purpose.

The Seminar was inaugurated by Shri Fakhruddin Ali Ahmed, Union Minister for Agriculture, who hoped that the seminar would furnish valuable data and suggestions which could be considered by the Government in formulating schemes for improving nutritional standards of people in the country.

There were six Sessions on potential for development, meeting the social objectives, raw-materials and quality control, research and development, product formulation and processing, and packaging, marketing and distribution.

Interesting papers on dimensions of the problem, feeding programmes and national planning, roles of CARE, UNICEF, groundnut flour and protein isolates, soyflour, preparations from cereal—legume combinations, Bal-ahar, work of Unichem Laboratories, Role of Britannia, work of Glaxo Laboratories, standards for protein rich foods, marketing of nutritious foods, etc., were read and discussed in the various sessions.

A Souvenir containing the papers presented was released on the occasion.

Seminar on Frozen Food Industry

The Seminar on 'Frozen Food Industry' organised by the Association of Food Scientists and Technologists (Eastern Branch) on 3rd March 1973 made the following recommendations:

1. Immediate steps should be taken for initiation by proper organisations like ICAR and various State Departments of Agriculture of research projects for evolving suitable varieties of horticultural produce like mangoes, oranges, pineapples, strawberries, peas, etc., to meet the proper qualities for freezing.
2. Deep-sea fishing by trawlers should be encouraged to exploit the vast resources of ocean as India possesses 3500 miles of coast line. Government should create facilities to build trawlers of adequate capacities. Until such time trawlers should be allowed to be imported liberally.
3. Freezing of meat from healthy beef cattles after proper ante-mortem and post-mortem examination may be encouraged for both internal consumption and export.
4. Efforts should be made by institutions like the CMERI, Jadavpur University and others in co-operation, to define specific methods of freezing for specific products which offer potential for export as well as internal consumption.
5. Urgent work is needed to standardise freezing and storage condition for buffalo milk and milk products. Work is also required to meet the needs of long distance transportation of fluid milk.
6. Work is needed as freezing of oil sardines, mackerel and fresh fillets so that these could be stored with a minimum shelf life of six months.
7. As ice is an important refrigerant for fish, institutions like the CMERI should induce manufacturers to produce ice at a low price by adopting latest techniques.
8. A study of the design and economic operation of refrigerated trucks and containers for road, rail and sea transport to meet the local condition of production, distribution and sale should be initiated and feasibility of application under diversified conditions undertaken.
9. Development of freezing preservation requires organised marketing set up with appropriate lockers, freezer provisioning industry. A national survey in assessing these requirements is essential.
10. To further develop the industry, market and consumer studies, test marketing, consumer education, appropriate export marketing policies are important. These studies should be undertaken on priority. Pilot projects for

test marketing should be set up by government or co-operative institution or Frozen Food Industry. Scope for the formation of the Frozen Food Association to undertake the above studies should be explored.

11. Taking into consideration the situation in the industry it is essential to organise suitable programme of training to meet the requirement of the industry at all levels-operator, technicians, technologist, personnel for marketing, servicing, quality control and trawler operations, maintenance etc.
12. Indian Standards Institution should be requested to frame suitable code of practice for hygiene in frozen food plants.

