JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

ASSOCIATION OF FOOD SCIENTISTS & TECHNOLOGISTS, INDIA

VOL. 17 NO. 5 SEPT.—OCT. 1980

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 Journal of Food Science and Technology—bi-monthly.
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. The Chapters of the Association are situated at Bangalore, Bombay, Calcutta, Delhi, Hyderabad, Ludhiana, Madras and Trivandrum.

Membership Fee			Admission Fee	Annual Journal Subscription		
Life Member	Rs	300	Rs 2	Inland	Rs	80
Life Member (Resident Abroad)	$	150	$ 1	Foreign:		
Corporate Member	Rs	300	Rs 5	Surface Mail	$	20
Member	Rs	20	Rs 2	Air Mail	$	28
Member (Resident Abroad)	$	10	$ 1			
Affiliate Member	Rs	30	Rs 2			
Student Member	Rs	10	Re 1			

For membership and other particulars kindly address

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

The Journal of Food Science and Technology is a bimonthly publication of the Association of Food Scientists and Technologists, India (AFST) issued in February, April, June, August, October and December.

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 made by cheque, draft, postal or money order in favour of Exec. Secretary, AFST.

JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

Volume 17 Number 5 Sept. - Oct. 1980

CONTENTS

Research Papers

Research Notes

RESEARCH PAPERS

Polyphenols of Avocado *(Persea americana)* and Their Endogenous Oxidation

T. N. PRABHA AND M. V. PATWARDHAN
Central Food Technological Research Institute, Mysore-570 013, India

Manuscript received 17 *January* 1980; *revised* 6 *June* 1980

Polyphenols from the peel, pulp, seed and seed coat of avocado were separated and identified by paper chromatography. Catechin, epi-catechin and three leucoanthocyanidins were present in all the different tissues of the fruit. Cis and trans-chlorogenic acids and two flavonol glycosides were present exclusively in the peel. p-Coumaric and caffeic acids were detected only in pulp, while isoflavone was present in both pulp and seed coat. Chromatograms sprayed with endogenous polyphenol oxidase preparations showed that catechin and epi-catechin were the major browning substrates in all the tissues of avocado, and leucoanthocyanidins considerably contributed towards browning.

Avocado fruit (*Persea americana*) is known for its predominant fat content; its oil being used in cosmetic industry. Although polyphenols and their enzymatic oxidation in fruits and vegetables resulting in browning reactions have been widely studied and reviewed[1,2], not much is known about the phenolics of avocado and their endogenous oxidation. Catechin, leucoanthocyanidins and some simple phenolics like p-coumaric and caffeic acids have been reported to be present in the flesh of 'Fuerte' and 'Lermen' cultivars of avocado[3,4]. Avocado seeds were reported to be rich in catechin and polymeric substances[5]. Golan *et al*[3] have further pointed out that their attempts to identify the phenolic substrates specifically oxidized by the avocado polyphenol oxidase (PPO) were unsuccessful. A systematic study of the qualitative and quantitative nature of polyphenols in different tissues of avocado and their involvement in endogenous browning is not found in literature. The individual tissues of avocado, viz., peel, pulp, seed and seed coat have different rates of browning as evidenced by visual observation. Hence, it is likely that these tissues might differ in their phenolic content both quantitatively and qualitatively, particularly with respect to the endogenously oxidizable substrates. A detailed study was therefore, undertaken wherein the phenolic content of individual tissues of avocado and their possible role in enzymatic browning was studied.

Materials and Methods

Freshly harvested mature avocado fruits of green variety, obtained from an orchard near Ooty, were allowed to ripen at room temperature for about 6-7 days. The pulp, peel, seed and seed coat were separated and sliced. Polyphenols from tissue slices were immediately extracted with 85 per cent simmering ethanol, filtered, and concentrated under vacuum. The lipid matter and pigments present in the concentrated aqueous extracts were removed by repeated chloroform and petroleum ether washes. Aqueous extract was then directly used for the estimation of total phenolics, flavone and leucoanthocyanidins[6]. The phenolics in the aqueous layer were re-extracted exhaustively into ethyl acetate, concentrated and used for paper chromatography.

Chromatography: The polyphenols were separated by two-dimensional paper chromatography on Whatman No. 3 paper, using n-butanol-acetic acid-water (4:1:5 v/v) and 2 per cent acetic acid solvent systems. The phenolic spots were identified by standard procedures[7]. The chromatograms were also sprayed with endogenous PPO preparations extracted from respective tissues. The oxidized spots were eluted and optical density measured at 420 nm.

Preparation of PPO: The fruit tissues were blended in 0.001M potassium phosphate buffer (pH 7.4) containing 1 per cent polyvinyl pyrolidone (PVP) and 0.1 per cent ascorbic acid, and used for acetone powder preparations. PPO was extracted from the acetone powders with 5 volumes of 0.01M potassium phosphate buffer (pH 7.4), containing 1 per cent insoluble PVP. The extracts were squeezed through cheese cloth and centrifuged to get a clear supernatant and used as a source of PPO[8].

TABLE 1. AVOCADO PHENOLICS

Compound	R_f value		Absorption maxima (nm)	Distribution in tissues
	n-Butanol: Acetic acid: water 4:1:5 (v/v)	2% Acetic acid		
Flavonol glycoside I	0.68	0.15	270, 340	Pl, Pp, Sc
Flavonol glycoside II	0.81	0.22	275, 338	Pl
Leucoanthocyanidin I	0.49	0.43	287	Pl, Pp, Sc, Sd
Leucoanthocyanidin II	0.46	0.53	285	Pl, Pp, Sc, Sd
Leucoanthocyanidin III	0.54	0.66	285	Pl, Pp, Sc, Sd
Leucoanthocyanidin IV	0.49	0.24	290	Pp, Sc, Sd
Leucoanthocyanidin V	0.21	0.48	285	Sd
Pro-anthocyanidin complex	—	—	287	Pl, Sd
Catechin	0.68	0.41	283	Pl, Pp, Sc, Sd
Epi-catechin	0.54	0.35	295	Pl, Pp, Sc, Sd
Cis-chlorogenic acid	0.69	0.59	329	Pl
Trans-chlorogenic acid	0.70	0.77	326	Pl, Sd
Cis-caffeic acid	0.89	0.63	324	Pp
Trans-caffeic acid	0.87	0.30	320	Pp
Isoflavone	0.91	0.00	298	Pp
p-Coumaric acid	0.85	0.45	310	Pp
Non-flavone phenolic	0.83	0.17	298	Pp

Pl: Peel, Pp: Pulp, Sc: Seed coat, Sd: Seed

Results and Discussion

Table 1 presents the list of polyphenols present in both raw and ripe avocado tissues as identified by Rf data, spectral maxima, flluorescent behaviour and colour reactions. The identity of catechin, epi-catechin, chlorogenic acids, caffeic acids and p-coumaric acid were further confirmed by co-chromatography with authentic compounds. The identification of leucoanthocyanidin spots was verified by heating the individual spots in butanol-HCl[6]. Both the flavonol glycosides present in the peel, upon hydrolysis yielded two flavonol spots with R_f values entirely different from that of original compounds. Hence these were tentatively identified as flavonol glycosides.

Catechin, epi-catechin and the three leucoanthocyanidins were present in all the four tissues of avocado. Flavonol glycosides, cis and trans-chlorogenic acids were present exclusively in the peel, while caffeic and p-coumaric acids were found only in the pulp. Both the peel and seed contained large amounts of slow moving leucoanthocyanidin complex.

The concentrations of phenolics of avocado has been compared tissue-wise in Table 2. The peel contained maximum concentration of phenolics, its content in the pulp being minimum. About 40-60 per cent of the total phenolics was contributed by flavones viz., catechin, epi-catechin and leucoanthocyanidins. Ripening produced a little decrease in phenolic content except in the seed coat where there was a slight increase.

When the paper chromatograms of avocado peel, pulp, seed and seed coat were sprayed with their respective endogenous PPO preparations, only some phenolic spots were found to get oxidized by the enzymes. The concentration of the oxidizable substrates and their relative browning is shown in Table 3. In peel, catechin, epi-catechin, the three leucoanthocyanidins and chlorogenic acid spots were oxidized by the endogenous PPO. The high relative browning in the case of catechin is consistent with its high concentration in peel. In pulp, seed and seed coat, catechin, epi-catechin and leucoanthocyanidins were the oxidizable substrates. As the concentration of the phenolics in the pulp is low, the pulp undergoes less browning when

TABLE 2. TOTAL PHENOLICS, FLAVONES AND LEUCOANTHOCYANIDINS IN AVOCADO TISSUES*

Tissue	Total phenolics (as gallic acid)		Total flavones (as catechin)		Total leucoanthocyanidins	
	Raw	Ripe	Raw	Ripe	Raw	Ripe
Peel	13.25	11.55	8.28	7.85	4.10	3.73
Pulp	0.10	0.80	0.04	0.03	0.02	0.02
Seed	5.76	4.60	3.78	2.60	2.70	1.80
Seed coat	2.22	2.71	0.80	1.27	0.43	0.68

*g/100g wet wt.

TABLE 3. CONCENTRATION OF PHENOLICS OXIDIZABLE BY ENDOGENOUS PPO AND THEIR RELATIVE BROWNING RATES

Phenolics	Pee		Pulp		Seed coat		Seed	
	Concn (mg/100g)	Browning units	Concn (mg/100g)	Browning units	Concn (mg/100g)	Browning units	Concn (mg/100g)	Browning units
Catechin	2900	799	9.0	95	390	250	920	350
Epi-catechin	430	190	2.3	28	36	60	76	100
Leucoanthocyanidin I	520	29	1.1	—	30	30	890	120
Leucoanthocyanidin II	779	92	8.5	18	128	80	1080	330
Leucoanthocyanidin III	89	53	0.9	—	4	—	8	—
Leucoanthocyanidin IV	—	—	4.1	—	139	78	410	280
Cis-chlorogenic acid	36	18	—	—	—	—	—	—
Trans-chlorogenic acid	10	4	—	—	—	—	2	—

—, Not detectable;. Browning units were expressed as optical density at 420 nm.

compared to other tissues. The relatively high and quick browning visually observed in the seeds of avocado could be due to large concentration of leucoanthocyanidins and catechin in this tissue.

Thus, the major browning substrate in all the tissues of avocado appears to be catechin which is also the major phenolic compound. The contribution of epicatechin towards browning is also quite high though its concentration is not very high. Although leucoanthocyanidins have been generally considered as poor substrates for PPO[9,10], they contribute considerably towards browning in avocado tissues. Leucoanthocyanidins present in apple varieties were also poor substrates for endogenous PPO enzymes as reported in our further studies. Thus, it appears here that leucoanthocyanidins present in avocado tissues could be condensed phenolics made up of catechin type monomers, and hence form browning substrates. A detailed study on the characterization of leucoanthocyanidins and flavonol glycosides of avocado are underway.

References

1. Hulme, A. C., *The Biochemistry of Fruits and their Products*, Academic Press, Inc. New York, 1970, Vol. I, 269.
2. Harborne, J. B., Mabry, T. J. and Mabry, H., *The Flavonoids*, Chapman Hall Ltd., London, 1975, 241.
3. Golan, A., Kahn, V., and Sadovoski, A.Y., *J. agric. Fd Chem.*, 1977, **25**, 1253.
4. Ramirez Martinez, J. R. and Luh, B. S., *J. Sci. Fd Agric.*, 1973, **24**, 219.
5. Geissman, T. A. and Dittmer, H.F.K., *Phytochem.*, 1965, **4**, 359.
6. Swain, T. and Hills, W. E., *J. Sci. Fd Agric.*, 1959, **10**, 63.
7. Roux, D. G. and Maihs, A. E., *J. Chromatog.*, 1960, **4**, 65.
8. Wong, T. C., Luh, B. S. and Whitaker, J. R., *Plant Physiol.*, 1971, **48**, 19.
9. Walker, J. R. L., *New Zealand J. Sci.*, 1962, **5**, 315.
10. Peng, C. Y. and Markais, P., *Nature London*, 1963, **199**, 597.

Preliminary Screening of Mango Varieties for Wine Making

J. H. KULKARNI, HARMAIL SINGH AND K. L. CHADHA
Central Mango Research Station, B-53, Sector-A, Mahanagar, Lucknow-226 006

Manuscript received 31 *January* 1980; *revised* 21 *April* 1980

Preliminary screening of ten varieties of mangoes (*Mangifera indica* Linn.) for wine making was undertaken. Pulp was analysed for pH, TSS and titratable acidity. The pulp was subjected to alcoholic fermentation using *Saccharomyces cerevisiae* var. *ellipsoideus* (No. 522) for 7-10 days at 22°C. Wines made from varieties 'Fazri', 'Langra' and 'Chausa' were good. The alcohol content of the wines ranged from 5 to 13 per cent, while the tannins in these wines were low. Sweet wine made from variety 'Dashehari' was also adjudged as good possessing characteristic fruity flavour.

Mango cultivation in India covers an area of 9.77 lakh hectares with a total annual production of 8.925 million tonnes[1]. Mango in general, contains high amount of total soluble solids (TSS), proteinous substances, vitamins and minerals thus making it a suitable medium for the growth of wine yeasts. Fruits such as apple, apricot, cherry, plum, pear, banana, pineapple, orange, grapefruit, guava and passion fruit have been used for wine production[2-10]. Wine from grapes and cider from apples are popular all over the world. Our aim is to study the possibility of using mangoes for wine making. In the past only one such study has been reported from Venezuela by Czyhrinciw[6] on a limited scale using one or two varieties. The possiblity of making wine from ten commercial table varieties which are available in abundance was studied.

Materials and methods

Ten varieties viz. 'Bombay Green', 'Chausa', 'Dashehari', 'Fazri', 'Langra', 'Mallika', 'Lucknow Safeda', 'Suvernrekha' were procured locally while 'Kurukkan' and 'Mylepelian' were procured from South India. Five kg each of sound, healthy and ripe fruits were selected, peeled and pulp was separated from stones using stainless steel knife. The pulp was ameliorated to obtain 20° Brix by adding cane sugar. Yeast activity was suppressed by adding 100 ppm of SO_2 in the form of potassium metabisulphite. Pectinase enzyme (Obtained from CFTRI, Mysore) was also added to the pulp at the rate of 0.5 per cent and after holding the same for 8-12 hr, the pulp was inoculated with *Saccharomyces cerevisiae* var. *ellipsoideus* of Montrachet strain No. 522 in the ratio of 1:10. The fermentation was carried out at 22°±2°C for 7-10 days. After the completion of fermentation, clear liquid was filtered through a clean muslin cloth and stored in sterile glass bottles at 21-24°C for a month when the suspended matter settled leaving clear wine on the top. The wine was further treated with bentonite and stored in bottles with 100 ppm SO_2 as potassium metabisulphite.

For preparing sweet and dry fortified wines from 'Dashehari' mango, the fermentation was stopped after 5 days by adding mango brandy at the rate of 10 per cent v/v. For sweet wine, cane sugar at the rate of 5g/l. of wine was added. The wines were filtered, clarified and stored as usual.

After 8 months, analysis of the wine samples for pH, titratable acidity, volatile acidity, alcohol, reducing sugars and tannins was done according to the method described by Amerine and Ough[11]. Organoleptic evaluation of wines was conducted by a panel of 5 judges on a total score of 20.

Results and Discussion

The composition of the musts varied with variety (Table 1). The TSS of the musts ranged from 12° to 24° Brix while titratable acidity as tartaric acid ranged from 0.202 to 0.472 g/100 ml. The pH of the musts was from 3.82 to 4.92. The musts with low TSS were raised to 20° Brix by adding cane sugar. The fruit musts low in TSS are required to be ameliorated to obtain desired alcohol content. Jarezyk and Wzorek[3] stressed the need for sweetening of musts because of the low sugar content in majority of the fruits.

Effect of changes in the composition of the musts did have influence on the various constituents and

Contribution No. 891 of Indian Institute of Horticultural Research, Bangalore-560 006.

TABLE 1. COMPOSITION OF MUSTS OF FERMENTED MANGO VARIETIES

Variety	Total soluble solids (°Brix)	Titratable acidity (g tartaric acid/ 100 ml juice)	pH
Bombay	15.0	0.371	4.80
Chausa	20.0	0.202	4.28
Dashehar	20.0	0.334	4.05
Fazri	15.0	0.342	4.92
Kurukkan	14.0	0.371	4.50
Langra	19.0	0.332	4.50
Lucknow Safeda	17.0	0.472	3.82
Mallika	24.0	0.202	4.28
Mylepelian	17.0	0.352	4.80
Suvarnrekha	12.0	0.420	4.00

organoleptic evaluation of diffierent wines (Table 2). Wines from varieties 'Fazri', 'Langra' and 'Chausa' were judged as best with organoleptic score of 14.2, 12.0 and 11.8 out of the total score of 20 respectively. These wines had light golden yellow colour with brilliant appearance and possessed good body. Wines made from variety 'Langra' contained 13.0 per cent alcohol while that of 'Fazri' and 'Chausa' contained only 8.0 and 11.4 per cent respectively. Although, the alcohol content in the wine made from variety 'Fazri' was low, the good sugar and acid blend of the final product made it more acceptable. 'Mallika' variety which had a TSS of 24° Brix yielded wine with 12.2 per cent alcohol. This wine possessed the characteristic fruity flavour. However, organoleptically the wine was not acceptable.

Although, pulp was ameliorated to bring the TSS to 20° Brix by adding cane sugar, the alcohol content in the wines ranged from 5.0 to 13.0 per cent. Theoritically the pulp with 20 per cent TSS should have yielded wine with 10 per cent alcohol. The wide variations in the concentration of alcohol might be due to the difference in the composition of other nutrients. Lack of nitrogenous yeast nutrients or certain growth factors are known to influence the rate of fermentation. Amelioration of these nutrients resulted in higher alcohol yield[2].

