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JOURNAL OF FOOD SCIENCE AND TECHNOLOGY

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Thank you

During my term as Editor of Journal of Food Science and Technology (1980-82), I received immense help from about 100 scientific colleagues from various research institutes who have advised me regarding the suitability of papers for publication, the Associate Editors and the staff of the AFST(I) Office. I wish to express my gratitude to each one of them. I wish to specially thank my colleague Sri K.A. Ranganath for his invaluable help in shaping the Journal and in the maintenance of standards set by my predecessors. My special thanks are due to M/s Sharada Press, Mangalore for cooperating in bringing out the issues on time. Dr K. R. Sreekantiah will take over as the new editor of the Journal from January 1983.

R. Radhakrishnamurthy
Editor

RESEARCH PAPERS

Development of a Continuous Process for Making Rice Flakes

H. V. NARASIMHA, T. K. ANANTHACHAR, R. SHANKARA, M. S. GOPAL AND H. S. R. DESIKACHAR
Central Food Technological Research Institute, Mysore, India

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A continuous process for making rice flakes (beaten rice, *Avalakki, Poha*) from paddy has been developed. The soaked paddy is roasted in a continuous roaster (similar to the one used for roasting Bengal gram), immediately shelled in a modified centrifugal type sheller and gently polished in a cone type rice polisher. It is flaked in a heavy duty roller flaker. Several 250 kg batches were run by the continuous process and the average yield of rice flakes is about 70%, which is 6–7% higher than that obtained by the traditional process.

Flaking of rice is an important industry in India. Flaked rice is produced from milled rice in the West by a process similar to that used for corn flaking[1]. The indigenous process consists of sand roasting of soaked paddy followed by flaking. Possibilities of improvement to the traditional process for making rice flakes (*Avalakki, Poha*) for improving product quality and yield have been indicated earlier by us[2,3].

The roasting and flaking steps in the traditional process are batch operations handling only about 2 kg per batch and increase of capacity can be achieved only through more number of roasting and flaking units. Also, roasting is a strenuous labour intensive and costly manual operation involving skill and fine judgement of the termination of roasting. Even a short departure from the optimal stage may entail loss of yield caused by puffing grains through over-roasting or breakage during flaking due to under-roasting. It was therfore, felt desirable to develop and standardise a continuous schedule for roasting and flaking and optimise the process conditions for the same. Such a process can be adopted for large or semilarge scale processing.

The possibility of using the 'gram roaster'[4] normally used for frying Bengal gram, has been investigated. For continuous flaking of the roasted paddy, use of 'edge-runner' machine was impractical and so the paddy was first shelled in a centrifugal type shelling machine, subjected to slight polishing in a rice polisher followed by flaking in a roller flaking unit used for making corn flakes.[5] Optimal processing conditions for operation with this combination of machines were worked out. Paddy used for roasting in the traditional process was too moist to flow freely to the mechanical roaster. Also, such paddy after roasting, could not be easily shelled in a centrifugal sheller. Optimal moisture had therefore, to be worked out as also other mechanical and processing factors. The results of our study are reported here.

Materials and Methods

Optimal moisture in paddy for shelling in centrifugal sheller: Paddy was soaked in water at 70°C for 18 hr. After draining off the soak-water, it was allowed to temper in a heap, mixed frequently and at hourly intervals its moisture content and free flowing character while feeding from the belt conveyor of the gram roaster unit was noted. A portion of the paddy was also roasted in *Bhatti* with sand immediately after which its shelling properties in a centrifugal sheller and flaking properties in a roller type flaking machine (*Akti Bolaget-Swedish*) were determined (Table 1).

Standardisation of roasting conditions in the gram roaster: As initial trials indicated that sand temperature and r.p.m. of the roaster as adjusted for Bengal gram (10 r.p.m. and 200°C) resulted in overheating and high puffing of paddy, roaster speed as well as sand temperature combinations were adjusted for optimal shelling and minimum puffing of paddy. Roaster speed was varied by changing the pulley diameter of the roaster motor, while temperature was adjusted by varying the feed rate of the paddy into roaster keeping the fuel supply to the burner at a contant low level.