New Members

1. Sujatha Ramamurthy, Lecturer in Foods and Nutrition, Dept. of Home Science, S. V. University College, Tirupathi, Chittor District.
2. A. K. Choudhary, CFTRI Hostel, *Mysore*-13.
3. A. M. Nanjunda Swamy, Discipline of Fruit and Vegetable Tech., CFTRI, *Mysore*-13.
4. G. Radhakrishna Setty, FVT Discipline, CFTRI, *Mysore*-13.
5. K. C. Chikkappaji, CFTRI, *Mysore*-13.
6. Shankar Lal Pagaria, 7/C, IFTTC Hostel, CFTRI, *Mysore*-13.
7. M. N. Narayan, Rice and Pulse Technology, CFTRI, *Mysore*-13.
8. K. G. Abraham, CFTRI, *Mysore*-13.
9. C. T. Dwarakanath, Scientists, CFTRI, *Mysore*-13.
10. S. C. Basappa, Discipline of Microbiology, CFTRI, *Mysore*-13.
11. Lt N. J. S. Chandhoke, Composite Food Laboratory, Teynampet, *Madras*-17.
12. S. Srikanta, Microbiology Discipline, CFTRI, *Mysore*-13.
13. M. S. Prasad, Microbiology Discipline, CFTRI, *Mysore*-13.
14. B. K. Jha, McDowell and Company Ltd., PO *Shertallay*, Kerala.
15. B. P. S. Puri, c/o Larsen and Toubro Ltd., P.O. Box 278, *Bombay*-1.
16. K. Suriyanarayanan, Nandi Breweries and Distillers, 6/1, 111rd Cross, H. Siddiah Rd., Ramaswamy Layout, *Bangalore*-27.
17. B. Aravinda Prasad, FVT Discipline, CFTRI, *Mysore*-13.
18. Snigdha Basu, 4/8, G.T. Road (South), *Howrah*-1.
19. S. M. Ramakrishnan, 3-6-531, Hardikar Bag, Himayat Nagar, *Hyderabad*, (A.P.)
20. A. C. Chakravarthy, c/o Modern Bakeries (India) Oppal Kalan, *Hyderabad*-39, A.P.
21. K. M. Chittemma Rao, College of Home Science, Saifa Bad, *Hyderabad*-4.
22. P. Geervani, Associate Professor, College of Home Science, *Hyderabad*-4.
23. K. Umakumari, College of Home Science, Saifa Bad, *Hyderabad*-4, (A.P.)
24. G. Sarojini, College of Home Science, APAU, *Hyderabad*-4, (A.P.)
25. V. S. Kabade, CFTRI, *Mysore*-13.
26. M. C. Badami, Prabhat, Plot No. 38, Shivaji Park, *Bombay*-28.
27. M. R. Salunke, Maharashtra Agrl. Devpt., and Fertiliser Promotion Corpn., Mistri Bhavan, 6th Floor, Dinsa Vacha Road, *Bombay*-23.
28. Geetha Ramachandra, Assistant Prof. of Biochemistry, University of Agrl. Sciences, Hebbal, *Bangalore*-24.
29. Norbert Karikkassary, Malabar Marines, Thukumpadi, *Cochin*-5.
30. R. B. Samudhra, Deokar Distillery, Post *Kherdi*, (Chiplun), Rathnagiri (dist.,) Maharashtra.
31. Milagros I. Dolores, CFTRI Hostel, *Mysore*-13.
32. Sunderraj Sharma, D.12 International Hostel, CFTRI, *Mysore*-13.
33. D. K. Viswas, Research Engineer and Associate Professor, Engineering Div., IARI, *New Delhi*-12.
34. P. N. Maheswari, Research and Development Laboratory, Tata Oil Mills Co., Ltd., Sewri, *Bombay*-33.

Change of Address

1. A. D. Raj, Managing Partner, The Taste-well Foods Co., D-3, Industrial Estate, *Batlagundu* (P.O.) Madurai (Dist.), Tamilnadu.
2. N. L. Jain, Defence Food Research Laboratory, Jyothinagar, *Mysore*.

3. V. V. Koteshwara Rao, Senior Inspecting Officer, Directorate of Marketing and Inspection, 111rd floor, New C.G.C. Building, *Bombay*-20.
4. A. K. Marathe, Saiba Industries Pvt. Ltd., 129/131, Kazi Sayed Street, *Bombay*-3.
5. Ananda Prakash S. Pradhan, c/o Sri Tripurbar Singh Pradan, 6/227, Khichapokhari, *Kathmandu*, Nepal.
6. B. R. Srinivasan, Department of Biochemistry, Agricultural College, U.A.S. *Hebbal*-24.
7. D. K. Pathak, Food Technology Dept., H.B. Technological Institute, *Kanpur*-2 (U.P.)
8. R. F. Mane, 3-3-54/69, 1st floor, Veer Savarkar Road, *Hyderabad* (A.P.)
9. B. R. Bedekar, Manager, Horlicks Factory, Bommuru, Rajahmundry, Andhra Pradesh.
10. K. G. Nair, Uisko Food Products, Vazhakulan P.O., *Muvattarpuzha*, Dist., Ernakulam, Kerala.
11. S. T. Chari, Deputy Director of Fisheries, 87, Poonamale High Road, Kilpauk, *Madras*-60010.
12. Basudeb Gupta, Dept. of Food Technology, Biochemical Engineering, Jadavpur University, *Calcutta*-82.
13. G. S. Sbhis, R & D Department, Romco, Sewri, *Bombay*-33.
14. Pratap Chkaraborthy, Dept. of Biochemical Engineering & Food Technology, H.B.T.I., *Kanpur*-2.
15. A. K. Sachdev, Carl Duisberg Centrum, 8000 Munchen 19, Zimmer Nr. 121, *West Germany*.
16. V. N. Bachhil, Biological Products, I.V.R.I., *Izatnagar*, U.P.
17. R. V. Ch. Kesava Rao, Cirear Dehydrates (P) Ltd., 'Sesha' Villa, Subhas Road, *Kakinada*-533001.