The titratable acidity in all the samples increased after fermentation (Tables 1 and 2). This might possibly be due to production of certain organic acids. Beech and Carr[12] reported that during the fermentation of apple juice, yeasts formed organic acids such as malic acid, lactic acid and succinic acids. The difference in the titratable acidity of wines (Table 2) did not show much influence on pH; increase in acidity should have resulted in decrease in pH. Amerine *et al*[2] reported that buffer capacity of the wine and the relative amount of various acids influenced the acidity. At the same titratable acidity, the order of sourness was malic, tartaric, citric and lactic acids but at the same pH the order was malic, lactic, citric and tartaric acids. Although various contituents of acids were not analysed

TABLE 2. COMPOSITION AND ORGANOLEPTIC EVALUATION OF WINES FROM MANGO VARIETIES

Variety	Alcohol (% vol)	Titratable acidity (g tartaric acid/100 ml wine)	Volatile acidity (g acetic acid/ 100 ml wine)	pH	Reducing sugars (g/100 ml)	Tannins (g/100 ml)	Organoleptic score**
Bombay Green	10.0	0.651	0.0108	3.83	0.357	0.0085	5.3
Chausa	11.4	0.686	0.0078	4.02	0.970	0.0115	11.8
Dashehari	8.5	0.644	0.0114	4.04	0.575	0.0070	8.9
Fazri	8.0	0.826	0.0108	3.75	1.010	0.0080	14.2
Kurukkan	7.6	0.841	0.0216	3.69	0.535	0.0950	—
Langra	13.0	0.658	0.0060	3.70	0.575	0.0090	12.0
Lucknow Safeda	5.0	2.381	0.2340	3.75	0.860	0.0120	—
Mallika	12.2	0.602	0.0188	3.98	0.700	0.0125	10.4
Mylepelian	9.3	0.658	0.0240	3.94	0.535	0.0125	—
Suvarnrekha	11.4	0.613	0.0192	3.38	0.460	0.0125	—
Fortified Wines							
Dashehari (Sweet)	15.2	0.826	0.0158	4.17	1.400	0.0130	11.1
Dashehari (Dry)	15.1	0.700	0.0126	4.20	0.920	0.0125	7.5

*Max. score 20, av. of 5 judges. —Not tested Data based on average of 5 replications.

in the present study, similar situation as observed by Amerine *et al*[2] may be true.

Wines made from 'Suvernrekha,' 'Mylepelian,' 'Kurukkan' and 'Lucknow Safeda' had a high acidic taste as revealed by higher values of volatile acidity. Hence, these wines were not used for organoleptic evaluation. The titratable acidity and volatile acidity were too high in the wines prepared from 'Lucknow Safeda,' while alcohol content was only 5 per cent. Low alcohol content and higher volatile acidity suggested the possible acetification in this sample.

Czyhrinciw[6] recommended 'Hilcha' variety for wine making. The wine contained 13.2 per cent alcohol and was organoleptically excellent. However, mango variety 'Bocado' was not acceptable as it contained very light body. He further noted very low tannins in the mango wine. Similarly, in the present study, the tannins in the wines ranged from 0.007 to 0.0125 g/100 ml which is approximately 5 to 10 times less than usual white wines[2]. Low levels of tannins in these wines resulted in lesser astringeney.

The sweet fortified wine made from 'Dashehari' variety contained 15.2 per cent, while dry fortified wine contained 15.1 per cent alcohol. The dry wine without fortification contained 8.5 per cent alcohol. The sweet wine possessed a characteristic flavour of mango. This might be due to abrupt arresting of the fermentation through addition of mango brandy which resulted in the retention of some fruit sugars and flavour. The dry fortified wine also had a fruity flavour. However, due to its complete dryness, it was not acceptable as sweet wine.

Based on these preliminary studies, it can be concluded that all the varieties of mangoes are not suitable for wine making. It is important to screen a large number of varieties before attempting to produce the wine on large scale. Low tannins in the wines call for addition of tannins for fermentation.

Acknowledgment

Authors are thankful to Dr S. Ethiraj, Indian Institute of Horticultural Research, Bangalore, for providing the yeast culture used in this study.

References

1. Chadha, K. L., *Mango Industry in India*, Central Mango Research Station, Lucknow, India, 1975.
2. Amerine, M. A., Berg, H. W. and Cruess, W. V., *The Technology of wine Making*, AVI Publishing Company Inc. Westport, U.S.A., 1972.
3. Jarezyk, A. and Wzorek, W., in *The Alcoholic Beverages*, Vol. I by Rose, A. H., Academic Press Inc. New York 1977.
4. Cruess W. V., Marsh, G. L. and Mendels, S. *Fruit Prod. J.*, 1935, **16**, 295.
5. Karamfilka, P., *Lozar Vinar* Bull. 1972, **21**, 35.
6. Czyhrinciw, K. N., *Am. J. Enol. Vitic.*, 1966, **17**, 27.
7. Stillman, J. S. *Am. J. Enol. Vitic.*, 1955, **6**, 32.
8. Yang, H. Y., *J. Agric. Fd Chem.*, 1953, **1**, 331.
9. Bardiya, M. C., Kundu, B. S. and Tauro, P., *Haryana J. hort. Sci.*, 1974, **3**, 140.
10. Kundu, B.S., Bardiya, M.C. and Tauro, P., *Haryana J. hort. Sci.*, 1976, **5**, 160.
11. Amerine, M. A. and Ough, O. S., *Wine and Must Analysis*, John Wiley and Sons, New York, U.S.A., 1974.
12. Beech, F. W. and Carr, J. G., in *Alcoholic Beverages* Vol. I, by Rose, A. H., Academic Press Inc., New York, 1977.

Evaluation of Exotic Grapes Grown in Haryana for White Table Wines

B. S. KUNDU, M. C. BARDIYA, B. S. DAULTA* AND P. TAURO
Department of Microbiology, Haryana Agricultural University, Hissar-125 004, India

Manuscript received 23 *November* 1979; *revised* 15 *April* 1980

Seven exotic grape cultivars viz. 'Pearl of Csaba', 'Champion', 'Early Muscat', 'Mandeline Angevine', 'Bianshi Rai', 'Jaosbeli' and 'Riesling' were used for the preparation of white table wines for three years (1974–1976). The requisite Balling acid ratio of the juice for wine preparation was found only in case of 'Champion''. The cooler 1976 vintage affected the composition of juice, fermentation rate and wine adversely. Good quality dry white table wine was obtained from 'Champion', 'Pearl of Csaba' and 'Early Muscat'. However, considering the yield potential, 'Early Muscat' and 'Champion' are found useful for commercial plantings.

Grape cultivation in Haryana has steadily been increasing during the last fifteen years. The deep sandy loam soils of this region are suitable for the cultivation of grapes. The climatic conditions such as temperature (max 40±1°C and min 23.5±1.5°C), low rainfall (2±1 mm/month), low humidity (max 50±10 per cent and min 30±10 per cent) and bright and long day length (12.5±0.5 hr) during the grape maturation (May and June) are also favourable for grape cultivation in this region. Some of these conditions have been reported to favour higher sugar content in the grapes of Washington[1,2]. A large number of exotic varieties are being continuously tried for yield potential, juice recovery, wine making qualities and suitability for table purposes. The present communication deals with screening of seven grape cultivars belonging to *Vitis vinifera* (L) for dry white table wine preparation for three consecutive years.

Materials and Methods

Grapes of each of the seven exotic varieties (5 kg) namely, 'Pearl of Csaba', 'Early Muscat', 'Mandeline Angevine', 'Champion', 'Bianshi Rai', 'Jaosbeli' and 'Riesling' were obtained from the Experimental Vineyard of Horticulture Department, Haryana Agricultural University, Hissar. The wine yeast *Saccharomyces cerevisiae* var. *ellipsoideus* (No. 522) was obtained from Department of Enology and Viticulture, University of California, Davis, USA. The chemicals used were of BDH/Merck.

The grapes were destemmed and crushed gently with hands immediately after harvesting. The wines were prepared as per the procedure described elsewhere[3,4]. The juice and wines were analysed by the general procedures described by Amerine[5]. Total aldehydes and ethanol contents were determined by the method of A.O.A.C.[6] and Caputi *et al*[7] respectively. Total phenols were estimated by using phosphomolybdic–phosphotungustic acid reagent[8]. The extent of browning in wines was determined by measuring the colour intensity at 420 nm using Bosch and Lomb colorimeter[9]. The wines were also evaluated organoleptically according to the method of Ough and Baker[10].

Results And Discussion

In order to examine the effect of variations in climatic conditions on the composition of the must and wines, all the varieties were screened for three years. The month of May, 1976 was exceptionally cooler because of hailstorm and higher rainfall (30mm). Therefore, 'Bianshi Rai' and 'Jaosbeli' were not available due to complete damage caused to these crops.

Among these cultivars, 'Pearl of Csaba', 'Early Muscat' and 'Champion' were having their distinct varietal aroma. Some of the characteristics of these cultivars are listed in Table 1. All the cultivars were seeded and ripening time varied from early to late June. Total acidity and Brix reading (measure of mainly sugar content) did not differ in the first two years. However, because of cooler 1976 vintage, all varieties in general had low Brix reading and higher acidity (Table 2). The recovery of juice was lowest from 'Riesling' (50-52 per cent) and consistently higher from 'Early Muscat' and 'Jaosbeli' (62-66 per cent). The requisite

*Dept. of Horticulture, Haryana Agricultural University, Hissar.

TABLE 1. CHARACTERISTICS OF GRAPE CULTIVARS

Variety	Bunch type	Berry		Ripening time (June)	Yield (kg/acre)
		Colour	Seed (Nos)		
Pearl of Csaba	Loose	Yellowish green	2-4	1st week	2007
Early Muscat	Very loose	Greenish yellow	3-5	3rd week	4905
Mandeline Angevine	Loose	Yellowish green	2-5	2nd week	3200
Champion	Loose	Greenish	3-4	3rd week	4208
Bianshi Rai	Loose	Greenish	2-3	3rd week	3803
Jaosbeli	Compact	Yellowish green	2-5	3rd week	3600
Riesling	Very loose	Greenish yellow	1-2	Last week	1508

Brix (24° Brix) and total acidity (0.60-0.75 per cent) of the juice for wine making was observed only in 'Champion'. However, to get the desired level of ethanol (10-12 per cent), the juice of other varieties was ameliorated with cane sugar to 24° Brix before fermentation.

The composition of fresh and aged wines are presented in Table 3 and 4, respectively. The wines of 1974 and 1975 had higher ethanol content and low residual sugar as compared to 1976. High content of residual sugars in dry wines is considered to be an undesirable character. The fermentation rate was also exceptionally slow in 1976 as 'Champion' took nearly 16 days for complete fermentation. Being a cooler year, it may be due to poor maturity as well as imbalanced composition of the juice. These findings have further been confirmed by Agenbach[11] who reported that imbalance in assimilable nitrogen and sugar contents of the must results in incomplete and slow fermentation.

None of the varieties showed a significant tendency towards browning even after six months of ageing.

TABLE 2. ANALYSIS OF JUICE PRIOR TO FERMENTATION

Variety	Year	Juice recovery (%)	pH	°Brix	Total acidity (%)	Balling acid ratio
Pearl of Csaba	1974	58.5	3.4	19.5	0.60	33.3
	1975	56.0	3.5	18.0	0.64	28.0
	1976	63.2	3.1	18.0	0.81	20.6
Early Muscat	1974	62.5	3.3	17.0	0.70	24.2
	1975	65.0	3.5	18.0	0.71	25.4
	1976	63.5	3.1	16.0	0.87	18.4
Mandeline Angevine	1974	60.2	3.6	19.5	0.49	39.8
	1975	56.5	3.4	18.0	0.54	33.3
	1976	60.0	3.3	15.0	0.61	24.7
Champion	1974	55.0	3.3	24.0	0.71	33.1
	1975	55.6	3.2	24.0	0.84	30.0
	1976	58.5	3.6	19.5	0.54	36.1
Bianshi Rai	1974	54.8	3.2	20.0	0.83	22.9
	1975	52.5	3.2	16.0	0.81	19.7
	1976	—	—	—	—	—
Jaosbeli	1974	66.5	3.4	17.0	0.71	22.6
	1975	62.3	3.4	16.0	0.66	24.2
	1976	—	—	—	—	—
Riesling	1974	50.0	3.0	16.0	0.94	16.9
	1975	50.0	3.0	16.5	0.95	17.4
	1976	52.6	3.0	16.0	0.94	16.9

TABLE 3. ANALYSIS OF FRESH DRY WHITE TABLE WINES

Variety	Year	Colour intensity (420 nm)	pH	Total acidity (%)	Volatile acidity (%)	Alcohol (%, v/v)	Total aldehydes (ppm)	Sugar (%)	Total phenols (%)
Pearl of Csaba	1974	0.14	3.4	0.56	0.042	12.8	77.0	0.25	0.021
	1975	0.11	3.4	0.59	0.014	12.2	30.8	0.35	0.015
	1976	0.13	3.5	0.61	0.021	9.5	55.0	0.94	0.024
Early Muscat	1974	0.09	3.4	0.64	0.030	12.8	57.2	0.15	0.020
	1975	0.08	3.4	0.57	0.024	12.4	50.6	0.12	0.022
	1976	0.11	3.3	0.61	0.036	9.7	70.7	0.34	0.020
Mandeline Angevine	1974	0.21	3.0	0.75	0.038	12.1	79.2	0.40	0.023
	1975	0.10	3.3	0.65	0.024	12.4	63.8	0.22	0.018
	1976	0.16	3.4	0.54	0.021	10.9	48.4	0.26	0.021
Champion	1974	0.18	3.4	0.57	0.024	12.3	50.6	0.48	0.025
	1975	0.13	3.3	0.67	0.027	11.2	44.0	0.39	0.026
	1976	0.17	3.2	0.60	0.061	9.7	57.2	0.96	0.019
Bianshi Rai	1974	0.11	3.4	0.63	0.029	12.2	50.6	0.43	0.025
	1975	0.06	3.2	0.68	0.023	12.4	51.8	0.30	0.026
	1976	—	—	—	—	—	—	—	—
Jaosbeli	1974	0.11	3.5	0.56	0.022	12.3	39.6	0.35	0.022
	1975	0.08	3.3	0.65	0.027	12.4	33.0	0.16	0.015
	1976	—	—	—	—	—	—	—	—
Riesling	1974	0.18	3.2	0.75	0.023	12.8	49.5	0.38	0.025
	1975	0.17	3.3	0.60	0.032	11.7	30.8	0.44	0.026
	1976	0.08	3.0	0.96	0.016	9.7	28.6	0.64	0.020

TABLE 4. ANALYSIS OF DRY WHITE TABLE WINES AFTER SIX MONTHS OF AGEING

Variety	Year	Colour intensity (420 nm)	pH	Total acidity (%)	Volatile acidity (%)	Alcohol (%v/v)	Total aldehydes (ppm)	Sugar (%)	Total phenols (%)	Total SO_2 (ppm)	Mean score*
Pearl of Csaba	1974	0.29	3.7	0.54	0.031	12.6	24.2	0.22	0.013	16	16.0
	1975	0.15	3.6	0.53	0.018	11.7	30.8	0.34	0.012	14	16.2
	1976	0.27	3.8	0.52	0.031	9.8	60.5	1.00	0.023	13	14.4
Early Muscat	1974	0.30	3.7	0.60	0.025	12.8	26.4	0.18	0.012	12	16.5
	1975	0.12	3.6	0.53	0.041	12.4	81.4	0.20	0.019	41	15.7
	1976	0.14	3.6	0.60	0.042	9.5	51.7	0.16	0.020	57	14.8
Mandeline Angevine	1974	0.23	3.3	0.72	0.031	12.0	50.6	0.31	0.018	23	12.2
	1975	0.13	3.3	0.51	0.036	11.7	46.2	0.22	0.018	34	13.2
	1976	0.20	3.6	0.53	0.027	10.7	39.8	0.11	0.020	11	11.8
Champion	1974	0.35	4.0	0.45	0.040	12.0	35.2	0.45	0.016	18	16.6
	1975	0.19	3.8	0.59	0.023	10.6	50.6	0.37	0.026	40	16.0
	1976	0.21	3.3	0.58	0.021	9.8	48.4	0.91	0.019	50	14.0
Bianshi Rai	1974	0.20	3.6	0.60	0.039	12.1	50.6	0.42	0.017	32	11.6
	1975	0.07	3.5	0.66	0.042	11.7	33.0	0.51	0.022	65	12.0
	1976	—	—	—	—	—	—	—	—	—	—
Jaosbeli	1974	0.18	3.6	0.53	0.027	12.0	28.6	0.36	0.014	19	13.3
	1975	0.12	3.6	0.62	0.044	11.9	29.2	0.28	0.020	48	14.2
	1976	—	—	—	—	—	—	—	—	—	—
Riesling	1974	0.30	3.3	0.72	0.030	12.3	41.8	0.40	0.016	20	15.3
	1975	0.21	3.7	0.76	0.032	11.6	49.0	0.43	0.026	18	14.9
	1976	0.15	3.3	0.91	0.022	9.8	20.9	0.67	0.020	28	13.2

Max. score is 20.

This was probably due to the cold settling treatment given to the juice prior to fermentation which removed most of the suspended material. The suspended particles contribute towards higher phenolics in wines resulting in increased tendency to browning[12]. During storage, there was no appreciable change in ethanol and residual sugars as compared to fresh wines. The pH and total acidity of the wines decreased during ageing which is due to the precipitation of potassium tartrate. Total phenols also decreased and the possible reason being combination with aldehydes and subsequent polymerization and/or due to the precipitation with natural proteins of the wines[12].

Aged wines were also evaluated by five experienced tasters using 20-point score card. The scores for wines prepared from 'Pearl of Csaba', 'Early Muscat' and 'Champion', except for the year 1976, were almost at par, but were higher as compared to other varieties. By considering the cropping level of these varieties, only 'Early Muscat' and 'Champion' are recommended for commercial cultivation as suitable for preparing white table wines.

References

1. Amerine, M. A. and Fong, D., *Am. J. Enol. Vitic.*, 1974, **25**, 44.
2. Nagel, C. W., Atallah, M., Carter, G. H. and Clore, W. J., *Am. J. Enol. Vitic.*, 1972, **23**, 14.
3. Bardiya, M. C., Kundu, B. S. and Tauro, P., *J. Fd Sci. Technol.*, 1976, **13**, 268.
4. Kundu, B. S., Bardiya, M. C. and Tauro, P., *Process Biochem.* 1979, **14**, 14.
5. Amerine, M. A., *The Procedures for Enologists.* Assoc. Student Stores, Davis, IInd Ed. 1973.
6. *Official Methods of Analysis*, Ass. Off. Anal. Chem. Washington, D. C., 12th Ed., 1975, 159.
7. Caputi, A. Jr., Ueda, M. and Brown, J., *Am. J. Enol. Vitic.*, 1968, **19**, 160.
8. Singleton, V. L. and Rossi, J. A. Jr., *Am. J. Enol. Vitic.*, 1965, **16**, 144.
9. Rossi, J. A. Jr. and Singleton, V. L., *Am. J. Enol. Vitic.*, 1966, **17**, 231.
10. Ough, C. S. and Baker, C. A., *Hilgardia*, 1961, **30**, 587.
11. Agenbach, W. A., *Proc. Internat. Cong. of South African Soc. of Enol. Vitic.*, 1977, 66.
12. Peri, C., Pompei, C., Montedoro, G. and Cantarelli, C., *J. Sci. Fd Agric.*, 1971, **22**, 24.