Shelling and polishing of roasted paddy: Shelling was carried out in a centrifugal sheller. This unit had an impeller rotational speed of 3200 r.p.m. Shelling efficiency was tested upto 5000 r.p.m. The rubber ring normally fitted into the sheller unit had to be removed to improve the shelling efficiency. The shelled rice was polished in a cone-polisher (Dandekar make) to different degrees and flaked in a heavy duty roller

TABLE 1. SHELLING CHARACTERISTICS OF SAND ROASTED PADDY AT DIFFERENT MOISTURE CONTENTS

Draining time (hr)	Moisture content of soaked paddy (%) (DB)	Nature of soaked and drained paddy	Moisture content of roasted paddy (%) (DB)	Puffed paddy (%)	degree of shelling on the centrifugal sheller* (%)	Suitability for flaking of shelled rice
0	42.0	High surface moisture, lumpy	23.0	0.65	70	Cup shaped flakes (Poor)
1	40.5	Some surface moisture, not easily free flowing	22.5	0.75	80–82	– do –
2	39.0	Very little surface moisture, free flowing	20.8	1.00	90–91	Moderately good flaking
3	37.0	Dry appearance, free flowing	18.5	2.30	92–95	Good for flaking
4	35.0	Very dry appearance, very well free flowing	16.0	4.20	98	Cracked appearance and some breakage of flakes

*Paddy was roasted at 260°C for 30–35 sec in *Bhatti*.

flaker to a thickness of about 0.06 cm. Data on yield of flakes and brokens were collected by sieving on an 8-mesh sieve (BSS).

The continuous flaking process was operated on 250 kg batch of paddy and yield data were collected and a comparison was made with the traditional process under standardised conditions[3].

Results and Discussion

The relationship of initial moisture content of soaked as well as roasted paddy to its shelling characteristics is presented in Table 1. Paddy with initial moisture content of 37 per cent on roasting contained 18.5 per cent moisture which could be shelled to about 95% in the centrifugal sheller. Lower moisture (35%) improved the shelling efficiency to 98%, but caused cracked appearance in the flakes and also more puffing during roasting and breakage during shelling. Higher initial moisture (42%) posed difficulties both in shelling and flaking.

For each speed (r.p.m.) of the roaster, the temperature of sand to be maintained for minimum puffing and satisfactory shelling efficiency has been worked out and presented in Table 2. Optimal conditions were 14 r.p.m. of roaster permitting a retention time of 40 sec in the roaster. The final temperature of sand-

TABLE 2. ROASTING CONDITIONS FOR DIFFERENT ROASTER SPEEDS

Roaster speed (r.p.m.)	Retention time of paddy in roaster (sec)	Initial sand temp (°C)	Sand-paddy temp. at discharge (°C)	Moisture content of roasted paddy (%) (DB)	Puffed paddy (%)	Degree of shelling (%)
Control (*Bhatti*)	35–40	230		20.80	1.00	92
10.0	60	160	125—135 (10 kg)	22.16	1.00	85
12.5	50	180	150—160 (8 kg)	23.60	1.00	80
14.0	40	200	165—175 (7 kg)	21.30	0.75	95
18.0	30	200	175—180 (6 kg)	24.80	1.40	75

Figures in the parenthesis indicate the feed rate/min.

TABLE 3. COMPARATIVE YIELD OF FLAKES IN CONTINUOUS FLAKING AND TRADITIONAL PROCESSES

Degree of polish (%)	Whole* flakes (%)	Brokens (%)	Powdering during flaking (%)	Husk (%)	Colour
		Continuous process			
0	72.6	1.0	2.80	22	Dull
2	70.4	2.0	2.85	22	Acceptable
4	68.5	2.3	2.20	22	,,
6	66.0	2.5	2.50	22	Very bright
		Traditional flaking with edge-runner			
	64.3	5.2	—	29.8	Acceptable

* All flakes were flaked to 0.06 cm thickness.
The shape of the flakes are roundish in continuous process and normal elongated in traditional flaking.

paddy mixture was 165–175°C and the roasted paddy was at 100–102°C and had a moisture content of 21 per cent and could be shelled to about 95 per cent.