Corporate Members for 1973

1. M/s Britania Biscuit Co., Ltd., Nirmal, 20th Floor, Nariman Point, *Bombay*-1.
   Shri R. B. Rao, Production Director.
   Dr D. V. S. K. Rao, Research and Development Manager.
2. M/s Glaxo Laboratories, (India) Limited, Dr Annie Besant Road, Worli, *Bombay*-18, W.B.
3. M/s Skol Breweries Limited, Chandar Mukhi, B. Block, 15th Floor, Nariman Point, *Bombay*-20 B.R.
   Shri P. G. Daftry, Director.
   Shri M. S. Ramachari, Project Manager.
4. M/s Des Met (India) Pvt. Ltd., Srinikethan, Shivsagar, Dr Annie Besant Road, Worli, *Bombay*-18, W.B.
   Shri Ram Sharma.
   Shri K. S. Sheshadri.
5. M/s The Spices Export Promotion Council, World Trade Centre, Mahatma Gandhi Road, Ernakulam, *Cochin*-16.
6. M/s Jagatgith Industries, Ltd., Jagatgith Nagar P.O., Railway Station, Hamira, N. Rly., Kapurthala Dist., *Punjab*.
   Shri P. N. Sapra.
   Dr A. Kar.

PRINTED IN INDIA BY P. M. KURUVILLA AT THE WESLEY PRESS, MYSORE

AVAILABLE

UTILIZATION OF GROUNDNUT AND OTHER OILSEEDS FOR EDIBLE PURPOSES

Proceedings of the Workshop held at C.F.T.R.I., Mysore
on 25th-26th October 1971

Jointly Sponsored by

Protein Foods Association of India

Oil Technologists Association (Southern Zone)

Association of Food Scientists and Technologists (India)

Contains articles on:

AGRO-ECONOMIC ASPECTS

PROCESSING ASPECTS

UTILIZATION OF PROTEIN FOR PROCESSED FOODS

QUALITY ASPECTS

MARKETING ASPECTS

Published by

Association of Food Scientists and Technologists (India)

Copies can be had on request, from Hon. Exe. Secretary, A.F.S.T., Central Food Technological Research Institute, Mysore-570013, India, on payment of Rs. 5 per copy towards packing and postage by ordinary mail. (Include additional Re. 1 bank commission for Cheque. Draft, Postal Order and Money Order are also accepted).

INSTRUCTIONS TO CONTRIBUTORS

1. Manuscripts of papers should be typewritten in double space on one side of the paper only. They should be submitted in triplicate. The manuscripts should be complete and in final form, since no alterations or additions are allowed at the proof stage. The paper submitted should not have been published or communicated elsewhere.

2. Short communications in the nature of letters to the editor should clearly indicate the scope of the investigation and the salient features of the results.

3. Names of chemical compounds and not their formulae should be used in the text. Super-scripts and subscripts should be legibly and carefully placed. Foot notes should be avoided as far as possible.

4. *Abstract:* The abstract should indicate the scope of the work and the principal findings of the paper. It should not normally exceed 200 words. It should be in such a form that abstracting periodicals can readily use it.

5. *Tables:* Graphs as well as tables, both representing the same set of data, should be avoided. Tables and figures should be numbered consecutively in Arabic numerals and should have brief titles. Nil results should be indicated and distinguished clearly from absence of data.

6. *Illustrations:* Line drawings should be made with Indian ink on white drawing paper preferably art paper. The lettering should be in pencil. For satisfactory reproduction, graphs and line drawings should be at least twice the printed size. Photographs must be on glossy paper and contrasty; two copies should be sent.

7. Abbreviations of the titles of all scientific periodicals should strictly conform to those cited in the World List of Scientific Periodicals, Butterworths Scientific Publication, London, 1962.

8. *References:* Names of all the authors should be cited completely in each reference. Abbreviations such as *et al.*, should be avoided.

In the text, the references should be indicated by numbers placed above the line (superior). They should be numbered and included at the end of the article in serial order.

Citation of references in the list should be in the following manner.

(*a*) *Research Paper:* Menon, G. and Das, R. P., *J. sci. industr. Res.*, 1958, 18, 561.

(*b*) *Book:* Venkataraman, K., *The Chemistry of Synthetic Dyes*, Academic Press, Inc., New York, 1952, Vol. II, 966.

(*c*) *References to article in a book:* Joshi, S. V. in *The Chemistry of Synthetic Dyes*, by Venkataraman, K., Academic Press, Inc., New York, 1952, Vol. II, 966.

(*d*) *Proceedings, Conferences and Symposia:* As in (*c*).

(*e*) *Thesis:* Sathyanarayan, Y., *Phytosociological Studies on the Calcicolous Plants of Bombay, 1953*, Ph.D. thesis, Bombay University.

(*f*) *Unpublished work:* Rao, G., unpublished, Central Food Technological Research Institute Mysore, India.

Who put the goodness of fruits in your beverages?

Bush Boake Allen!

BUSH | ABRAC

STAR BRAND | GOLD MOHUR

All the richness of sun ripened fruits—tangy! Clean, good taste-palate tickling! The secret lies with Bush Boake Allen!

Merged into a new world of flavour are W. J. Bush and A. Boake Roberts—in India. Adding new dimensions to existing sophisticated techniques, imaginative research and exotic creations.

For complete development of your product using flavours, food colours, essential oils and oleoresins···

Bush Boake Allen (India) Ltd.
Madras-16

Interpub/BBA/3