Cyclopropenoid Fatty Acids in Some Malaysian Edible Seeds and Nuts*

SHIV K. BERRY*

Department of Food Science and Technology, Faculty of Agriculture, University of Agriculture, Malaysia, Serdang, Selangor, Malaysia

Manuscript received 12 *November* 1979; *revised* 28 *December* 1979

The presence of cyclopropenoid fatty acids (CPFA), which cause numerous physiological disorders in experimental animals, in some Malaysian edible seed oils was established by the Halphen test and infrared spectroscopy. Employing gas chromatography and *Sterculia foetida* seed oil as a reference standard to identify and quantitate sterculic and malvalic acids, oils from the seeds of durian (*Durio zibethinus*), kapok (*Ceiba pentandra*), China-chestnut (*Sterculia monosperma*) and gnemon (*Gnetum gnemon*) were found to contain 65.4%, 10.1%, 18.7% and 51.6% of CPFA respectively. Cooking had no appreciable effect on the CPFA content, and it would therefore, seem extremely unwise to consume these seeds or products thereof.

Cyclopropenoid fatty acids (CPFA) are found in seed lipids of the order *Malvales*[1] which comprises several important sources of food for man and animals. The two common cyclopropenoid fatty acids that have been identified in seed oils are malvalic and sterculic acids, which frequently occur together. Cottonseed, which is one of the important sources of edible oil and feed for livestock, contains about 1 per cent CPFA[2,3]. The finding that cottonseed meal containing residual oil produced "pink egg-white" disorder when fed to poultry, gave considerable impetus to further investigation of these compounds[2-5]. The CPFA can also be carried in the food chain by way of egg milk and the lipids of animals fed diets constituting cottonseed meal[2].

*Presented at the International Congress on Oilseeds and Oils, New Delhi, February 9-13, 1979.

The unusual physiological effects of these fatty acids have been studied using *Sterculia foetida* oil, which contains over 60 per cent of CPFA, in test diets of experimental animals.

The deleterious biological effects that have been observed include: development of pink discolouration to avian egg-white during storage; inhibition of fatty acid desaturation in several animals and fish; interference in lipid metabolism; delayed sexual maturity in the female rat and sterility in the house fly; extensive liver cell damage in animals and fish; aortic atherosclerosis in rabbit; co-carcinogenicity and carcinogenicity in rainbow trout; pre-and postnatal mortality in the progeny of rats; embryo mortality in the Japanese quail and mortality among adult rats. The mechanism of action of these acids is yet to be clearly defined. Miller *et al*[6] believe that altered membrane permeability and increased capillary fragility could be responsible for the detrimental effects of CPFA.

In addition to cottonseed and *Sterculia foetida* seed, seeds of other plants of lesser or no importance to man have also been analysed for their CPFA content[1,2]. Plants of the order *Ebenales* have been reported to contain CPFA in their seed oils[2], but seeds and nuts that are consumed by man have received little attention. In Malaysia, a number of seeds are consumed and some of these are now described.

Description: Durian, *Durio zibethinus*, Murr. belongs to the family *Bombacaceae*. The fruits are much liked in South East Asia for their delicate flavour The edible portion is the aril which contains a seed, but the latter is also consumed after boiling or roasting. A full description of the fruit and its proximate analyses have been reviewed by Stanton[7]. The oil content of the aril varies from 3 to 5 per cent, while the seeds contain only a small amount.

Kapok, *Ceiba pentandra*, Gaertn. (*Bombacaceae*) is well known for its silky floss in which a number of dark brown seeds are embedded. The seeds are known to contain 20 to 25 per cent oil. In Malaysia, particularly in the rural areas, the seeds are roasted and consumed after removing the husk. Both oil and the residual cake are reported to have commercial value[8,9]. However, a recent study reported that kapok seed cake impaired the live weight of chickens[10]. This could be due to the residual CPFA in the feed[2], since rats fed kapok seed oil at a level of 40 per cent or more calories in their diet were reported to have died within 18 days, while lower levels resulted in slower growth[11].

China-chestnut, *Sterculia monosperma*, Ventenat. (*Sterculiaceae*) seeds are contained in pods that split open at maturity. The edible portion (nut) is enclosed in the three layers of skin of which the outer covering is glossy black covered with a sticky substance. These nuts are eaten after boiling and removing the three outer skins. The kernels are rather mealy and have a pleasant taste[12]. They contain a small amount of oil.

Gnetum gnemon, Linn. (*Gnetaceae*) is a gymnosperm (order *Gnetales*), found in Malaysia, Indonesia and other South East Asian islands. The seeds are eaten after roasting or boiling. The kernel may be mashed, moulded into cakes, biscuits or "keropok" (crisps) that are dried in the sun and consumed after deep-frying in oil[13]. The seeds are starchy, astringent, and con tain a small amount of oil. The purpose of the present study was to explore the occurrence of CPFA in such seeds and nuts as are consumed in Malaysia.

Materials and Methods

All the seeds were procured locally. Methyl fatty acid ester standards were obtained through Sigma Chemical Company, U.S.A., sodium methoxide reagent (0.5N) was purchased from Supelco Inc. U.S.A. and all other reagents used were of analytical grade.

Extraction of oil and analysis: The oven dried seeds, after removing the skins, were pulverized to a fine powder and extracted separately with petroleum ether (b.p. 40° to 60°C) in a Soxhlet apparatus for 16 hr. The oil was recovered by evaporating the solvent on a rotary evaporator under reduced pressure.

A sample of seeds from the same lot was roasted or boiled in water until soft. The boiled seeds were then dried and extracted for oil in the same manner. A 100 g sample of gnemon "keropok" (crisps) was divided into two portions, of which one part was turned into powder and extracted for oil. The second portion was deep-fried in cooking oil for 1 min at 175°C. The excess oil from an individual crisp was blotted off and then the crisps were ground to fine powder to extract the oil.

All the oil samples were subjected to the Halphen test performed according to the method of Coleman and Firestone[14].

Preparation of methyl esters and $AgNO_3$-CH_3OH derivatives: Methyl esters of the oil fatty acids were prepared by transmethylation using sodium methoxide (0.5N) in methanol as described by Timms[15]. The contents of the reaction vessel were centrifuged for clarification, and where necessary, were further extracted with petroleum ether (b.p. 40° to 60°C), dried over anhydrous Na_2SO_4 and solvent removed. Methyl esters were then treated with $AgNO_3$-CH_3OH according to Schneider *et al*[16] to obtain stable CPFA derivatives. The normal fatty acid esters and the CPFA derivatives were recovered from the reaction maxture in the usual manner.

Gas-liquid chromatography: The mixture of normal fatty acid methyl esters and CPFA derivatives was analysed on a Pye Unicam, series 204 gas chromatograph

equipped with hydrogen flame ionization detectors. The analysis was performed using a glass column (1.5m × 4mm ID) packed with 10 per cent w/w polyethylene glycol succinate adsorbed on 100-120 mesh Diatomite CAW, operated isothermally at 180°C with carrier gas nitrogen (OFN) at a flow rate of 30ml/min. The injection port and detector temperatures were maintained at 200°C.

Gas chromatograph peaks were identified by comparison with pure methyl esters through retention time relative to methyl heptadecanoate. The identity of malvalic and sterculic acids was based on comparision with $AgNO_3$-CH_3OH derivatives of methyl esters of *Sterculia foetida* oil fatty acids through retention time and cochromatography. The area per cent of each peak was obtained on a Hewlett-Packard 3380A Integrator linked directly to the gas chromatograph.

Infrared (IR) spectra of methyl esters were determined on a Beckman 4240 Infrared spectrophotometer. Ultraviolet (UV) absorptions were measured on a Varian Techtron Model 635 spectrophotometer.

Results

Occurrence of cyclopropenoid fatty acids: The oil samples from all seeds gave a positive Halphen test indicating the presence of CPFA. Colour development was rather slow for oils derived from cooked seeds. This could probably be attributed to partial polymerization of CPFA on heating[1]. The occurrence of CPFA in these oils was further supported by infrared evidence, the methyl esters showing the characteristic IR band for the cyclopropene (CP) moiety at 1008 cm^{-1}. The spectrum did not exhibit the presence of a hydroxyl or terminal acetylenic group. The UV spectra showed no conjugation in the oils.

The presence of malvalic and sterculic acids was confirmed by comparision with $AgNO_3$-CH_3OH derivatives of methyl esters of *Sterculia foetida* seed oil through retention time and cochromatography. *Sterculia foetida* seed oil is well known to contain both malvalic and sterculic acids and is widely employed as a reference standard. The roasting or boiling of seeds did not affect appreciably the CPFA content of their oils, indicating that the cooking temperatures were not sufficiently high enough to destroy CPFA. The effect of heat on CPFA in oils has been summarized by Phelps *et al*[2].

Quantitation of CPFA: The cyclopropenoid fatty acid content of the seed oils, as determined by GLC of $AgNO_3$-CH_3OH derivatives of their methyl esters, is presented in Table 1. Durian seeds contain only 1 to 2 per cent of oil, but this has an unusually high concentration of CPFA; 65 per cent of the total fatty acids in the oil are CPFA of which sterculic acid constitutes over 70 per cent. Kapok seeds, though rich in oil, contain a lower amount of CPFA (10 to 12 per cent). Chinachestnuts contain about 3 per cent oil, which is constituted of about 19 per cent sterculic acid as the major CPFA, malvalic acid occurring only in traces. Gnemon seeds that do not belong to the order *Malvales*, also carry in the oil large amounts of CPFA (51.6 per cent), of which malvalic acid is the major component.

Discussion

The foregoing results are of considerable interest since CPFA are present in rather high concentrations in the oil of these edible seeds. Furthermore, the effect of heat, as shown by a strong positive Halphen test and GLC data (Table 1), was in most cases negligible in lowering the CPFA content of these seeds. In durian seed oil, the malvalic and sterculic acid contents decreased only by about 38 per cent and 31 per cent respectively. The CPFA values for fried gnemon "keropok" are much lower probably solely because of dilution by the frying oil since the oil content of nonfried "keropok"

TABLE 1. CYCLOPROPENOID FATTY ACID CONTENTS OF EDIBLE SEED OILS AS DETERMINED BY GLC

Species	Part examined	Oil content (%) (DB)	Total CPFA	Cyclopropenoid acid content area %)			
				Malvalic		Sterculic	
				Fresh seeds/ Keropok	Cooked seeds/ Keropok	Fresh seeds/ Keropok	Cooked seeds/ Keropok
Durio zibethinus	Seed	1-2	65.4	19.8	12.3	45.6	31.3
	Germ	6.7	79.4	1.8	ND	77.6	ND
Ceiba pentandra	Seed	28	10.1	7.2	7.1	2.9	2.9
Sterculia monosperma	Nut	3	18.7	Trace	0.6	18.7	21.0
Gnetum gnemon	Seed	4	51.6	38.6	39.6	13.0	13.2
	*Keropok	2(11)**	46.9	37.7	3.0	9.2	0.9

DB = Dry basis ND = Not determined * = Origin unknown **Values in bracket for fried "keropok"

was only 2 per cent, whereas fried "keropok" yielded about 11 per cent oil. Roasted kapok seed oil lost only a negligible proportion of these fatty acids. The oils from boiled China-chestnuts and gnemon seeds exhibited an increase in these fatty acids. This could probably be due to nonuniformity in maturity of the seeds employed since the proportion of CPFA varies with maturity[4,17,18]. Whether after cooking of these seeds, the CPFA still remain biologically active is not known.

The results also indicate relatively high concentrations of sterculic acid in these seed oils with the exception of kapok seed. In a separate experiment it was found that the durian seed germ oil contained as much as 78 per cent sterculic acid with only traces of malvalic acid. Some consumers have experienced skin irritation when whole durian seeds were consumed, but lessened by removal of the germ. This could be due to the preponderance of sterculic acid which has been reported to exert stronger biological effects in animals[2,19].

The severity of biological effects, such as cancer in rainbow trout, aortic atherosclerosis in rabbit and induction of cell division in rat liver parenchyma, following ingestion of even ppm amounts of CPFA, is really alarming and a matter of great concern. However, the consequences of the ingestion of CPFA in these seeds by man are at present difficult to assess. Firstly, because of the lack of information on the quantity of seeds consumed per day per person and the frequency of intake. Secondly, there is a lack of data concerning their effects on animals whose metabolism is close to that of man. A biological response observed in animals cannot be taken as evidence of actual risk to man, but is an indication of concern as being indicator test system[20]. It would, therefore, seem extremely unwise to continue to consume these seeds or their products.

Acknowledgement

The author is grateful to the University of Agriculture, Malaysia, for the facilities, to the Australian Development Assistant Bureau, Canberra, for financial assistance that enabled presentation of this paper at the congress, to Dr. M.S. Sambhi, University of Malaya, for providing facilities for IR studies, and to Prof. I.C. Enoch for identifying plant species.

References

1. Carter, F. L. and Frampton, V. L., *Chem. Rev.*, 1964, 64, 497.
2. Phelps, R. A., Shenstone, F. S., Kemmerer, A. R. and Evans, R., *Poult. Sci.*, 1965, **44**, 358.
3. Mattson, F. H., *in Toxicants Occurring Naturally in Food*, National Academy of Sciences, Washington, D. C., 2nd, Ed., 1973, 189.
4. Shenstone, F. S., Vickery, J. R. and Johnson, A. R., *J. agric. Fd Chem.*, 1965, **13**, 410.
5. Christie, W. W., in *Topics in Lipid Chemistry*, by Gunstone, F. D., Logos Press Limited, London, Vol. I, 1970, 1.
6. Miller, A. M., Sheehan, E. T. and Vavich, M. G., *Proc. Soc. exp. Biol. Med.*, 1969, **131**, 61.
7. Stanton, W. R., *Trop. Sci.*, 1966, **8**, 6.
8. Georgi, C. D. V., *Malay, agric. J.*, 1922, **10**, 284.
9. Grist, D. H., *Malay, agric. J.*, 1922, **10**, 51.
10. Kategile, J. A., Ishengoma, M. and Katule, A. M., *J. Sci. Fd Agric.*, 1978, **29**, 317.
11. Thomasson, H. J., *J. Nutr.*, 1955, **56**, 455.
12. Allen, B. M., *Malayan Fruits*, Donald Moore Press Ltd., Singapore, 1967.
13. Maheshwari, P. and Vasil, V., *Gnetum*, Council of Scientific and Industrial Research, New Delhi, 1961.
14. Coleman, E. C. and Firestone, D., *J. Ass. Off. anal. Chem.*, 1972, **55**, 1288.
15. Timms, R. E., *Aust. J. Dairy Technl.*, 1978 **33**, 4.
16. Schneider E. L., Loke, S. P. and Hopkins, D. T., *J. Am. Oil Chem. Soc.*, 1968, **45**, 585.
17. Johnson, A. R., Pearson, J. A., Shenstone, F. S., Fogerty, A. C. and Giovanelli, J., *Lipids*, 1967, **2**, 308.
18. Yano, I., Nichols, B. W., Morris, L. J. and James, A. T., *Lipids*, 1972, **7**, 30.
19. Lee, D. J., Wales, J. H. and Sinnhuber, R. O., *Cancer Res.*, 1971, **31**, 960.
20. Kraybil, H. F., *Fd Technol.*, 1978, **32**, (8), 62.

Prevention of Foul Odour and Minimising Soaking Loss in Conventional Parboiling of Paddy

P. PILLAIYAR, B. S. VASAN, G. RAJENDRAN AND V. DHARMARAJAN
Paddy Processing Research Centre, Tiruvarur-610 108, India

Manuscript received 30 *October* 1979; *revised* 10 *April* 1980

The characteristic off odour developed in conventional parboiling can be eliminated by soaking paddy in water containing 0.10% mercuric chloride, 0.10% copper sulphate, 0.05% sodium chromate, 0.30% ferric chloride (AR), 0.15% Acinol and 0.10% thiram. In these cases the dry matter loss sustained during soaking is minimised. Of these, sodium chromate at 0.05% level (w/w) not only completely eliminated the smell but also minimised the soaking loss to a great extent. The residual chromium present (3 to 4 ppm) in such rices is not absorbed in the human system.

In both single steaming (paddy is hydrated at room temperature and steamed) and double steaming (presteamed paddy is hydrated and steamed) processes of parboiling, which are mostly practised in conventional rice mills, the soak water and rice invariably emit a bad smell. The development of smell was ascribed to microbial fermentation during soaking.[1-3] The various attempts made from time to time to get rid of this smell are soaking under sterile conditions[3] or repeatedly changing the soak water or blowing air[1] into it, or using antimicrobial agents like chloramphenicol[4] or maintaining a low pH. Different chemicals like acid calcium sulphate[1], glacial acetic acid[5], acetic acid[6], bleaching powder with acid to release chlorine[3] were used to maintain a low pH in soak water. However, these agents are either corrosive or hazardous.

The smell could be eliminated by soaking paddy at 60-80°C.[1-3] But this requires some mechanization to suit the operations of the conventional rice mills. Moreover, high temperature soaking may lead to discolouration, deformity and dry matter loss.[7-9] Considering the wide adoption of single and double steaming processes for producing parboiled rice, studies on eliminating the smell in soaking and minimising the associated dry matter loss were taken up and the results are given here.

Materials and Methods

Five varieties of paddy procured from trade were used. In studies on dry matter loss, the paddy was either cleaned in Burrows dockage tester (designated 'cleaned paddy': 'C') or used as such ('uncleaned paddy': 'U'). Samples were taken using a sample divider. In the single steaming process, paddy was soaked in 1.5 times of tap water in plastic containers with or without added chemicals. In the double steaming process, the raw paddy was presteamed (at 0 kg/cm^2) for 10 min and soaked as above. Observations on the development of odour, gas formation and their intensities were recorded at different intervals The changes in the pH of the medium were noted.