Impeller speed in relation to shelling efficiency: The centrifugal sheller which is usually adjusted to about 3200 r.p.m. for milling of paddy gave very low shelling efficiency for the roasted paddy. Increasing the impeller speed upto 5000 r.p.m. gave higher shelling efficiency without causing breakage. The shelling should be done immediately after roasting when the husk is dry and loose from the grain and the endosperm is plastic resisting breakage. The rubber ring normally used for shelling of raw paddy could be dispensed with while shelling of roasted paddy. A speed of 4800 r.p.m. was employed for further tests at which the shelling efficiency was 98%.

Comparison of traditional edge-runner and roller flaker: The yield of whole and broken flakes by the continuous process consisting of roasting in the mechanical roaster, immediate shelling in a centrifugal sheller and polishing in a cone polisher followed by flaking in a roller flaker are presented in Table 3. It is seen that the increase in degree of polish given to the roasted rice prior to flaking correspondingly reduced the yield of whole flakes and also slightly increased the breakage. A polish of 4% give flakes comparable in whiteness to those obtained by the traditional method; the yield increase at this stage is about 4%. Reducing the degree of polish increased the product yield, but such flakes are somewhat dull in colour and may pose difficulties of consumer acceptance. It may also pose problems of lower shelf life caused by higher retention of bran. The results obtained with 250 kg batch lots are being repeated with larger batches to obtain costing data which would be helpful in translating the results to commercial application. The results so far obtained indicate that the continuous process would be economically feasible and would be superior to the traditional batch process.

Acknowledgement

Authors wish to thank Sri R. Gururaj of Process Development and Design for his assistance in running the 'gram roaster', for roasting moistened paddy.

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Studies on Pressure Parboiling of Rice

S. Zakiuddin Ali and K. R. Bhattacharya
Discipline of Rice and Pulse Technology
Central Food Technological Research Institute, Mysore, India

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The long cooking time and hard texture of pressure-parboiled rice have been investigated. Paddy adjusted to various moisture contents (12–30%) was steamed under different pressures (0–3 kg/cm^2) for different times (5–80 min). Translucence index (per cent rice area not covered by white belly), gelatinization index (equilibrium moisture content attained by paddy immediately after steaming when soaked in water at room temperature, or immediate EMC–S), retrogradation index (per cent fall in EMC–S of rice after drying and milling as compared to immediate EMC–S), cooking resistance index (per cent fall in water uptake during cooking of parboiled as compared to that of raw rice), colour and head-rice recovery were studied. Degree of each property increased with increase in moisture content, pressure and time of steaming. Complete parboiling (100 per cent translucence) could be achieved even at very low grain moisture (12–20 per cent) when steamed under high pressure. However, such rice was too hard to cook. A translucence index of about 80 per cent was the maximum in pressure-parboiled rice that was acceptable in terms of cooking quality and colour. Its milling breakage was negligible. With this modification, pressure-parboiling process will be acceptable.

Parboiled rice is produced by soaking paddy in water until it is saturated, steaming it to gelatinize the starch, followed by drying and milling. Recently, a novel method of parboiling has been evolved in which the soaking step is partially or completely eliminated and the paddy is steamed under pressure of 0.75–2 kg/cm^2. The high-pressure steaming brings about complete gelatinization of the grain upto the centre even at a low moisture level[1-3]. The whole process is completed in an hour or less, thus increasing the plant turnover considerably. Further, due to the relatively low moisture content of the final product, the time and cost of drying is also reduced. These advantages have led to its enthusiastic adoption by rice millers in Punjab where rice is not a staple food, but is processed almost entirely for export to other states.

However, such pressure-parboiled rice has been found to have a very long cooking time, hard texture and high colour, which have caused much consumer resistance. In fact, it has been nicknamed 'iron rice' in Kerala, where it was mostly marketed.

Therefore, a comprehensive study of the effects of different processing factors—viz., initial paddy moisture, and the time and pressure of steaming—on the properties of the rice was carried out to identify, if possible, a suitable combination of processing condions which would reduce the disadvantages while retaining the inherent advantages of the method. Since starch retrogradation has been shown to play a key role in reducing the cooking rate of parboiled rice[4-6], the extent of retrogradation and its possible prevention or reduction was also studied.