For studies on dry matter loss, 1 kg lots of cleaned paddy were taken in nylon netted bags and soaked in different media. After an appropriate time, the bags were removed and thoroughly rinsed. It was then steamed (at 0 kg/cm^2) for 10 min, dried in shade, dehulled in a Satake laboratory dehusker and the brown rice yield determined. To determine the initial yield i.e. 0 hr yield, an identical 1 kg sample of paddy was autoclaved at 0 kg/cm^2 for 10 min and then at 1.41 kg/cm^2 for 20 min, dried and shelled as above. By this method, the initial yield could be determined without any milling damage (which could not have been possible if raw paddy was used). Dry matter loss was also recorded by noting the weight of paddy before and after soaking, but to preclude the possibility of losses in husk constituents by chemicals or otherwise, brown rice yield was used as the index in most cases. Moisture content was determined by drying in an oven at 105°C for 24 hr. All trials were repeated many times with different varieties and in different seasons. The quantity of sodium chromate utilized during soaking was determined by titrating the filtered solution with thiosulphate.[10]

Results and Discussion

Off odour: In both the single and double steaming processes, the soak water emitted off odour in 24 hr of soaking and then the smell intensified. During soaking in the latter process, microbial action proceeded vigorously because of the initial temperature gradient.[2,11] The development of off odour was ascribed to

TABLE 1. CHANGES IN THE SOAK WATER pH WITH TIME OF SOAKING

Period of Soaking (hr)	pH of Soak Water		
	Control	Sodium chromate (0.05%)	Potassium ferricyanide (0.50%)
0	7.0	6.5	6.4
12	7.0	6.5	—
24	6.0	6.0	6.2
48	5.0	6.0	5.4
72	4.5	5.5	5.2

TABLE 2. EXTENT OF UTILIZATION OF SODIUM CHROMATE DURING COLD SOAKING OF PADDY HAVING VARYING PROPORTIONS OF DIRT, CHAFF AND IMMATURE GRAINS

Period of Soaking (Hr).	Sodium chromate (%)*	
Cleaned Paddy	A	B
0	0.20	0.20
24	0.18	0.18
48	0.14	0.15
72	0.13	0.10
96	0.12	0.09
154	0.08	0.02
Uncleaned Paddy	E	F
0	0.10	0.10
72	0.00	0.06

*Concentration Reckoned on Paddy Basis

A and B = 15.4 and 30.4% Immature Grains

E and F = 15.0 and 3.0% Dirt and Chaff (Immature Grains were removed).

the growth and activity of coliform bacteria,[12] and to the multiplication of both yeasts and bacteria.[3] The lowering of pH of soak water which was fast in control was to some extent retarded by the addition of certain chemicals into it (Table 1); this is because of the absence of fermentative changes. The development of off odour was prevented by treating the soak water with chromium trioxide at 0.03 per cent level; sodium and potassium chromates at 0.05 per cent level; copper sulphate, mercuric chloride, silver nitrate, ferric chloride (A.R.), ferric ammonium citrate, Acinol, Captan, Diflatan, Fytolan, Thiram, Phosvel at 0.10 per cent level; formaldehyde at 0.20 per cent level; ammonium molybdate at 0.30 per cent level; para xylenol benzo methanol (PXBM) at 0.50 per cent level; ferric alum at 0.60 per cent level; alumino ferric at 0.60 per cent level (in this case water was sprinkled once in 3 hr instead of complete soaking). For prolonging the soaking period, as would be required during inclement weather conditions, higher concentration of the chemical was required. (e.g., 0.10 per cent chromate prevented the odour development upto 144 hr, 0.30 per cent copper sulphate upto 240 hr; 0.10 per cent mercuric chloride upto 168 hr; 0.30 per cent Acinol upto 170 hr; 0.10 per cent Diflaton upto 264 hr; chromates in combination with common salt (1.0 per cent) and Acinol prevented the odour development upto 120 and 144 hr respectively, whereas chemicals like boric acid (0.50 per cent), salicylic acid (0.02 per cent), sulphanamide (0.02 per cent), superphosphate (0.50 per cent) or maintaining the pH at 6.0 to 7.0, did not supplement the action of chromates). As the soak water containing bleaching powder (0.03 per cent) had to be acidified to release the chlorine and such acidity would adversely affect the cooking quality of rice[3], the medium was adjusted to pH 7.0 by incorporating sodium carbonate; but the bleaching powder required in such case was 0.50 per cent. Besides profuse gas formation, the pH of soak water while using iron salts (ferric chloride (AR) at 0.30 per cent level; ferric alum at 0.60 per cent) was 3.0 to 4.0 and soaking under such a low pH would adversely affect the cooking quality.[3] In a bulk trial wherein alumino-ferric (0.60 per cent w/w) solution was sprayed on paddy (once in 3 hr for manitaining a saturated humidity) instead of complete soaking, the paddy germinated. Because of certain defects (chemical smell, proven toxicity, gas formation, corrosiveness etc.) some of the above chemicals though eliminated the off odour during soaking, cannot be used in regular practice and hence several commercial scale studies with sodium chromate at 0.05 per cent (w/w) level were carried out in Tamil Nadu, Pondicherry and Andhra Pradesh.[13] In all these cases parboiled rice obtianed was free from bad odour.

The nature of the impurities (with and without dirt and chaff or immature grains) present in paddy greatly influenced the quantity of chromate required for preventing the fermentative changes and consequently, paddy containing more impurities required 0.10 per cent sodium chromate (Table 2).

The residual chromium in the polished rice (5 to 6 per cent polish) of two varieties ('Co 25', and 'Kannagi') soaked in 0.05 per cent sodium chromate for 72 hr was 2 to 3 ppm respectively; whereas it was 0.4 to 0.5 ppm respectively in the control lots and other market samples[14]. Chromium balance studies (eight trials) conducted on human subjects with the above samples of polished rices having 2 to 3 ppm chromium indicate that none of the additional chromium was absorbed in the system.[15]

Chemicals like sodium silicate at 0.05 per cent level; chromium sulphate, ferric ammonium citrate, potass-

TABLE 3. EXTENT OF DRY MATTER LOSS IN COLD SOAKING OF CO 25 PADDY

Period (Hr.)	Brown Rice Yield (%)	Soaking Loss (%)
0	76.77	—
12	76.32	0.45
24	76.00	0.77
36	75.71	1.06
48	75.61	1.16
60	75.53	1.24
72	75.04	1.73

ium chlorate, sodium thiosulphate; sodium nitrate, ferric sulphate, aluminium alum and zirconium sulphate each at 0.30 per cent level; cetyl trimethyl ammonium bromide (0.03 per cent), trichloroacetic acid (0.50 per cent), acetone (0.50 per cent), paraformaldehyde at 0.20 per cent or in combination with furfural (0.20 per cent); furfural (0.10 per cent) with urea or sodium bisulphite (0.20 per cent); bleaching powder with urea (0.10+0.10 per cent) and urea (0.50 per cent) were not useful in eliminating the off odour during soaking of paddy.

TABLE 4. EXTENT OF MINIMISING DRY MATTER LOSS DURING CONVENTIONAL SOAKING WITH DIFFERENT CHEMICALS

Chemical	Concn (w/w) on Paddy (%)	Paddy variety	Av. Increase in yield of Brown Rice over Control
Copper Sulphate	0.5	IR 8	1.23
Mercuric Chloride	0.1	IR 8	0.49
Copper Sulphate+ Mercuric Chloride	0.1+0.1	IR 8	0.41
Copper Sulphate (rinsed)+ Sodium Chromate	0.1	CO 33 U	0.48
Sodium Chromate	0.1	IR 20	1.10
		CO 25	0.84
	0.05	CO 25 U	0.90
		CO 33	0.42@ (24 hr.)
			0.68@ (48 hr.)
			0.94@ (72 hr.)
			1.13@ (96 hr.)
			1.43@ (120 hr.)
Ferric Chloride	0.3	CO 25	0.79
Ferric Chloride+ Common Salt	0.3+1.0	CO 25	1.04
	0.3+0.5	CO 25	0.66
Ferric Sulphate (AR)	0.5	IR 8 U	0.99
	0.3	IR 8 U	1.10
Ferric Alum	0.8	CO 25 U	1.46
	0.6	CO 25 U	0.97
Ferric Alum + Common Salt	0.6+1.0	CO 25	0.38
Alumino Ferric (Rinsing At Regular Intervals Upto 72 Hr)	0.7	CO 33	1.42
Bleaching Powder	0.5	IR 8	0.96

@—On Paddy Basis; U—Uncleaned Paddy; Others Cleaned Paddy

Soaking loss: Paddy undergoes varying degrees of dry matter loss during soaking. In 12 hr soaking 0.45 per cent loss (in terms of brown rice) had occurred and this had increased to 1.73 per cent in 72 hr (Table 3). Irrespective of the variety, season, soaking method and its duration, soak water treatment minimised the dry matter loss during soaking (Table 4). Factors like dormancy and endosperm opacity also contributed to the difference in dry matter loss during soaking.[15] Large scale trials conducted in conventional rice mills in Tamil Nadu, Pondicherry and Andhra Pradesh had also indicated that whenever the soak water was treated with Na_2CrO_4 or Na_2CrO_4 with common salt, or ferric alum with common salt, or alumino ferric with common salt, the dry matter loss during soaking was less compared to controls.[16]

Acknowledgement

Profound and sincere gratitute to late Dr. V. Subrahmanyan for the guidance and keen interest in this study, to the Director, National Institute of Nutrition, Hyderabad, for carrying out human metabolic studies with the parboiled rices produced out of chromium soaked paddy and to the authorities of the Food Corporation of India for their help in conducting large scale trials in different States.

References

1. Charlton, J., *Agric. Res. Inst. Burma Bull.*, 1923, **146.**
2. Subrahmanyan, V., Desikachar, H.S.R. and Bhatia, D. S., *J. sci. ind. Res.*, 1955, **14**, 110.
3. Desikachar, H. S. R., Majumder, S. K., Pingale, S. V., Swaminathan, M. and Subrahmanyan, V., *Bull. Cent. Food Technol. Res. Instt., Mysore*, 1955, **5**, 50.
4. Ali, S. Z. and Bhattacharya, K. R., *Lebensm. Wiss. Technol.*, 1972, **5**, 207.
5. Paul, H., *Farm J. British Guiana*, 1954, **17**, 10.
6. Raymond, W. D. and Squires, J. A., *Colon. Plant Anim. Prod.*, 1956, **6**, 117.
7. Mohandoss, R. and Pillaiyar, P., *RPEC Reporter*, 1978, **4**, 48.
8. Pillaiyar, P. and Mohandosss, R., *J. Fd Sci. Technol.*, 1979, (Communicated).
9. Bhattacharya, K. R. and Subba Rao, P. V., *J. agric. Food Chem.*, 1966, **14**, 473.
10. *Methods of Analysis*, Association of official Analytical chemists Washington DC, 1970, 876.

11. Tata, S. N., *Rice News Teller*, 1962, **10**, 50.

12. Purela, G. S., *Microbial Profile of Paddy Soaked Water*, M.Sc. dissertation, 1975, Mysore University, Mysore.

13. Pillaiyar, P., Vasan, B. S., Rajendran, G. Dharmarajan, V., Chandrasekaran, R., Gangadharan, N. S., Iengar, N. G. C. and Subrahmanyan, V., Paper presented at the rice milling seminar, Amritsar, Sept., 1973.

14. Srikantia, S. G., 1977 National Institute of Nutrition,, Hyderabad, (private communication).

15. *Annual Report for* 1973, International Rice Research Institute. Philippines, 10.

16. Pillaiyar, P., *Report of the Action Oriented Field Workshop for Prevention of Post Harvest Rice Losses*. Malaysia, Food and Agricultural Organisation of the United Nations, Bangkok, 1977, p. 28.

Effect of Various Factors on Breakage of Rice During Commercial Milling

N. IBRAHIM* AND R. N. DATTA

Food and Nutrition Board, Shastri Bhavan, Madras-6, India

Manuscript received 24 *October* 1979; *revised* 8 *January* 1980

The original quality of paddy as exemplified by its content of damaged grains (sun cracked and immature grains), is the main determinant of rice breakage during milling. A portion of damaged grains remained unbroken during milling in the modern milling unit. Hence improved milling equipments have a substantial sparing action on the damaged grains. The extent of breakage is also dependent upon the stress applied during polishing stage.

Grain breakage during milling of rice, reduces rice out turn and its market value. Several factors have been identified as contributing to rice breakage such as grain damage, variety, moisture content, degree of milling and type of machinery. The initial condition of the paddy as represented by damaged (cracked and immature) grains has been considered as the most important contributing factor[1-3]. However, the rice milling modernisation programme in the country[4] has revealed a marked difference in total and head rice out turn between different mill types also.

In view of this, the relation of various factors to rice breakage was studied in a commercial installation containing both a traditional and a modern mill.

Materials and Methods

The study was carried out in the Ryots Agricultural Produce Co-operative Marketing Society, Mandya, where a traditional under-runner sheller-cone polisher (capacity, 1,5 tonne/hr) and a modern Satake rubber roller-horizontal abrasive polisher mill (capacity, 1 tonne/hr) are installed. Samples of paddy were collected at the input points of the respective mills. Samples of brown rice and milled rice were also collected after various stages of the milling operation. Broken grains less than 3/4th of whole grain) were seperated by hand and expressed as per cent of the respective sample.

Cracked and immature grains in the orginal sample were determined in a small portion of the respective paddy sample, after manual shelling, and was identified with the help of a magnifying lens. Grain length (L) and breadth (B) were determined by arranging ten sound whole grains of milled rice lengthwise and breadthwise respectively and measuring. Moisture content of paddy was determined by universal moisture meter. The degree of milling of the samples was determined by comparing with known standard of polished samples prepared in the laboratory.

Results and Discussion

The results are presented in Tables 1 and 2. It is clear that there was great sample to sample variation in the extent of grain breakage during milling. But on the whole these differences were related primarily to the original quality of the paddy. As the contents of damaged grains in the sample increased, the breakage also increased, which showed that the paddy quality is an important factor for breakage of rice during milling.

However, the type of mill also affected breakage, Breakage was much lower in the brown rice obtained from the rubber roller sheller than from the under runner sheller. But this initial difference in breakage was

**Present address:*

Regional Centre for Extension Service, Modernisation of Rice Processing, Annamalai University, Annamalainagar-608 101.

TABLE 1. BREAKAGE OF RICE DURING MILLING IN A TRADITIONAL MILL

Rice variety	Dimensions		Paddy moisture (%) wet basis)	Damaged grains (%)		Degree of milling (%)	Breakage (%) after		
	Length L (mm)	Length / Breadth (L/B)		Cracked	Immature		Shelling	1st Cone	IInd Cone
S 701	5.74	2.72	12.1	14.2	2.1	3.0	12.4	13.3	15.1
-do-	5.74	2.72	11.8	26.2	3.2	3.5	15.5	19.4	26.5
-do-	5.74	2.72	11.6	13.2	4.2	5.5	10.8	14.6	18.3
-do-	5.74	2.72	11.5	19.2	3.4	6.5	11.2	18.5	22.3
Salem Sanna	6.00	2.67	12.6	74.4	4.2	4.5	32.2	52.9	61.1
IR-8	6.60	2.54	12.9	26.2	3.1	6.5	12.1	20.3	31.0
Manila	6.90	2.80	14.2	3.4	8.2	6.5	5.6	8.8	14.0
Halubbulu	5.20	2.32	14.7	11.9	8.4	6.5	6.8	14.7	20.5

TABLE 2. BREAKAGE OF RICE DURING MILLING IN A MODERN MILL

Rice variety	Dimensions		Moisture (% wet basis)	Damaged grains (%)		Degree of milling (%)	Breakage (%) after			
	L (mm)	(L/B)		Cracked	Immature		Shelling	Ist Polisher	II Polisher	III Polisher
S-701	5.7	2.78	11.5	22.4	2.3	3.5	3.5	11.8	18.4	21.0
-do-	5.7	2.78	11.6	13.6	4.4	4.7	2.2	6.3	8.4	12.8
-do-	5.7	2.78	12.4	9.6	6.8	5.0	4.8	10.4	12.6	16.6
-do-	5.7	2.78	12.9	37.2	3.5	5.5	3.5	12.0	14.5	18.2
-do-	5.7	2.78	12.1	36.0	2.2	6.0	10.9	12.3	18.4	21.4
Manila	6.9	3.07	13.3	18.4	4.4	4.5	2.1	8.2	10.2	14.2
-do-	6.9	3.07	16.6	6.1	5.7	5.5	6.3	9.3	13.6	18.2
Jaya	5.6	2.67	12.3	30.1	3.2	3.5	12.8	14.2	18.4	22.8
Halubbulu	5.8	2.32	12.8	16.8	4.1	6.8	4.2	9.3	15.0	16.8

considerably reduced after final polishing, In other words, while the ultimate cause of rice breakage may reside in the damaged grains, good or improved mill equipment has substantial sparing action on the damaged grains.

Rice breakage increased in both the mills during the successive steps of the milling process. Breakage also increased with increasing degree of milling, showing that breakage was related to the stress of milling.

Acknowledgement

Authors thank Dr. K. R. Bhattacharya of CFTRI, Mysore, for valuable suggestions in the conduct of this study and for reviewing the manuscript. Thanks are also due to the Administrator and his staff at the Ryots Agricultural Produce Cooperative Marketing Society Limited, Modern Rice Mill Project, Mandya, for providing laboatory and milling facilities. Authors also express their appreciation to Shri. N. Sabapathy, Asst. Technical Adviser, Food and Nutrition Board, Shastri Bhavan, Madras, for his valuable assistance in the preparation of this manuscript.

References

1. Rhind, D., *Trop. Agric. Trinidad*, 1962, **39**, 19.
2. Angladette, A., *Rice Drying'—Principles and Techniques* Informal Working Bulletin No. 23, FAO, Agric. Engineering Branch, Rome, 1963, 1-73.
3. Bhattacharya, K. R., *Cereal Chem.*, 1969, **46**, 478.
4. *Government of India, Modern Versus Traditional Rice Mills' —A Performance Study'*, Dept. of Agriculture, Govt. of India, New Delhi, 1971.

Use of Triticale for Bread, Cookie and Chapati Making

K. S. SEKHON, A. K. SAXENA, S. K. RANDHAWA AND K. S. GILL
Department of Plant Breeding, Punjab Agricultural University, Ludhiana, Punjab, India

Manuscript received 20 *November* 1979; *revised* 2 *May* 1980

Studies on some physico-chemical characteristics, bread, cookie and 'chapati' making qualities of triticale with respect to wheat and their blends are reported. Triticale had higher protein content, diastatic activity, non-reducing sugars, total sugars and ash content in the flour but had lower sedimentation value, Pelshenke value, water absorption and loaf volume than wheat. The loaf volume, and crumb texture of triticale bread improved with the increased proportion of wheat flour. Blends upto 1:1 ratio gave very good breads. Triticale and its blends gave very good cookies. A blend of triticale 'atta' with wheat 'atta' in 1:3 ratio gave as good a 'chapati' as from wheat 'atta' alone.

A number of studies[1-4] have shown that triticale is high in protein and lysine contents[5-7]. However, it has very poor bread making quality[8-10]. It gives reddish and relatively harder chapaties as compared to wheat[7,11].

Some of these defects could be improved by blending triticale flour with wheat flour. But very few studies have been reported on this aspect[8,12]. The present study is, therefore, taken up to understand the effect of blending triticale with flour on the resultant bread, cookie and chapati making properties.