Materials and Methods

Materials and processing: Two varieties of paddy, both high-amylose type, purchased from the local market were used. These were Ratnachudi, a traditional Indian variety of grain type MqS[7] and Gowri Sanna, a fine-grained modern semidwarf of grain type MqT[7].

Paddy was soaked in water at room temperature, portions being removed at intervals and tempered in closed bottles to obtain paddy having various initial moisture contents. Five moisture levels selected were in the ranges of 12–13 (original unsoaked paddy), 16.0–17.7, 20–21, 23.2–24.5 and 27–30 per cent (wet, basis). These will be nominally referred to as 12, 17, 20, 24 and 28 per cent, respectively. These samples represented paddy thoroughly equilibrated (by tempering) at the respective moisture. In the second series of studies, paddy barely washed with water or soaked briefly was immediately subjected to steaming. The moisture contents of these second series samples represented only the mean moisture contents of the grains, for the grains were not equilibrated at the respective moistures. Steaming was carried out in a line-connected autoclave, the paddy being kept in a wire-mesh tray.

All samples were dried in shade for 1–2 days to approximately 12–13% moisture and milled with

laboratory McGill equipments under standard conditions. Broken grains (less than three-fourths) were separated using an appropriate indented plate. Per cent head rice yield was calculated in terms of milled rice.

Analytical: Equilibrium moisture content attained by rice when soaked in water at room temperature (EMC–S) was determined, both immediately after steaming (termed 'immediate EMC–S') and also after shade drying and milling ('final EMC–S') by methods described earlier[6]. The rise in the immediate EMC–S of a parboiled rice as compared to that of raw rice (38 per cent moisture, d.b.) gave an estimate of the extent of its gelatinization[4]. On the other hand, calculation of the per cent fall in final EMC–S as compared to immediate EMC–S gave an estimate of starch retrogradation[6] and is called retrogradation index. Water uptake by rice when cooked at 96°C for 1 hr was determined as described[4]; however, for simplicity, the moisture content (dry basis) attained by rice after cooking (M) was itself considered as the water uptake. The per cent fall in M value of a parboiled sample as compared to that of raw milled rice gave a measure of its resistance to cooking and is called the cooking resistance index. 'White belly' (ungelatinized opaque central core) area was estimated visually and the translucence index was calculated as 100—mean per cent area covered by white belly.

Colour score was as follows: raw rice, 1; normal mild parboiled rice (paddy fully soaked at room temperature and steamed at atmospheric pressure for 10 min), 4; normal moderately severe parboiled rice (paddy fully soaked at room temperature and steamed at atmospheric pressure for 60 min), 6–7; the most coloured sample (17 per cent moisture paddy steamed at 3 kg/cm^2 for 15 min), equivalent to medium amber coloured glass bottle, 100. A comparative idea of the colour score is given in Fig. 1.

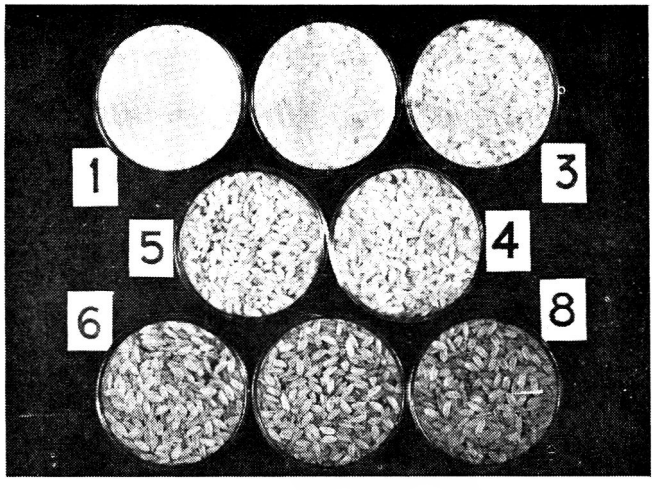

Fig. 1. Photograph of a few samples to illustrate the colour score. Scores: No. 1 = 1, No. 2 = 4, No. 3 = 6, No. 4 = 20, No. 5 = 30, No. 6 = 50, No. 7 = 75, No. 8 = 100.

For studying the effect of quick drying in preventing or reducing starch retrogradation, the paddy, immediately after steaming, was dried at 60–80°C in a Kilburn cabinet dryer to 16–18 per cent moisture (wet basis) and then finish-dried in the shade.

All moisture contents of paddy ready for steaming are expressed on wet basis (w.b.). But EMC–S and M are expressed on dry basis (d.b.) to facilitate calculation of percentage drop after processing.

Results and Discussions

Effect of processing conditions: In these studies, Ratnachudi paddy was adjusted to moisture contents ranging from 12 to 30 per cent (w.b.) and then steamed under different pressures (0, 0.5, 1.0, 2.0 and 3.0 kg/cm^2) for different time periods each (5–80 min). The immediate EMC–S of the material was determined, giving an idea of its gelatinization index. Paddy was then dried in shade and milled. The final EMC–S, water uptake, colour, white belly area and head rice yield were measured. Retrogradation, resistance to cooking and translucence indices were calculated.

In view of the large volume of data, the results are only presented schematically in Fig. 2. It will be seen that the extent of each property increased as one moves from left to right and top to bottom, i.e., with increasing moisture content, pressure of steaming and time of steaming. The pressure seemed to have the maximum effect. More specifically, the following points emerge:

Translucence index was 100 per cent or so (i.e., complete or nearly complete parboiling upto the centre of the grain) under any condition of steaming at 24 per cent moisture and above. However, the same could be achieved even at much lower moistures when the samples were steamed under high pressure. The minimum levels of treatment to achieve full translucence with different paddy moistures were:

Paddy moisture (% w.b.)	Steaming pressure (kg/cm^2)	Steaming time (min)
24	any	any
20	1.0	20
	2.0	10
17	2.0	10
	3.0	10
12	3.0	15