Material and Methods

Samples of wheat variety 'WL-711' widely cultivated in Punjab) and a promising triticale strain, 'TL-257' (grown at the Punjab Agricultural University farm) were procured from the 1978 crop.

The samples were cleaned and conditioned to 14 per cent moisture. The flour was extracted through a Quardrumatic Junior Mill. One kg lots of wheat and triticale flour mixtures of 3:1, 1:1, and 1:3 proportions were prepared for analysis. For chapati making, a portion of the sample was ground in a small stone *chakki* in the laboratory and blends of wheat and triticale flours (atta) were prepared in the proportions of 3:1, 1:1 and 1:3.

The protein content, sedimentation value, Pelshenke value, ash content, diastatic activity, reducing and non-reducing sugars were determined according to AACC methods. The rheological properties were studied through Brabender farinograph and the curves obtained were interpreted as recommended by them.[13] Bread and cookie tests were conducted as are followed at the International Maize and Wheat Improvement Centre, Mexico. The chapati making test was conducted as described earlier.

Results and Discussion

The data on the physio-chemical characteristics of 'WL-711' and 'TL-257' are given in Table 1. 'TL-257' had higher protein content, diastatic activity, non-reducing sugars, total sugars and a higher content of ash in the flour as compared to wheat variety 'WL-711'. 'TL-257' had lower sedimentation and Pelshenke values than 'WL-711'. These observations are in agreement with those reported earlier[2,11,12]. Lorenz *et al*[14], Tsen *et al*[15] and Farell *et al*[16] observed higher ash content in triticale flours than wheat flours.

'TL-257' was found to have lower water absorption and shorter mixing time as compared to 'WL-711' (Table 2). The water absorption and other farinographic characteristics like mixing time, arrival time, departure

TABLE 1. PHYSICO-CHEMICAL CHARACTERISTICS OF WL-711 AND TL-257

Characteristics	WL-711	TL-257
100 grain wt. (g)	4.52	4.38
Grain protein (%)	12.0	13.00
Flour protein (%)	12.0	12.17
Sedimentation value (ml)	26.00	22.00
Pelshenke value (min.)	88.00	66.00
Ash (%)	0.44	0.90
Diastatic activity (maltose/10g flour)	281	365
Reducing sugars (mg/10g flour)	30	28
Non-reducing sugars (mg/10g flour)	178	217
Total sugars (mg/10g flour)	208	245

TABLE 2. FARINOGRAPHIC CHARACTERISTICS OF WL-711 AND TL-257 AND THEIR BLENDS

WL-711:TL-257	Water absorption (%)	Mixing time (min)	Arrival time (min)	Departure time (min)	Stability (min)	Tolerance index (B.U.)	Time to break (min)
1 : 0	72	3.0	1.50	6.00	4.5	60	5.5
0 : 1	54	3.0	0.75	6.25	5.6	70	5.5
3 : 1	60	3.3	1.25	8.25	7.0	50	5.5
1 : 1	56	3.3	1.00	7.50	6.5	55	5.5
1 : 3	54	3.0	1.00	7.00	6.0	65	5.5

time, stability and tolerance index, improved with the higher content of wheat flour in the blends. Earlier studies[8,10,12] also reported lower water absorption for triticale as compared to wheat.

Triticale strain 'TL-257' showed poor loaf volume, specific volume and poor crumb texture than wheat variety 'WL-711'. Lorenz *et al*[14] and Harber *et al*[10] also reported poor loaf volume and specific volume for triticale than that of wheat. However, Lorenze *et al*[14] and Lorenz[17] observed that highly acceptable breads could be produced from triticale flours with slight adjustments in water, absorption and mixing time. The blending of triticale with wheat flour improved these characteristics considerably and the blending upto 50 per cent level gave as good loaf volume and crumb texture of bread as the wheat flour itself. In fact the loaf volume obtained from a blend of 25 per cent triticale flour with wheat flour was better than that obtained from wheat flour alone (Table 3). Unrau and Jenkins,[8] and Rao *et al*[12] have also reported that blending flours of triticale with wheat improves the bread making properties of triticale flours.

Cookies prepared from triticale had very good qualities and desirable spread. Cookies prepared from different blends of triticales and wheat flours were quite comparable to wheat flour cookies (Table 4). These were liked by the panel of tasters. Rao *et al*[12] have also observed that biscuits prepared from triticale had very good spread and acceptability.

The data with respect to chapati making qualities are given in Table 5. The data show that chapaties prepared from 'TL-257' were comparable to those prepared

TABLE 3. BREAD MAKING CHARACTERISTICS OF WL-711, TL-257 AND THEIR BLENDS

WL-711:TL-257	Loaf vol. (cc)	Loaf wt. (g)	Specific vol. (cc/g)	Crumb colour	Crumb texture
1 : 0	548	136	4.02	Yellow cream	V. good
0 : 1	400	140	2.85	Creamish	Regular
3 : 1	584	138	4.03	Creamish	V. good
1 : 1	548	130	4.21	Creamish	Good
1 : 3	500	135	3.70	Creamish	Poor

TABLE 4. COOKIE CHARACTERISTICS OF WL-711, TL-257 AND THEIR BLENDS

WL-711:TL-257	Wdth (W) (cm)	Thickness (cm)	W/T	Acceptability
1 : 0	5.50	1.00	5.50	V. good
0 : 1	5.20	1.08	4.80	Good
3 : 1	5.13	1.10	4.66	Good
1 : 1	5.25	1.10	4.75	Good
1 : 3	5.00	1.10	4.54	Good

TABLE 5. CHAPATI MAKING CHARACTERISTICS OF WL-711, TL-257 AND THEIR BLENDS

WL-711:TL-257	Dough colour	Dough handling	Chapati colour	Puffing	Texture	Absorption (%)	Chapati score	Rating
1 : 0	Creamish	Non-sticky	Creamish	Full	Soft	64	39	V. good
0 : 1	Red	Sticky	Red	Full	Hard	60	27	Fair
3 : 1	Creamish	Non-sticky	Creamish	Full	Soft	64	39	V. good
1 : 1	Reddish	Non-sticky	Dull creamish	Partial	Hard	64	32	Good
1 : 3	Reddish	Sticky	Reddish	Partial	Hard	62	23	Fair

All the samples possessed pleasing appearance and sweet taste.

from 'WL-711' and except that, these were red in colour and harder in texture. This observation is in agreement to our previous observations[7,11]. The blending of *atta* of 'WL-711' and TL-257' in the ratio of 3:1 gave very good chapaties, similar to those prepared from 'WL-711' alone. However, the blending in the ratio of 1:1 made the colour of chapaties reddish and the texture hard. This showed that for chapati making the triticale *atta* could be blended with wheat *atta* to the extent of 25 per cent without any detrimental effect on chapati quality.

References

1. Larter, E. N., Tanchiya, T. and Evens, L. E., *Proc. 3rd Int. Wheat Genet. Symp.* Canberra, Australia, 1968, 291.
2. Villegas, E. *Improving nutritional quality in triticale breeding and research at CIMMYT*, Res. Bull. No. 24, 1973, 55.
3. Bakhshi, A. K., Gill, K. S., Sandha, G. S. and Dhindsa, G. S., *Crop Improv.*, 1975, **2**, 84.
4. Zhebrak, E. A. and Gruzdev, L. C., *Trital Genet.*, 1975, **9**, 453.
5. Young, F. C. and Unrau, A. M., *J. agric. Fd Chem.*, 1966, **14**, 8.
6. Pavlov, P., Berova, S and Tatorova, V., *Rastinievaol Nauki*, 1976, **13**, 22.
7. Sekhon, K. S. Bakhshi A. K. Sehgal, K. L. and Gill, K. S. *Indian J. Biochem. Biophys. (Suppl.)* 1977, **14**, 41.
8. Unrau, A. M. and Jenkins, P. O., *Cereal Chem.*, 1965, **41**, 365.
9. Medl, R. L. and Tsen, C. C., *Cereal Chem.*, 1973, **50**, 215.
10. Harbar, T., Seyam, A. A. and Bauasik, O. J., *Bakers Digest*, 1976, **24**, 50.
11. Bakhshi, A. K., Sekhon, K. S., *J. Res. Punjab, agric Univ.*, 1978, (communicated).
12. Rao, G. V., Ranga Rao G. S. P., Vatsala, C. N., Kumar G. V. and Shurpalakar, S. R., *J. Fd Sci. Technol.*, 1978, **15**, 11.
13. *Cereal Laboratory Methods*, American Asaociation of Cereal Chemists Inc. U.S.A., 1969.
14. Lorenz. K., Welsh, J. Norman, R. and Maga, J., *Cereal Chem.*, 1973, **49**, 187.
15. Tsen, C. C., Hoover, W. J. and Farrel, E. P., *Cereal Chem.*, 1973, **50**, 16.
16. Farrel, E. P. Tsen, C. C. and Hoover, W. J., in *Triticale, First Man Made Cereal*, Tsen, C. C. (ed.) AACC, St. Paul, Minnesota, 1974, 224.
17. Lorenz, K. *Food Technol., Chicago.*, 1972, **26**, 66.

Studies on the Improvement of Cooking Quality of Kidney Beans *(Phaseolus vulgaris)*

EDUARDO CARO BUENO, H. V. NARASIMHA AND H. S. R. DESIKACHAR
Central Food Technological Research Institute, Mysore,13, India

Manuscript received 25 *February* 1980; *revised* 27 *May* 1980

Sodium bicarbonate, trisodium phosphate and ammonium carbonate have been used as cooking aids for kidney bean *dhal* (*Phaseolus vulgaris*). These were found to be more effective when precoated on the *dhal* than when added directly to the cooking water. Presoaking of the *dhals* in the salt solution also reduced the cooking time by about 50% without affecting the organoleptic qualities.

Legumes constitute an important source of protein in the diets of people in the developing world. A large proportion of edible legumes are generally consumed after cooking to soft consistency. The cooking time varies from 1 to 3 hr[1,2] the longest being for beans (*Phaseolus vulgaris*)[3] particularly in the whole grain form. Different methods of preparing quick-cooking beans have been attempted over the years. Steinkrauss *et al*[4], Rockland and Metzter[5] and Kon *et al*[6] have reported processes for preparing various types of quick-cooking dry beans. These methods require elaborate and high cost drying freezing operations. The possibility of inexpensive simple techniques of soaking and coating of bean *dhal* with certain inorganic salts for reducing the cooking time and improving the cooking characteristics is described in the present investigation.

Materials and Methods

Commercially available red kidney beans were purchased from the local market. These were treated with 0.5 per cent oil, split in a sheller, conditioned for 2 hr and dehusked in a pearler to obtain *dhal* (dehusked split) as per the method of Kurien[7].

The cookability of whole bean and *dhal* was studied by following the rate of hydration and solids dispersed into cook water as described earlier for *tur* (*Cajanus*

cajan)[8]. The time needed for the bean to become soft enough to be pressed between two glass slides was taken as cooking time. Three independent observations[3] were made in each case. Ten grams of *dhal* was cooked in 100 ml water in all the experiments.

Coating or presoaking studies: *Dhal* samples were first cooked in water to which chemicals like $NaHCO_3$, Na_2CO_3, $(NH_4)_2CO_3$ and Na_3PO_4, which had been shown earlier to reduce the cooking time of *tur dhal*[9,10], were added in different concentrations as detailed in Table 2. *Dhal* was given a coating of the above chemicals by impregnation with the respective solution (5 ml per 100 g) containing the same quantity of chemicals as added to the cooking water. After the coating treatment the *dhal* was allowed to equilibrate for 2 hr in a glass stoppered flask and then dried in a truck drier using a current of air at 50°C. In parallel studies *dhal* was also soaked for 2 hr in 1.5 parts of water to which 0.5-1.5 g of the chemicals were added per 100 g *dhal* as shown in Table 2. The excess soak water was drained off and then the soaked *dhal* was rinsed once with water and cooked in water as explained earlier.

Whole bean, husk and dehusked *dhal* were analysed for Ca, Mg and P contents by standard procedures[11-13].

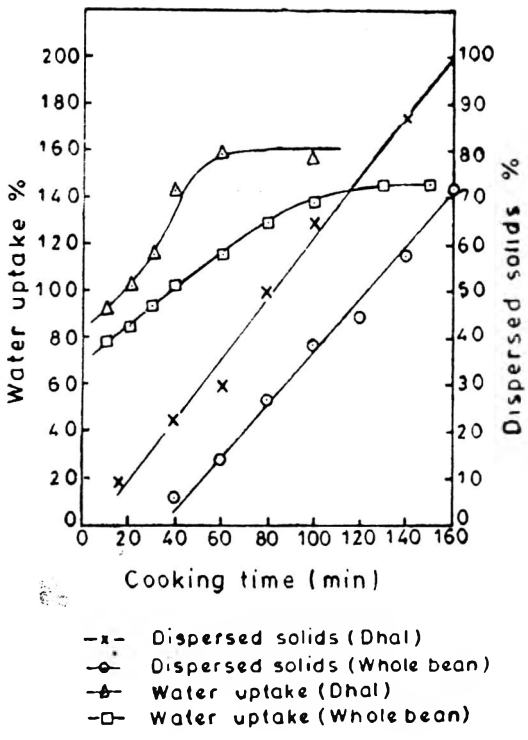


FIG. 1. Water uptake and dispersed solids of Kidney bean (whole and *dhal*) during different periods of cooking.

Results and Discussion

The data regarding the rate of hydration and dispersed solids for *dhal* and whole beans are presented in Fig 1. Kidney bean *dhal* showed higher rate of hydration and became soft far earlier (60 min) than whole beans (135 min). The husk acts as a physical barrier to the absorption of water which was also observed by Kon *et al*[6]. Further it is observed from Table 1 that the husk is far richer than the endosperm with respect to divalent metals Ca and Mg while the reverse was the case with respect to phosphorus.

Data on the cooking characteristics of *dhal* when treated with various chemicals either singly or in combination are presented in Table 2. It is seen that the chemicals were more effective in reducing the cooking time when used as presoaking or for coating on the *dhal* than when added to the cooking water; similar was the case with *tur dhal*[14]. Trisodium phosphate or sodium bicarbonate along with ammonium carbonate applied by coating to the *dhal* at 0.5 per cent level brought about nearly 50 per cent reduction in the cooking time. Higher concentration of the chemicals greatly reduced the cooking time but the cooked *dhal* was not organoleptically acceptable due to high alkalinity (pH > 7.4). Trisodium phosphate had a better softening effect and a level of 0.5 per cent in combination with ammonium carbonate was found suitable as the resultant pH was about 7.2. Combination of sodium carbonate and ammonium carbonate gave high pH and alkaline taste even at 0.5 per cent levels each, and hence was not acceptable.

Dispersed solids and water uptake which are parameters of cooking quality were greater in coated *dhal* than the control untreated *dhal* when cooked in water containing the same amount of chemicals (Table 2).

TABLE 1. PROXIMATE COMPOSITION OF BEAN (PER 100 G)

Samples	Protein	Fat	Carbohydrate (by diff)	Ash	Acid insoluble ash	Ca	M	P.
Whole bean	16.3	1.75	67.17	4.83	0.22	0.18	0.08	0.285
Dehusked split bean (*dhal*)	19.0	1.87	69.04	3.81	0.14	0.07	0.01	0.311
Husk	4.4	0.52	85.15	5.27	0.43	1.06	0.39	0.061

TABLE 2. COOKING CHARACTERISTICS OF COATED AND PRESOAKED BEAN *DHALS*

Chemicals used for cooking	Cooking time (min)	Dispersed solids at 30 min (%)	Water uptake (g/g) (at 20 min)	pH of the cooked mash	Flavour/taste of the cooked *dhal*	Overal acceptability
a) Control (none)	60	52.7	0.80	6.6	Normal	Acceptable
**b*) $NaHCO_3+(NH_4)_2CO_3$ (0.5% each)						
Added to cook water	42	69.4	1.42	7.6	Slightly alkaline	Not acceptable
Coating	35	76.8	1.61	7.2	Normal	Acceptable
Presoaking	26	92.4	1.80	7.3	Normal	Acceptable
**c*) $Na_3PO_4+(NH_4)_2CO_3$ (0.5% each)						
Added to cook water	44	71.5	1.45	7.1	Normal	Acceptable
Coating	33	83.5	1.60	7.0	Normal	Acceptable
Presoaking	24	94.5	1.60	7.2	Normal	Acceptable
d) Presoaking						
$(NH_4)_2CO_3$ (1.5%)	25	91.8	1.90	7.3	Normal	Acceptable
$(NH_4)_2CO_3$ (1%)	32	84.5	1.70	7.1	Normal	Acceptable
Na_3PO_4 (1%)	36	84.6	1.65	7.2	Slight biting taste	Acceptable
Na_2CO_3 (1%)	31	89.0	1.85	7.8	Alkaline	Not acceptable
$NaHCO_3$ (1%)	34	79.5	1.80	7·6	Alkaline	Not acceptable

*Higher concentration of the chemicals than indicated in (*b*) and (*c*) i.e. 0.5% reduces the cooking time but the cooked product had an alkaline taste.

Presoaking of the *dhal* for 2 hr in the chemical solutions brought down the cooking time by more than 50 per cent.

Although all chemicals used were effective in reducing the cooking time and increasing the proportion of dispersed solids as compared with the control, a combination of ammonium carbonate or trisodium phosphate with sodium bicarbonate (0.5 per cent each) was found to be more suitable. Ammonium carbonate alone at a concentration of 1.5 per cent also effectively reduced the cooking time without affecting the organoleptic quality. The beneficial effect of chemicals is believed to be due to their effect in raising the pH. The quantity of chemicals that could be added is governed by the organoleptic acceptability of the cooked *dhal*.

References

1. Muneta, P., *Food Technol. Champaign*, 1954, **18,** 130.
2. *A brief overview of the grain legume situation-Production, Processing, Utilisation and Storage*, Prepared by Central Food Technological Research Institute, Mysore for the FAO Expert Consultation on Grain Legume Processing held at CTRI, Mysore, November 1977. AGS:GLP/77/2.
3. Morris, H. J. and Wood, E. R., *Food Technol. Champaign.*, 1956, **10,** 225.
4. Steinkrauss, K. H., Van buren, J. P., La Belle, R.L. and Hand D. B. *Food Technol. Champaign.* 1964, **18,** 121.
5. Rockland L. B. and Matzler, E.R. *Food Technol. Chicago*, 1967, **21,** 30.
6. Kon, S., Dhanneson, A. U. and Booth, A. N., *J. Fd Sci.*, 1973, **38,** 496.
7. Kurien, P. P., *Grain Legume Milling Technology* presented at FAO Expert Consultation on Grain Legume Processing held at CFTRI, Mysore, in November 1977. AGS:GLP/77/11.
8. Narasimha, H. V. and Desikachar, H. S. R. *J. Fd Sci. Technol.* 1978, **15,** 47.
9. Maltson, S., *Acta Agric. Suecona*, 1946, **2,** 185 (*Chem. Abstr.* 1948, **42,** 4689.)
10. Subba Rao, P. V., Ananthachar, T. K. and Desikachar, H. S. R., *Indian J. Technol.*, 1964, **2,** 417.
11. Beron, G. M. and Joyee, L. B. U., *Clin. Chem. Acta.* 1957, **2,** 327.
12. *Official Standardised and Recommended Methods of Analysis*, The Society for Anal. Chem., 1963, 168.
13. Allen, R. J. L., *Biochem. J.*, 1940, **34,** 858.
14. Narasimha, H.V. and Desikachar, H. S. R., *J. Fd Sci. Technol.*, 1978, **15,** 149.