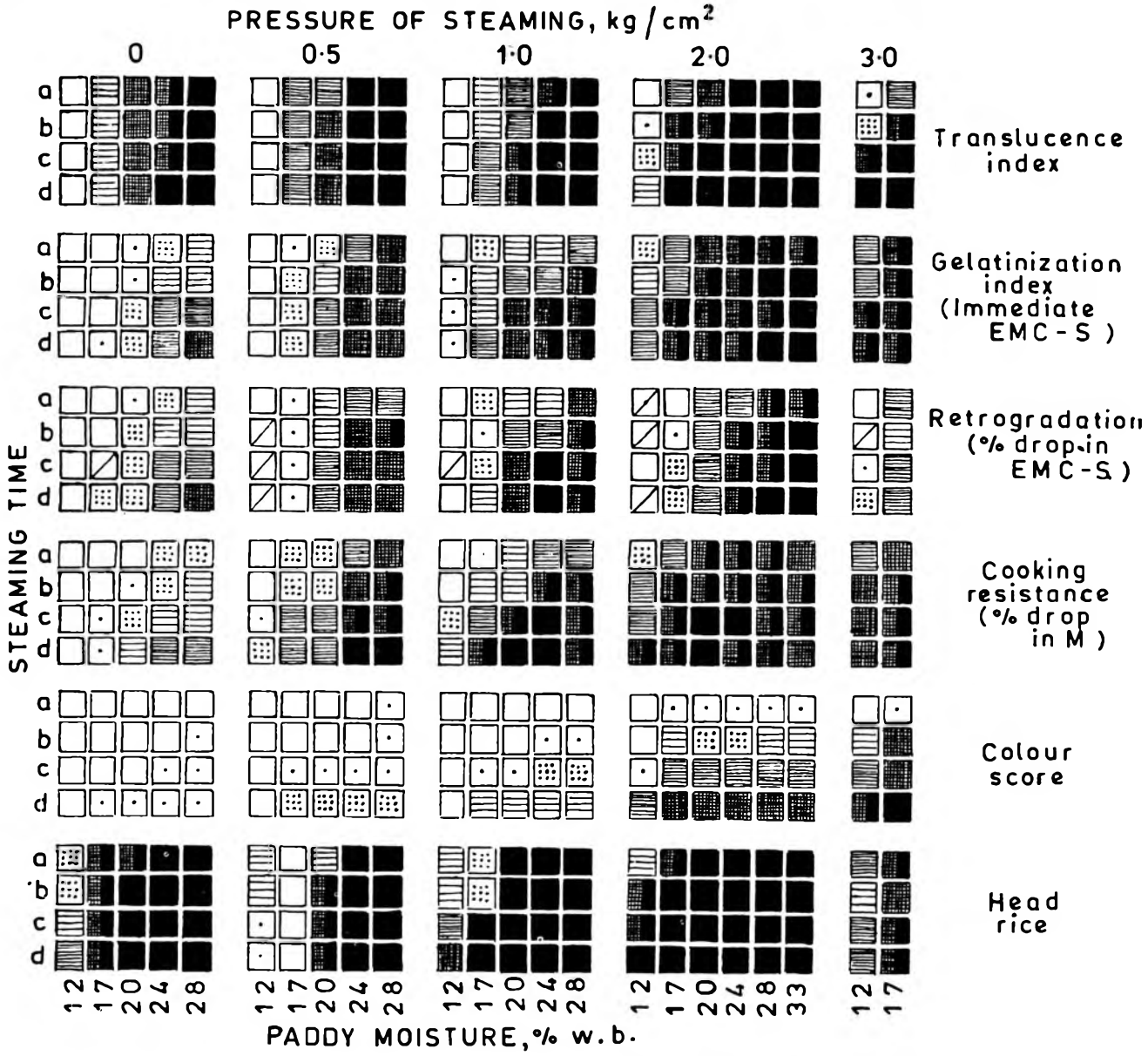

Fig. 2. Effect of paddy moisture, steam pressure and steaming time on properties of parboiled rice. Steaming time: a, b, c, d represent 10, 20, 40 and 80 min for 0 kg; 10, 20, 40 and 60 min for 0.5 kg; 5, 10, 20 and 40 min for 1 kg; 5, 10, 15 and 30 min for 2 and 3 kg/cm² steam pressure respectively. Meaning of the symbols is as follows.

Symbol	Translucence index (%)	Immediate EMC-S (% d.b.)	% Drop in EMC-S	% Drop in water uptake(M)*	Colour score	Head rice %
	10	37–45	0–5	0–8	1–4	0–10
	20	46–55	6–10	9–13	5–7	11–30
	40	56–70	11–20	14–18	8–10	31–50
	60	71–90	21–30	19–23	11–15	51–65
	80	91–120	31–40	24–28	16–25	66–80
	90	121–150	41–50	29–33	26–50	81–90
	98	151–200	51–60	34–38	51–75	91–96
	100	201–250	61–70	39–42	76–100	97–100
	—	—	0–5 (–ve)	—	—	—

* As compared to raw rice.

These results explain the rationale of the pressure-parboiling process, i.e., how the soaking step can be minimized or eliminated by steaming under pressure.

The gelatinization index (initial EMC–S) increased as the severity of treatment increased. From previous experience in this laboratory, mildly parboiled rice (represented by paddy fully soaked at low temperatures followed by steaming at atmospheric pressure for 10 min, equivalent to the top right corner sample under 0 kg/cm^2 in the figure) gives an immediate EMC–S of about 80–85 per cent moisture (d.b.), which may be considered as the minimum acceptable level of gelatinization for parboiled rice. Minimum conditions needed to give such minimum gelatinization were:

Paddy moisture (% w.b.)	Steaming pressure (kg/cm^2)	Steaming time (min)
20	0.5	20
	1.0	5–10
17	1.0	10–20
	2.0	< 5
12	2.0	10
	3.0	< 5

These conditions were much milder than those to achieve full translucence enumerated above. Such rice, accordingly, usually had very low translucence indices, i.e., big white bellies.

Starch retrogradation (i.e., per cent fall in final EMC–S as compared to immediate EMC–S) was directly proportional to the immediate EMC–S. In other words, higher levels of moisture, steaming pressure and steaming time led not only to increasing levels of gelatinization but also to increasing degrees of retrogradation. This would explain why normal pressure-parboiled rice has been found to be so difficult to cook and hard in texture. In fact, the greatest retrogradation was not necessarily in the extreme right and bottom corners in the diagram but somewhere in between. This may be because, as has been pointed out earlier[6], starch retrogradation is maximum at an optimum moisture content, falling off on either side. Maximum retrogradation, unfortunately, coincided precisely with those conditions of intermediate moisture which are presently employed in commercial operation (Incidentally in a few cases of negligible gelatinization, the retrogradation was negative i. e., the final EMC-S was more than the immediate EMC–S. This anomaly remains to be explained).