Major Food Constituents of Rice-bean *(Vigna umbellata)*

S. P. Singh and B. K. Misra
Biochemistry Division, Indian Agricultural Research Institute, New Delhi-110012, India

and

K. P. S. Chandel and K. C. Pant
National Bureau of Plant Genetic Resources, IARI Campus, New Delhi-110012

Manuscript received 3 *April* 1980; *revised* 25 *May* 1980

Rice-bean (*Vigna umbellata*), a little known pulse has remained underexploited till today. Six promising strains of rice-bean ('GRRS-1' to 'GRRS-6')* recently isolated by National Bureau of Genetic Resources were analysed for their important food constituents. The results have been compared to other traditional pulses. On the basis of present data, it is presumed that the rice-bean may find a place in the pulse cultivation in India along with other common pulses.

Rice-bean, a native of South and South-east Asia is cultivated by the tribals in various ethnic groups in the Eastern and North-eastern regions and to some extent in South India. Its present day cultivated forms seem to have originated from its wild forms which occur extensively in the north-western and eastern Himalayas and also in the hot humid climate of western ghats[1-3]: The rich genetic diversity, high agricultural and nutritive potential of rice-bean were highlighted recently[2,3]. It was also reported that this species is completely free from yellow mosaic virus which takes very heavy toll of other common *Vigna* species. Its seeds are also free of a serious insect, bruchide.

From the available information it appears that inspite of several attributes, no systematic work has so far been undertaken for the evaluation of the composition and nutritive quality of rice-bean. It is with this objective that the results of the preliminary biochemical investigations on six promising strains of rice-bean (recently isolated by NBPGR) have been reported in the present communication.

Materials and Methods

Six promising strains of rice-bean viz. 'GRRS-1' to 'GRRS-6' supplied by NBPGR were analysed for their biochemical parameters. Twenty gram seeds of each strain were made free of ether soluble substances using petroleum ether (40-60°C). The samples were powdered to 100 mesh and made free from moisture. Each sample was used in duplicate. Crude protein, ash content, calcium, iron, crude fibre and total phenols were determined by A.O.A.C. methods[4], ether extract was determined by cold percolation method[5], phosphorous was estimated by King's modification[6] of Fiske Subbarao's method. Free sugars were estimated by using the method of Nelson[7] and Somogyi[8]. Methionine was determined by original colorimetric method of McCarthy and Sullivan[9] and McCarthy and Paille[10]. Estimation of tryptophan was accomplished by the method of Spies and Chambers[11]. Total free amino acids were determined by the method of Lee and Takashi[12]. The quantity of total free amino acids was computed from the standard curve prepared for alanine. Starch content was estimated by difference.

Results and Discussion

The seed colour, seed weight and the chemical composition of the rice-bean selections are presented in Table 1. Strains varied greatly in their seed size and colour. Seed colour was observed to be creamish yellow, light green to deep red while the 1000 grain weight varied from 56.1 to 137.6 g. Crude protein content ranged from 17.81 to 25.18 per cent. The ash content of the strains did not show any remarkable difference. Similarly, there was not much variation in ether soluble extract of the strains. Crude fibre content varied from 3.3 to 4.8 per cent. Calcium content was quite high in all the strains and it varied from 315 to 450 mg/100g. Iron content was low except in 'GRRS-2'. There was a

*GRRS—Denotes Genetic Resources Rice-bean Selection identified by National Bureau of Plant Genetic Resources, (NBPGR), New Delhi-110 012.

TABLE 1. PHYSICAL CHARACTERISTICS AND CHEMICAL COMPOSITION[a] OF RICE BEAN STRAINS

Strain	Colour	1000 grain wt. (g)	Crude protein (N x 6.25) (%)	Ash (%)	Ether soluble extract (%)	Crude fibre (%)	Calcium (mg/100g)	Iron (mg/100g)	Phosphorus (mg/100g)
GRRS-1	Creamish yellow	108.2	18.86	3.87	1.60	4.0	450	1.0	258
GRRS-2	Green	56.1	21.56	4.00	1.00	3.3	405	5.0	393
GRRS-3	Light green	131.1	19.56	3.81	1.06	4.6	392	0.0	255
GRRS-4	Deep red	137.6	17.81	4.31	1.10	3.8	421	2.0	270
GRRS-5	Deep red	84.5	25.18	4.06	1.00	3.5	315	1.0	210
GRRS-6	Green	94.5	22.00	4.02	1.06	4.8	432	2.0	197

[a] All values are on moisture and fat free basis.

striking difference in the contents of phosphorous and it varied from 197 to 393 mg/100g.

It is evident from the data in Table 2 that the total free amino acid content was low which ranged from 1.90 to 4.40μ moles/g of alanine. Total phenols did not differ much in these strains (0.09-0.14 per cent). Likewise, non-reducing sugar content was almost same in all the strains (3.71-5.37 per cent) but was low in 'GRRS-6'. Tryptophan and methionine contents ranged from 0.80 to 1.10 and 0.40 to 0.94 per cent respectively. Strains 'GRRS-2', 'GRRS-5' and 'GRRS-6' were found to be low in methionine content. The starch content was high ranging from 60.64 ('GRRS-5') to 67.33 per cent in 'GRRS-4'.

On comparing the results of the present investigation with the data on traditional pulses[13–17], it has been observed that rice-bean compares well with other pulses in its crude protein, ash, ether soluble extract, crude fibre and phosphorus contents. The presence of high amounts of calcium and tryptophan in rice-bean as compared to other pulses, might prove its eminence over them from nutritional point of view. However, the low amounts of iron and methionine may probably affect the biological value adversely to some extent.

The chemical composition of rice-bean has not been worked out adequately. Thus the results of present investigation cannot be compared with earlier findings. The strains, under study, differed considerably in their seed size, colour and seed weight. 'GRRS-4' was found to contain the lowest amounts of crude protein (17.81 per cent), while 'GRRS-5' contained maximum amount (25.18 per cent). Present results indicate that the rice-bean strains differed considerably in their protein content but it may be regarded as a good source of protein like other popular pulses.

As regards the ash content, rice-bean ranked above all the traditional pulses. This may be due to the higher contents of phosphorous and calcium. Crude fibre content of rice-bean is comparable with other common pulses except chick pea and field bean. The importance of fibre in our diet is already brought out[18].

Calcium content was maximum in strain 'GRRS-1', and in other strains also its content was higher than in the common pulses. The content of iron was lower in all the rice-bean strains excepting 'GRRS-2' which showed some similatity with other pulses. Phosphorus content of the rice-bean is well at par with other common pulses. Rice-bean may be ranked above the traditional

TABLE 2. OTHER CONSTITUENTS[a] OF RICE BEAN STRAINS

Strain	Total free amino acids (μmole/g)	Total phenols (%)	Free reducing sugars (%)	Free non-reducing sugars (%)	Tryptophan[b] (%)	Methionine[b] (%)	Starch (by diff.) (%)
GRRS-1	3.05	0.09	0.084	5.37	0.80	0.94	65.87
GRRS-2	1.90	0.14	0.094	5.07	0.93	0.42	64.45
GRRS-3	2.50	0.11	0.080	5.19	0.79	0.81	65.34
GRRS-4	4.40	0.12	0.098	5.17	1.10	0.94	67.33
GRRS-5	3.45	0.14	0.089	5.18	0.95	0.40	60.64
GRRS-6	1.55	0.10	0.085	3.71	0.85	0.39	64.03

[a]All values are on moisture and fat free basis; [b]per 16g nitrogen basis

pulses with respect to the contents of calcium and phosphorus.

Low amounts of total free amino acids in rice-bean strains suggest that the loss of amino acids on cooking will be lesser which is one of the desired characteristics. The low contents of total phenols in rice-bean suggest its use in our diet since it will not be injurious to health.

Generally, pulse proteins are deficient in methionine and tryptophan, which results in low biological value of protein. But rice-bean appears appreciably rich in tryptophan content. Methionine content however, is comparatively low in three strains than in the common pulses. Rice-bean is a rich source of starch, a digestible carbohydrate and in this respect it may have an edge over other common pulses.

From these results it is evident that rice-bean is a good source of protein, calcium, phosphorus, tryptophan and starch but poorer in iron and crude fibre contents. However, it is necessary to investigate the anti-nutritional factors (trypsin inhibitor) and toxic principles, if any, present in rice-bean.

References

1. Chandel K. P. S., Joshi, B. S. and Pant K. C., *Genetic Resources of Vigna species in India and their Contribution in crop improvement* Presented at "International Conference on cytogenetics and crop improvement" held during 3 to 6 March, 1978 at Banaras Hindu University, Varansai.
2. Chandel, K. P. S., Joshi, B. S., Arora, R. K. and Pant, K. C., *Indian Fmg.*, 1978 19.
3. Chandel, K. P. S., Arora, R. K., Joshi, B. S. and Pant, K. C., *Rice-bean (Vigna umbellata): it's origin, distribution, genetic diversity and agricultural potential;* presented at National Symposium on Plant and Animal Genetic Resources held during December 27-31, 1978 at Indian Agric, Res. Institute, New Delhi.
4. *Official Methods of Analysis*, A.O.AC., Washington, D. C., U.S.A., 11th Edn. 1970.
5. Kartha, A.R.S. and Sethi, A. S., *Indian J. agric. Sci.*, 1957, **27**, 211.
6. King E. J., *Biochem. J.*, 1932, **26**, 292.
7. Nelson, N. J., *Biol. Chem.*, 1944, **153**, 375.
8. Somogyi, M., *J. biol. Chem.*, 1937, **117**, 771.
9. McCarthy, T. E., and Sullivan, N., *J. biol. Chem.*, 1941 **141**, 871.
10. McCarthy, T. E., Paille, M. M., *Biochem. Biophys. Res. Comm.*, 1959, **1**, 29.
11. Spies, J. R. and Chambers, D. C., *Anal. Chem.*, 1948, **20**, 30.
12. Lee, Y. P. and Takashi, T., *Anal. Biochem.*, 1966, **14**, 71.
13. Singh, S., Singh, H. D. and Sikka, K. C., *Cereal Chem.*, 1968, **45**, 13.
14. Lal B. M., Rohewal S. S., Verma, S. C. and Ved Prakash, *Annals Biochem. exp. Med.*, 1963, **23**, 543.
15. Verma, S. C., Lal, B. M. and Ved Prakash, *J. Sci. Fd Agric.*, 1964, **1**, 25.
16. Rao, G. R. and Kadkol, S. B., *Food Sci.*, 1957, **6**, 153.
17. Chatterjee, S. R. and Abrol, Y. P., *J. Fd Sci. Technol.*, 1975, **12**, 221.
18. Food and Nutrition Research 1974, *Report of ARC/MRC Committee*, London, Elsevier Scientific Publishing Company, Amsterdam, Netherlands, 141.

RESEARCH NOTES

ANTHOCYANINS OF AVOCADO (*PERSEA AMERICANA*) PEEL

The development of bright purple colour in the peel of avocado (*Persea americana*) fruit during its post-harvest ripening was found to be due to the synthesis of two anthocyanin pigments. The major pigment was identified as cyanidin-3-galactoside and the minor one as cyanidin-3, 5-diglucoside-p-coumarate.

Anthocyanin pigments which impart bright attractive shades of red and purple colour have been studied in several fruit systems.[1] However, there is no report on the anthocyanins of avocado which is a commercially significant member of the genus *Persea*. In the purple variety of avocado fruits chosen for the study, there is a change in colour of its peel from intense green to intense purple during post-harvest ripening. This communication presents the identification of anthocyanins in avocado peel.

Purple vareity of avocado fruits obtained from an orchard near Ooty, were allowed to ripen at room temperature and used in our studies. The anthocyanins from the peel of fully ripe fruits (6 days after harvest) were extracted with chilled 1 per cent methanolic HCl. The extract was initially purified by descending paper chromatography on Whatman No. 3 paper using formic acid:HCl:water (5:2:3 v/v). The two distinctly separated bands obtained were re-chromatographed in butanol: acetic acid:water (4:1:5 v/v) and 1 per cent HCl solvent systems for further purification. The anthocyanin pigments were hydrolysed by heating with 2N HCl. The hydrolyzate was first shaken with solvent ether to remove any carboxylic acid and then with isoamyl alcohol to extract the anthocyanidins. The aqueous layer containing only free sugars was purified further by passing through Dowex-1 (hydroxyl form)[2]. The alkaline degradation of anthocyanidin was carried out by the method of Hsia *et al.*[3]

Identification of anthocyanins, anthocyanidins and their alkaline degradation products, carboxylic acid and sugars obtained from the hydrolyzate of anthocyanins was made by R_f data on paper chromatograms[2-6]. Whatman No. 3 paper was used in all chromatographic separations. Precoated thin layer sheets were also used for TLC of sugars. Cyanidin, protocatechuic acid, p-coumaric acid, glucose and galactose were co-chromatographed with authentic samples. Spectral data for the pigments and the phenolic acids was obtained by using Perkin Elemer Coleman Division 575 model spectrophotometer.

The anthocyanin mixture extracted from avocado peel gave two distinct spots on paper chromatograms. Their R_f values in various solvent systems and spectral properties are presented in Table 1. Spectral studies made with chromatographically purified pigments showed absorption peaks at 263, 528 nm for anthocyanin-1 and at 253, 522 nm for anthocyanin-2. Both anthocyanin-1 and anthocyanin-2 yielded the same aglycone, cyanidin on hydrolysis as revealed by its chromatographic data, absorption maximum at 538 nm and a shift of +25 nm in absorption peak with aluminium chloride (Table 1). Further, the alkaline degradation product of both the aglycones were identified as protocatechuic acid by its R_f value and co-chromatography. The identity of cyanidin was further confirmed by co-chromatography.

Since both the pigments 1 and 2 yielded cyanidin on hydrolysis, the R_f values of the two anthocyanins were compared with those of known cyanidin glycosides. Accordingly, the anthocyanin-1 corresponded with cyanidin-3 galactoside and the anthocyanin-2 with perillanin, i.e., cyanidin-3, 5-diglucoside-p-coumarate. Indeed, the sugars obtained by the acid hydrolysis of

TABLE 1. R_f VALUES AND ABSORPTION MAXIMA OF ANTHOCYANINS AND THEIR AGLYCONE

	R_f values in						Absorption maxima in 0.01% HCl in methanol (nm)	Shift in peak with $AlCl_3$ (nm)
	Butanol: 2N HCl (1:1 v/v)	Acetic acid: HCl; water (30:3:10 v/v)	Buatnol: acetic acid: water (4:1:5 v/v)	1% HCl	Formic acid: HCl: water (5:2:3 v/v)	Formic acid: 3N HCl (1:1 v/v)		
Anthocyanin-1	0.18	0.240	0.345	0.066	+	+	263, 528	+
Anthocyanin-2	0.248	0.398	0.225	0.163	+	+	253, 522	+
Aglycone of both anthocyanin-1 and anthocyanin-2	0.71	0.51	0.67	+	0.23	0.22	538	+25

\+ Not applicable

TABLE 2. R_g VALUES OF SUGAR MOIETIES

	On paper		On pre-coated silica gel plates		
	Ethyl acetate: pyridine: water (12:5:4 v/v)	Iso-propanol: pyridine: water (3:1:1 v/v)	Acetone- butanol: water (5:4:1 v/v)	Dioxane: butanol: water (5:4:1 v/v)	n-Propanol: water (8.5:1.5 v/v)
Galactose (Anthocyanin-1)	85	92	0.15	0.31	0.40
Glucose (Anthocyanin-2)	100	100	0.22	0.42	0.50

anthocyanin-1 and anthocyanin-2 were found to be galactose and glucose respectively, as evidenced by their R_g values (Table 2). The identity of these sugars was further confirmed by co-chromatography with authentic samples.

The anthocyanin-2 upon hydrolysis, showed a highly prominent absorption peak at 264 nm in its ether wash. The compound was identified as p-coumaric acid based on its R_f value, absorption maxima and colour under ultra violet light. The identity was further confirmed by co-chromatography with authentic p-coumaric acid.

Thus, the identification of cyanidin and galactose in anthocyanin-1 and that of cyanidin, glucose and p-coumaric acid in anthocyanin-2 supports the probable identity of the anthocyanins derived from their R_f data.

These two anthocyanin pigments which are virtually absent in the fresh green fruits are synthesized subsequently yielding a purple coloured ripe fruit. The pigment synthesis starts two days after harvest, and will be almost complete by fifth day. In the fully ripened fruit, i.e., 6 days after harvest, the anthocyanin-1 and anthocyanin-2 exist in the ratio of about 9:1. It is likely that a strong anthocyanin synthesizing enzyme system in this variety is developing in the initial stages of harvest, or that which is already present in a latent form becomes active during ripening. Such a system may be absent in varieties of avocado fruits which remain green during ripening.

Central Food Technological Research Institute, Mysore-570 013,
T. N. PRABHA
B. RAVINDRANATH
M. V. PATWARDHAN
Received 17 *January* 1980
Revised 6 *June* 1980.

References

1. Hulme, A. C., *The Biochemistry of Fruits and their Products*, Academic Press, Inc., New York, 1970, Vol. I, 269.
2. Ranganna, S., *Manual of Analysis of Fruit and Vegetable Products*, McGraw Hill Co., New Delhi, 1977, 83.
3. Hsia, C. L., Luh, B. S. and Chichester, C. O., *J. Food Sci.*, 1965, **30**, 5.
4. Gunter Zweig and Joseph Sharma, *Hand Book of Chromatography*, CRC, Press, 1972, Vol. I, 364.
5. Ghebregzabhai, M., Rufini, S., Monaldi, B. and Lato, M., *J. Chromatog.*, 1976, **127**, 133.
6. Harbourne, J. B., *Comparitive Biochemistry of Flavonoids*, Academic Press, Inc., New York, 1967, 32.

A BUTYROMETRIC METHOD FOR RAPID DETERMINATION OF THE OIL CONTENT OF GROUNDNUT SEEDS

The butyrometric method was adapted to the rapid determination of oil content in groundnut kernels. One gram of seed sample and one ml of amyl alcohol were found optimum for the test. A chart was prepared relating the butyrometric reading to the oil content as determined by soxhlet extraction. The accuracy of the chart was found to be 3% from the standard method.

The soxhlet extraction method of determining fat content, widely used by the oil industry, is time consuming. Simplification and rapidity in determination of fat in oilseeds will help the industry in procurement of seeds, and could thus improve the efficiency of the oil crushing industry.

Very few methods have been reported in literature for rapid determination of oil content in oilseeds. The method of Kartha *et al*[1] involves determining the oil yield and iodine value on separate aliquots of a single extracted sample. Other methods include shaking the dried seeds in a stainless steel agitator[2] or with steel balls in a centrifuge tube[3] and weighing the oil after evaporation of a portion of the solvent. Other rapid determinations are based on the measurement of the dielectric constant[4] or on the ∝-bromonapthalein refractometric method[5].

The butyrometric method is simple, efficient and quick, and is used at village level by milk co-operative societies. In the present studies, the butyrometric method which is based on the volumetric principle using calibrated centrifuge tubes, was applied to the rapid

determination of oil content in groundnut seeds. This method[6] which liberates fat by dissolving the proteins present in milk using sulphuric acid, finds extensive application in the determination of fat in milk, cheese, cream and skimmed milk powder.

Approximately hundred grams of groundnut seeds from a representative sample were ground in a hand-operated grinder. The mass was sieved to give a very fine powder, which was used for the studies.

Butyrometers calibrated up to 10 per cent, which are generally used for the determination of fat in milk, were filled in the following sequence: 9 ml distilled water, 10 ml sulphuric acid (sp. gr. 1.820) and one ml amyl alchol. One gram of the sieved groundnut sample was allowed to slide into the butyrometer *via* a wide-mouthed glass funnel at 80–85°C. The contents of the butyrometer were mixed well for a few minutes and centrifuged for 15 min. The fat column in the butyrometer was read. The percentage of oil in the seed was determined from a chart earlier prepared correlating the oil content of groundnut samples determined by the soxhlet extraion method against the butyrometric reading given by each sample.

Separation of the fat column in the butyrometer was greatly influenced by the weight of the sample and volume of the solvent used in the test. At 0.5 g seed sample weight, the fat column in the butyrometer was very small, resulting in errors in recording the correct butyrometric reading. If the seed sample weighed more than one gram, a larger quantity of sulphuric acid was required for complete digestion and the oil column in the butyrometer went beyond the graduated scale. Addition of more than one ml of amyl alcohol increased the oil column by 0.2 units per ml. One gram powdered seed and one ml of amyl alcohol were optimum. The addition of sulphuric acid to water in the butyrometer raised the temperature to 112°C, so the procedure was revised. The ground seed sample had to be added to the mixture in the butyrometer at 80–85°C to prevent charring of the contents.

The oil content of 20 groundnut seed samples were analysed by soxhlet extraction following A.O.C.S methods[7]. The butyrometer reading of the oil column separated by the Gerber method was recorded for each of the same seed samples following the procedure indicated in the methodology. The fat column in the butyrometer (the calibrated centrifuge) was 2.8, 3.2, 3.5 and 3.7 for groundnut seeds, the oil content of which were 43.32, 44.58, 45,29 and 46.29 per cent respectively (Table 1). The calculated variation in oil content for each 0.1 unit change of the butyrometer reading was 0.64 per cent.

Based on this variation of oil content against butyrometer reading, a standard curve (fig. 1) was drawn from which the oil content of an unknown seed can be read directly from the Gerber reading. The accuracy of the method was that of the soxhlet extraction method, *viz.* ±3 per cent.

TABLE I. GERBER'S BUTYROMETRIC READING OF GROUNDNUTS AND THEIR OIL CONTENTS DETERMINED BY SOXHLET EXTRACTION

Serial no.	Butyrometer reading	Av. oil content by soxhlet extraction (%)
1	2.8	43.32
2	3.2	44.58
3	3.5	45.29
4	3.7	46.29
5	3.8	47.68
6	3.9	48.40
7	4.0	48.86
8	4.1	49.57
9	4.2	50.37
10	4.5	52.07

The volumetric method is empirical in character because of uncontrollable factors that affect the specific gravity of the seperated oil, the free fatty acidity and the solubility of the fat in the solvent. The correlation curve must, therefore, be tested at regular intervals against soxhlet extraction.

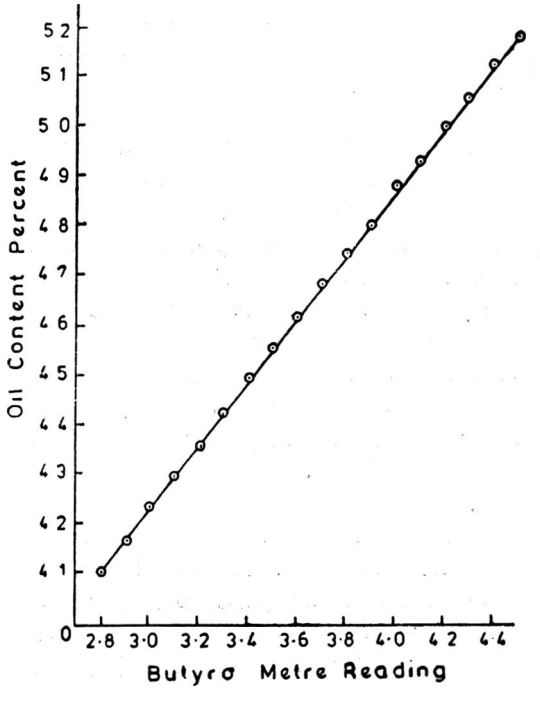


FIG. 1. Oil content related to butyrometre reading

The authors are thankful to Dr. R. P. Aneja, Secretary, National Dairy Development Board, Anand, for his interest in the work.

National Dairy Development Board,
Anand-388 001.
G. B. SHUKLA
A. N. BRAHMACHARI
C. K. SHARMA
T. NATARAJA MURTHI

Received 4 *January* 1980
Revised 9 *April* 1980

References

1. Kartha, A. R. S., Sethi, A. S. and Gulati, K. C., *Indian J. agric. Sci.*, 1955, **25**, Pt. 1, 79.
2. Francois, T., and Bleicher, G., *C. R. Acad. Agric., Fr.*, 1954, **40**, 314.
3. Troeng, S., *J. Am. Oil. Chem. Soc.*, 1955, **32**, 124.
4. Neustadt, M. H., *U.S. Dept., Agr. Tech. Bull.*, No. **1171**, 1955.
5. Grynberg H. and Patzek T., *Prazem. Spozywazy.*, 1952, **6**, 455
6. *Official Methods of Analysis*, Association of Official Agricultural Chemists, 9th Ed, Washington D. C., 1960, 190, 191.
7. *Official and Tentative Methods* American Oil Chemists. Society, 3rd Ed 1975.

AN EXTRUSION TEST FOR DETERMINING THE PALATABILITY OF PARBOILED RICES

Parboiled rice cooked to optimal cooking time is extruded at predetermined load for 5 min in a locally developed extruder and the material exrtuded correlates well with the type of parboiled rice. A positive correlation was observed between the taste panel scores for the tenderness of cooked parboiled rice and the extrusion test values, and based on the quantity of material extruded (g/g (w.b.) of cooked rice), the parboiled rice is grouped into three grades for their palatability.

The palatability characteristics of cooked rice are usually scored with taste panels[1]; but whenever samples differing in one or two processing variables are involved, accurate determination is not possible as this method has no fixed reference point. To overcome this defect, certain objective tests like sieve test,[2] adhesion test,[2] consistency test,[3] and hardness test using Instron tester[4] have been developed for correlating the eating characteristics of raw rice. As the tenderness (soft or hard) in cooked rice is the deciding factor in evaluating the palatability of parboiled rice, a simple, rapid extrusion test was developed. The principle of the test is fundamentally the same as the Haake consistometer test[2,3,5] and the Instron test[4] used for cooked rice.

One month old 'IR 20' paddy procured locally was soaked in hot water (65°C) for 4 hr, parboiled at 70°, 80°, 90°, 100°, 110° and 120°C for 5 (A) and 10 (B) min duration, shade dried and milled to 6.0 per cent bran removal.[6] Samples soaked at 70°C (70d) and 80°C (80d) and raw paddy (R) were also milled by the same method. Ten gram whole rice was cooked (cooking temperature 99°C) to optimal cooking time[7]. After cooling in a beaker of water for 1 min, the contents were strained over wire screen and the adhering moisture quickly wiped out in folded double filter paper for 30 sec. Fifteen gram of this sample was immediately placed in a locally fabricated extruder and extruded for 5 min with predetermined weights.

The extrusion test: The extruder consists of a hollow cylindrical body (5 cm diameter made of anodised aluminium with a movable plunger (Fig. 1). A detachable perforated disc having 36 equally distributed perforations of 1 mm diameter is provided at the base of the cylinder. A lever (C) attached with the movable arm (A-B) having loaded weight (D) is placed on the plunger which extrudes the rice. The material that is extruded through the perforated disc is collected in a weighed petridish below. All sides of the base wherein the petridish rests are provided with glass doors. The extruded material was expressed as g/g of cooked rice (w.b.).

The whole process including cooking was repeated thrice. The tenderness of the cooked rice was also evaluated by sensory evalution[1] immediately after cooking, by a panel of 6 judges. A score card of 1 to 19 with an increase of two points for each step was adopted.

TABLE 1. MATERIAL EXTRUDED IN AN EXTRUDER UNDER A CONSTANT LOAD OF 5 KG AND MEAN TASTE PANEL SCORES FOR COOKED RAW AND PARBOILED RICES

Condition of Parboiling	Quality of Rice Extruded g/g (w.b.)	Mean Taste Panel Score for tenderness
Raw	0.98	18
70 A	0.97	—
70-d	0.97	15
70 B	0.96	17
80 A	0.96	—
80-d	0.95	9
80 B	0.86	10
90 A	0.38	—
90 B	0.30	9
100-A	0.29	—
100-OSA	0.26	—
100-B	0.25	4
100-OSB	0.25	6
110-A	0.15	—
120 A	0.09	—
110 B	0.08	4
120 B	0.06	5

First figure in 1st column denotes °C; and A = 5 min and B = 10 min parboiling; d = soaking temp. and OS = open steaming at o psig.

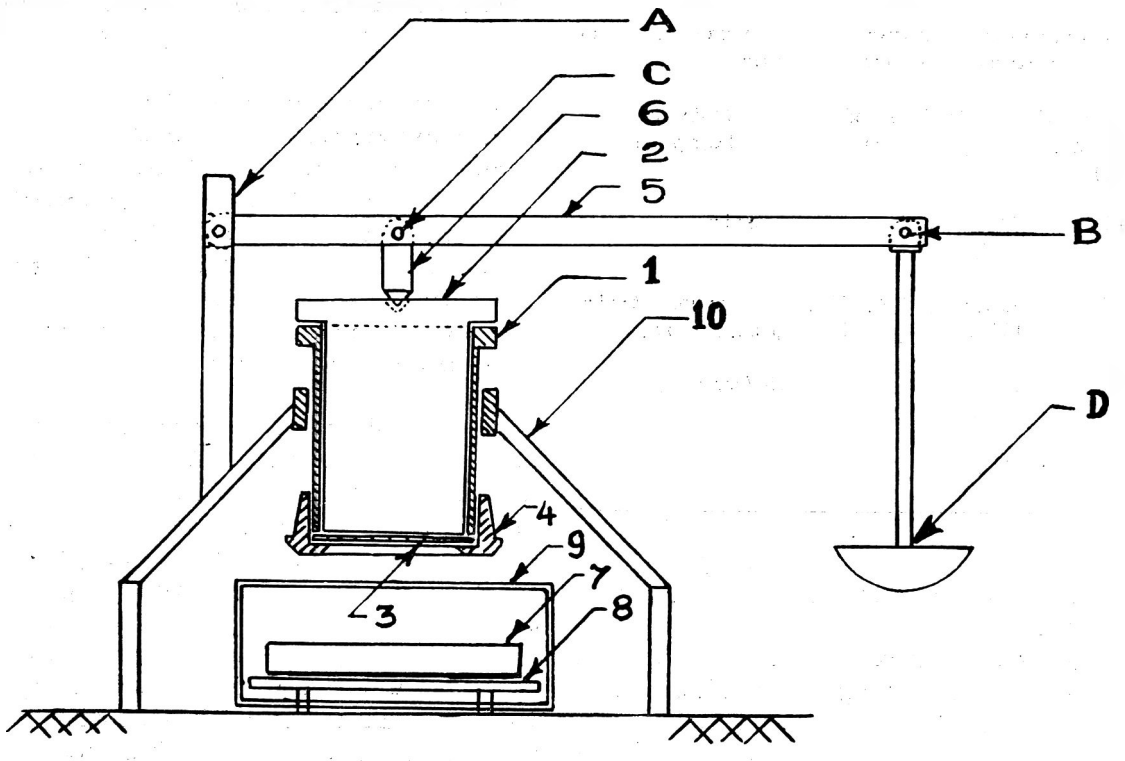


FIG. 1. Details of Extruder

1. Cylinder; 2. Piston; 3. Perforated Disc; 4. Screw Cover; 5. Movable Arm; 6. Connecting Lever (6 cm length) 7. Petri Dish; 8. Stand; 9. Glass Door; 10. Support; A-B = 29 cm; A-C = 4.5 cm; B-D = 22 cm in length A, B, C, D—Refer Text.

As the sensory panel could not differentiate the samples parboiled for 5 and 10 min duration, only the 10-min samples and 70-d, 80-d and R were taken up for sensory evaluation.

Under 5 kg load, more or less the entire cooked raw rice was extruded. Same is the case with 70A, 70B, 70-d, 80A, 80B and 80-d samples; whereas the material extruded out of 110° and 120°C samples was rather very little (Table 1). Even while extruding the entire cooked rice obtained from cooking 10 g rice and while expressing the extruded material on g/g dry basis, similar results were obtained. As expected, the raw cooked rice was scored to be soft and the parboiled rice hard; the hardness increasing with the degree of heat treatment during parboiling. Same trend was noticed in the extrusion test values also.

Though a positive correlation (r=0.884***) exists among the ratings of the taste panel and the extrusion test values, certain overlapping was observed in the taste panel scores (Table 1). But even the minor variations that existed among the samples (temperature and duration of parboiling) were clearly brought out in the extrusion test (Fig. 2). The temperature of parboiling and the tenderness of cooked parboiled rices correlated

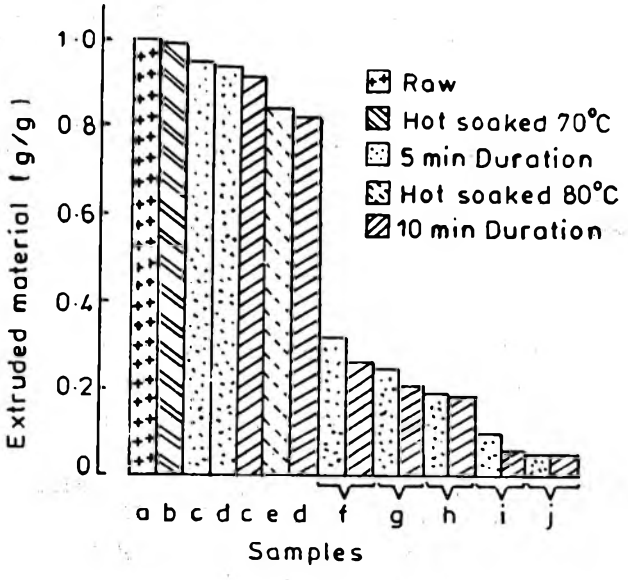


FIG. 2. Quantity of cooked rice extruded in an extruder under 5 kg load for 5 min.

a = Raw; c,d,f,h,i,j = Samples parboiled at 70° to 120°C; b,e = merely soaked at 70° and 80°C; g = Open steamed at 0 psig.

TABLE 2. GRADATION FOR PALATABILITY OF COOKED PARBOILED RICES BASED ON EXTRUSION TEST

Quantity of cooked rice extruded (g/g) (w.b.)	Condition of parboiling	Grade and description
>0.75	70A, 70B, 80A, 80B, 70-d, 80-d	I-Tender
0.75-0.25	90A, 90B, 100A, 100B, 100-OSA, 100-OSB	II-Moderately tender to slightly tough
<0.25	110A, 110B, 120A, 120B	III-Very tough

Legend as under Table 1.

negatively (-0.991***; -0.992***) indicating that more severe the heat treatment during parboiling harder are the cooked rices.

Based on g/g (w.b.) of the extruded material, parboiled rices can be grouped into three grades viz., I, II and III for their palatability (Table 2); the traditional consumers would prefer grade II parboiled rices and the raw rice eaters, the grade I. Because of its tough nature, consumers may not prefer grade III rices. Thus the extrusion test may serve as a tool for indicating the suitability of parboiled rices for different sections of consumers.

Sincere thanks to Dr. K. R. Bhattacharya, CFTRI, for the idea of the device and of the test and to Mr. A. N. Dyaneswaran, Project Head, for the facilities provided.

Paddy Processing Research Centre,
Tiruvarur-610 108.

R. MOHANDOSS
P. PILLAIYAR

Received 21 *November* 1979
Revised 6 *May* 1980.

References

1. Juliano B. O., Onate L.U. and de Mundo, A.M., *Fd Technol.*, 1965, **19**, 1006.
2. Manohar Kumar B., Upadhyay, J. K. and Bhattacharya, K. R., *Texture Studies.*, 1976, **7**, 271.
3. Bhattacharya, K. R., Sowbhagya, C. M. and Indudhara Swamy, Y. M., *J. Sci. Fd Agric.*, 1978, **29**, 359.
4. International Rice Research Institute, *Annual Report for* 1978, Los Banos, Philippines, 1979.
5. Hampel, G., *Getr. Mehl.*, 1965, **11**, 132.
6. Pillaiyar, P. and Mohandoss, R., *J. Fd Sci. Technol.*, 1979, (communicated)
7. Bhattacharya, K. R. and Sowbhagya, C. M., *Cereal Sci. Today.*, 1971, **16**, 420.

USE OF HOT AIR FOR PARBOILING AND DRYING OF PADDY

The processes of parboiling and drying of paddy in rice mills are being done with the use of steam and hot air respectively. It has been found that hot air at 200° to 220°C can be used first for parboiling the soaked paddy, instead of steam and then used for drying the same paddy at a temperature of 100° to 130°C. This finding opens up the possibility of eliminating the huge investment on boiler in the rice mills and at the same time, the same equipment can be used for both parboiling and drying.

Practically all the rice mills are using steam for parboiling the soaked paddy. Though there are different methods of soaking like, cold soaking, hot soaking, vapour phase soaking, etc., steam is invariably used for parboiling the soaked paddy. Parboiling which involves the application of heat as steam for gelatinising the soaked paddy can also be done by other methods, like the use of hot liquids and hot inert media[1,2]. Likewise hot air can also be used as a heat conducting media for parboiling soaked paddy[3]. If the optimum temperature required for gelatinising the soaked paddy is provided, parboiling will take place, irrespective of the source from which the heat energy is applied. The use of hot air in the same equipment for both parboiling and drying has been reported here.

Experiments were carried out in a small, portable husk fired drier made by Shaw Wallace & Co., Madras. The drier of 1 tonne drying capacity consists of a husk fired furnace, two drying chambers, and a hot air blower of 5000 CFM capacity. The unit is driven by a 5 H.P. diesel engine. One hundred kilogram of soaked paddy (variety 'CO 25') prepared by the hot soaking method[4] was fed manually into the drier and a total of three passes were given. The temperature of hot air, moisture content and condition of paddy, and time taken for each pass have been recorded (Table 1). During the first two passes a higher temperature of 220°C was maintained, whereas in the final pass the temperature was reduced to 130°C. Feeding rate of paddy into the drying chamber was maintained constant for all the three passes. The temperature and relative humidity of the inlet and outlet air were measured. About 100 g of paddy at the end of each pass was shelled in the Laboratory McGill sheller. The absence of white abdomen and the change in appearance of brown rice from opaque to translucent were taken as indications for the completion of the parboiling process. The milling yield of the parboiled paddy at 6 per cent polish was determined in the laboratory McGill mill No. 1 after a 12 hr tempering period. The moisture content of the paddy was estimated according to A.O.A.C. method[5].

TABLE 1. RESULTS OF PARBOILING CUM DRYING PROCESS IN THE HOT AIR DRIER

	Ist pass	IInd pass	IIIrd pass
Temp of inlet air (°C)	200–220	200–220	130–135
Temp of outlet air (°C)	55	55	65
R.H. of inlet air (%)	30	30	30
R.H. of outlet air (%)	95	95	75
Time taken for each pass (min)	12	10	10
Moisture content of paddy before drying (%)	30.3	25.6	20.5
Moisture content of paddy (%) after drying	25.6	20.5	14.4

Note:—Parboiling was incomplete in 1st pass; complete in 2nd pass; Parboiling and drying were complete in 3rd pass.

Parboiled paddy produced by the hot soaking method and dried in the L.S.U. type mechanical hot air drier was taken for comparison.

The application of hot air at 220°C not only parboiled the soaked paddy but also dried it simultaneously at the end of the second pass. There was no white belly and the rice was translucent and appeared like normal parboiled rice. The moisture content of paddy dropped from 30.3 to 20.5 per cent during the first two passes. The third pass reduced the moisture content to 14.4 per cent (Table 1). The total time taken for completing the process of parboiling and drying was only 32 min. The relative humidity of the hot air increased from 30 to 95 per cent from the first to second passes, which helped the parboiling process. This increase in the relative humidity in the first two passes was due to the evaporation of moisture from the paddy which simultaneously resulted in the drying. In the third pass the increase in the relative humidity of the air was only 75 per cent since the paddy had dried to 14.4 per cent. The time taken for completion of each pass was almost the same for all the three passes. The moisture drop in the paddy in each pass was also almost similar, that is 4.7, 5.1 and 6.1 in the first, second and third passes, respectively. The percentage yield of head rice and brokens during milling of this paddy was 66 and 5 as compared to 65 and 6 of the steam parboiled paddy. This indicates that the parboiled paddy produced by this method has the same milling quality as that of the commercially parboiled paddy. Since the parboiled paddy was also simultaneously dried in this method, the heat retention time in the paddy was considerably reduced. As a result, there was no heat discolouration, and the rice had acceptable light colour and appearance.

Since this method of using hct air for parboiling process completely eliminates the use of steam, this finding opens up the practical possibilities for eliminating the high investment cost on steam boilers and its related maintenance problems in the rice mills. At the same time the same equipment can be used for both parboiling and drying the paddy in a much shorter time, which can considerably increase the daily production and reduce the processing cost.

Paddy Processing Research Centre,
Tiruvarur-610 108
Tamil Nadu.

B. S. VASAN
J. BASHEER
V. VENKATESAN

Received 5 *November* 1979
Revised 17 *December* 1979.

References

1. Vasan, B. S., Iengar, N.G.C., Nagasubramanian, M., Bhasker, R., Shivanna, C. S., Mohandoss, R., and Subrahmanyan, V., *Proc. Indian Acad. Sci.*, 1973, **39**, B, 49.
2. Iengar, N. G. C., Bhasker, R. and Dharmarajan, P., *J. agric. Engng, India.*, 1971, **8**, 51.
3. Pillaiyar, P., Venkatesan, V. and Narayanaswamy, R. V., *J. Fd. Sci. Technol.*, 1977, **14**, 226.
4. Subrahmanyan, V., Desikachar, H.S.R. and Bhatia, D. S., *J. Sci. Ind. Res.*, 1955, **14**, 110.
5. *Official Methods of Analysis*, Association of Official Analytical Chemists, Washington, D. C., 11th Ed., 1970.

BOOK REVIEWS

Fundamentals Of Food Canning Technology: by John M. Jackson (Michigan) and Byron M. Shin (Illinois), AVI Publishing Company, Inc., West Port, Connecticut, 1979 Pp IX+406; Price: $ 22.50

This book is a highly useful and welcome addition to the series of AVI publications on various aspects of food science and technology. The excellent printing in bold type, on high quality paper, facilitating easy reading, leaves practically nothing to be desired in the matter of production and presentation of highly interesting and instructive topics and the latest advances in the field of food canning science and technology. With its 16 chapters covering varied aspects of technology, 25 appendicies packed with comprehensive statistics and technical data, it will be a most valuable addition to the select reference library of every food scientist and technologist, research scholar and industrialist. I enjoyed reading every line from beginning to end and learnt quite a few things. I am sure many others in the field will feel the same.

The different topics have been dealt with by well known specialists in the particular field. The development of the canning industry from the very begnning, its scientific basis and the economic significance together with governmental regulations have been succintly dealt with by Jackson. The chapter on heat sterilization of canned food by Plug and Esselen is most comprehsive and authoritative, and deals at great length with such aspects as principles of heat sterilization, lethal rates, process evaluation in the case of cans as well as glass containers, can handling methodology, process equipment including hydrostatic can cooker and cooler, continuous agitating cookers, aseptic canning etc., A large number of literature references have been cited.

The chapter on the rigid metal containers by Ellis is highly informative and so also the chapter on glass containers and closures by Drake. Lampi has contributed a highly instructive chapter on flexible packaging for thermo-processed foods, giving full details about the latest developments in production, unit operations, seal evaluation, heat processing method and quality assurance. This topic is attracting wide attention in different parts of the world including India.

Jackson has contributed four chapters giving clear details, in a systematic manner, about general canning procedures and their application in the case of a few typical fruits such as apple, cherry, peach, pineapple, citrus fruit and some commercially important vegetables, such as green beans, beets, corn, peas, spinach and tomato. Some of the speciality products dealt with are baby foods, dry bean products, and soups. The details given in the case of the products will be highly useful and instructive for the Indian fruit and vegetable processing scientist and technologist.

The chapters on canned meats and poultry by Shinn, marine products by Stansby, dairy products by Ellertson are packed with highly useful theoretical as well as practical details of great interest.

Coding, labelling, storage and distributing by Jackson and Shinn, hazard analysis and quality assurance and also waste disposal and water usage by Jackson are the other highlights of the book that will be appreciated much by any food technologist. The latest information on each topic has been included. Shinn's contribution on factors affecting nutrient content of canned foods is supported by exhaustive authentic data, and nutrition labelling with relative U.S. Government regulations will be of considerable interest to us in this country.

There are 25 appendices extending over 45 pages dealing with a variety of subjects of great importance. Special mention may be made of tables dealing with sterilizing values (FO) for some U.S. current commercial processes, pH ranges of foods, fruit and fruit juice packs and fresh, canned and frozen vegetables fruit packs by country, processing seasons, U.S. recommended daily allowances (US, RDA) etc. In these, one has ready access to information and data in one place, which would otherwise be difficult to reach, as they are diverse and widely separated.

The Index at the end has been so prepared that the reader can readly spot out the topic of interest to him and look it up in the text. The diagrams and photograpic reproductions are clear and good.

In conclusion, I can state with confidence that this latest AVI publication will be welcomed by one and all concerned with food science and technology.

G. S. SIDDAPPA,
COORG FRUITS PRODUCTS LTD., GONIKOPAL

Microbiology Of Food Fermentations: by Carl S. Pederson, AVI Publishing Co., Inc., Westport, Connecticut, U.S.A., IInd Ed., Pp. 384; Price: $ 29.00

This is a very useful compilation of valuable information on different topics of food fermentations. With a

brief introduction to the fermented foods of the world in the first chapter, sequential growth of microorganisms and the associated biochemical changes in some of the fermented foods have been summarised in the 2nd chapter. This is an additional chapter introduced in this edition. Taxonomy of the organisms commonly used in fermentations included in the third chapter is a special feature of this book. Fermented products of milk, vegetables, sausages, cereals are covered in chapters 5 to 9. In chapter 10, some of the important aspects of alcoholic beverages are lucidly described. Fermented foods of the orient being the oldest fermentative processes practised by the community to produce highly nutritious and palatable foods from cereals and legumes have received a good coverage in chapter 11 highlighting all the aspects of fermented foods.

Besides these products, there are several other agricultural products such as coffee, cacao, vanilla, tea, citron and ginger where a mild to moderate fermentation is allowed to obtain the final products. In chapter 12 attempt has been made to introduce these fermentations to the reader. After a brief coverage on organic acid production in chapter 13, microbial products consumed in foods and a projection of an idea of food fermentation as an approach to world feeding problems form the subject matter of chapters 14 and 15.

This book is a comprehensive coverage of all kinds of important fermentations widely practised not only as an industrial process but also as traditional home-scale operations. This is a rare combination which makes it very useful as a reference book to a student on fermentations.

V. SREENIVASA MURTHY
C.F.T.R.I., MYSORE

A Pedal-Operated Grain Mill: by G. S. Pinson, Tropical Products Institute, London, 1979; 32; Price: 55p.

This guide is the fifth in the series of Rural Technology Guides brought out by the TPI. It describes a simple, pedal-operated mill suitable for grinding hard grains (such as, maize, millets, sorghum) and legumes on a village scale. It gives complete component-by-component details of the mill and how it can be made. It also shows how an ordinary bicycle can provide support for the operator as well as power for the drive component.

The mill works at high speed (about 5000 rpm) and takes advantage of the smaller effort required when the legs rather than the arms of the operator are used to drive it. A second person is needed to feed the mill by hand. The mill is intended for use over brief periods at a time to meet the day-to-day needs of households and not for intensive use for long periods. The grinding action is broadly similar to that of a conventional hammer mill.

The publication is in the tradition of the recent 'appropriate technology' philosophy. While there may be a debate about this philosophy, there can be no two opinions about the authenticity of the effort behind the excellent innovation and the present attempt at its dissemenination.

K. R. BHATTACHARYA
C.F.T.R.I., MYSORE

The Market for Aubergines and Courgettes in Selected Western European Countries: by King P., *Rep. Trop. Prod. Inst.*, G. 113, pp. V+34, Price £ 1.20.

This report broughtout by the Tropical Products Institute is one of a series dealing with the market for minor, fresh, exotic and out of season vegetables imported into Europe. The aubergine of commerce is also called brinjal, garden egg or egg plant (*Solanum melongena*). The botanical name of courgettes is *Cucurbita pepo*.

This report includes 4 parts-dealing with the subject matter, 25 tables and also an Appendix-giving the list of importers. In part I of this report, a more detailed analysis on production, exports, imports, seasonality of supply, prices and prospects of individual country markets (France, Fed. Rep. of Germany, U.K. Switzerland, Belgium, Netherland and Italy) is presented. Quality and packing requirements for both aubergines and courgettes are presented in Part II. Details of tariffs and phyto-sanitary regulations are mentioned in Part III. Prospects with reference to out of season period have been dealt in Part IV-conclusions.

The report in general is very useful to those countries which are exporting and importing these two vegetables.

M. V. PATWARDHAN
C.F.T.R.I., MYSORE

ANNOUNCEMENT OF

Best Student award for the year 1980

Association of Food Scientists and Technologists (India) announces the institution of the BEST STUDENT AWARD for students with a distinguished academic record undergoing post-graduate courses in Food Science and Technology. There are two awards, each comprising a book grant of Rs. 500/-.

The award is open to candidates fulfilling the following conditions:

1. The candidates must be Indian nationals undergoing Post-graduate courses in the area of Food Science and Technology in any Institution in India.

2. The Head of the Post-graduate Department may put up for the award, the name of one candidate from each institution, who has at least completed one year of study, supported by the following information prepared by the candidate:

   (a) Graduate record

   (b) Post-graduate performance to date.

Nominations may be sent by **Registered Post** so as to reach Dr. K. R. Sreekantiah, Hon. Exec. Secretary, Association of Food Scientists and Technologists (India), Central Food Technological Research Institute, Mysore-570 013, before 31st January 1981.

ANNOUNCEMENT OF

Young Scientist award for the year 1980

Association of Food Scientists and Technologists (India), announces with pleasure the institution of the YOUNG SCIENTIST AWARD for distinguished scientific research and technological contributions to the field of Food Science and Technology.

The award consists of a cash prize of Rs. 1,000/-, a plaque, and a citation.
Nomination for the Award is open to aspirants fulfilling the following conditions:

1. The candidate should be an Indian National below the age of 35 years on the date of application working in the broad area of food science and technology.

2. The candidate should furnish evidence of either,

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

   OR

   (b) Technological contributions of a high order, for example in product development, process design etc., substantiated with documentary evidence.

The application along with details of contributions and bio-data (in triplicate) may be sent by **Registered Post,** so as to reach Dr. K. R. Sreekantiah, Hon. Exec. Secretary, Association of Food, Scientists and Technologists (India), CFTRI, Mysore-13 before 31st January, 1981.

ANNOUNCEMENT OF

Prof. V. Subrahmanyan Industrial Achievement Award for the Year 1980

Nominations for the above award for the year 1980 are invited. The guidelines for the award are as follows:

1. Indian Nationals engaged in the field of Food Science and Technology will be considered for the award.

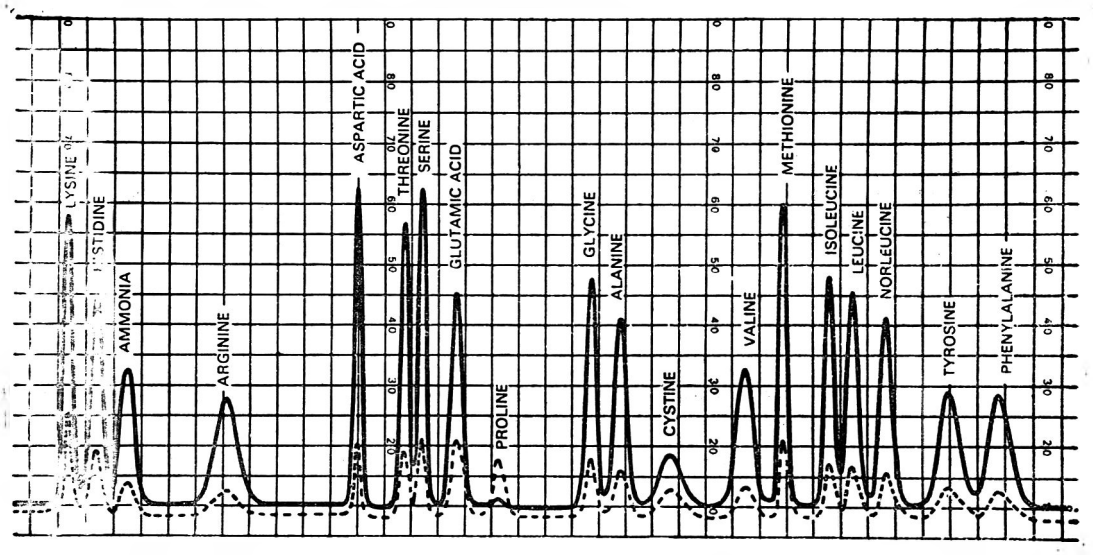
2. The Nominee should have contributed to the field of Food Science and Technology, for the develcpment ot Agro-based food and allied industries or to basic food science and technology with immediate prospect and/or future potential for industrial application.

3. The nomination should be proposed by any member of the Association; the bio-data of the candidate together with his consent should be given in detail including the work done by him and for which he is to be considered for the award.

4. The Awardee will be selected (from the names thus sponsored) by an Expert Panel constituted by the Executive Committee for the above purpose.

Nominations along with: bio-data and contributions, should be sent by **Registered Post,** *so as to reach Dr. K. R. Sreekantiah, Honorary Executive Secretary, Association of Food Scientists and Technologists (India), Central Food Technological Research Institute, Mysore-570013 latest by 31st of Janury 1981.*

Yes, it is true!
You can obtain this Amino Acid Chromatogram in only 75 minutes with our



TECHNICON SEQUENTIAL MULTI-SAMPLE® ANALYZER

At last, a system that takes the sweat and toil out of amino acid analyses... lets you process 25% more samples than any other analyzer!

All you need to do is to load the samples—and pull off the chromatograms! The Technicon Sequential Multi-Sample (TSM) Analyzer does all the rest—transferring samples to columns, changing buffers, regenerating columns—**automatically!** Technicon chromo-beads resin and micro-bore columns make the TSM System at least twice as sensitive as conventional amino acid analyzers.

What is more, the TSM uses the time-tested method of continuous flow analysis, and its modular construction affords you great flexibility.

For details, write to the nearest Blue Star office or to the
Analytical Instrument Department,
BLUE STAR LIMITED
'Sahas', 414/4 Veer Savarkar Marg,
Prabhadevi, Bombay 400025

Another quality product from

BLUE STAR ©

ULKA-T-9/80

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 anywhere.

2. Short communications in the nature of Research Notes 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. Superscript 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 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.

REG. No. 24918/64

JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

Vol. 17 No. 6 **Contents of forthcoming issue** **Nov.-Dec. 1980**

Research Papers

Research Notes

Review

Printed and published by K. R. Sreekantiah, Secretary, AFST (India), CFTRI, Mysore-570013, at Sharada Press, Mangalore-575001