Cooking resistance index (i.e., per cent drop in water uptake of the processed rice as compared to that of raw rice, the latter being 460 per cent moisture, d.b.) largely parallelled the above two properties. The water uptake was extremely low in severely treated samples, which fully accounts for the consumer resistance encountered by pressure-parboiled rice. Based on our previous experience in this laboratory, ordinary severely parboiled rice of commerce obtained by prolonged steaming at atmospheric pressure—more or less equivalent to the bottom right corner sample under 0 kg/cm^2 in the figure—has an M value on cooking of about 75 per cent of the corresponding raw rice[4] (The cooking rate of this rice however, is still less, as the water uptake *vs.* cooking time curve of rice is not linear but falls off progressively with time)[4]. This water uptake value (75 per cent of raw rice) may be considered as the least acceptable level of cooking rate in parboiled rice, as also verified by sensory testing of a few samples. On this basis, no fully translucent pressure-parboiled sample had an acceptable cooking rate. The upper limits of treatment for acceptable cooking rate were:

Paddy moisture (% w.b.)	Steaming pressure (kg/cm^2)	Steaming time (min)	Translucence index (%)
≥ 24	0.5	10	100
20	0.5	40	80–90
	1.0	10	80
17	1.0	20	80
	2.0	5	80
12	2.0	10	40
	3.0	5	40

The last column in these data would show that for steaming at 1 kg/cm^2 or more pressure, the maximum permissible degree of translucence for acceptable cooking quality in parboiled rice is about 80 per cent (i.e., 20 per cent area covered by white belly). Anything more severely parboiled would be unacceptable for cooking. This may be one index of determining the acceptability or otherwise of pressure-parboiled rice.

Colour of rice increased greatly with severity of treatment. From sensory point of view, it appeared that a colour index of 7–10 was the maximum that could be reasonably acceptable to the consumers. On this basis, the following were upper limits of treatment for acceptable colour:

Steaming pressure (kg/cm^2)	Steaming time (min)	Paddy moisture (% w.b.)
0.5	all	all
1.0	20	all
	40	12
2.0	10	≤ 24
	15	12
3.0	5	≤ 17

Since the upper limits observed for cooking quality earlier are well within these upper limits for colour, once the cooking quality is acceptable, the colour also would be reasonably acceptable. Interestingly, in the pressure-parboiled batches, the maximum intensity of pure brown colour was given by the 17 per cent moisture rice. The brownness remained more or less same with increasing moisture but the grayness of the samples progressively increased, giving an impression of darkness. In other words, 17 per cent moisture rice, gave deep but light (i.e., more white) brown colour, while 28 per cent moisture rice gave dark (i.e., more gray) brown colour.

Head rice yield was significantly lowered only in those treatments that combined a very low moisture content with low pressure of steaming, being satisfactory in all other treatments. Therefore, within the acceptable limits of treatment discussed above, rice breakage would not be a problem.

The moisture content of paddy increased slightly after steaming, but the extent of increase was almost constant for all conditions except that there was a slight rising trend with time of steaming (Table 1).

Incipient soaking: Having understood the general trend of effects of the three primary process variables on rice quality, it was necessary to study the effects under more practical process conditions. The samples discussed above had been soaked and then equilibrated at the respective moisture contents. Such would not be feasible in industrial practice where paddy would be only briefly soaked and immediately steamed, for quick turnover is one of the important rationales for going in for pressure parboiling. Most of the added moisture under such circumstance would be absorbed only by the outer layers and hence the results might be somewhat different.

To test this aspect, several samples of Gowri Sanna paddy were incipiently soaked (or steamed at atmospheric pressure to increase the moisture) and then immediately pressure steamed under a variety of conditions. Some typical results are shown in Table 2. These results were on the whole similar to those in Fig. 2, except that corresponding properties were produced at 3–4 per cent higher mean moisture levels. On this basis, it can be said that brief soaking for about 15 min (with adhering moisture) followed by pressure steaming at 1–2 kg/cm^2 for 10–20 min would be the upper limit of treatment for giving rice with reasonably acceptable cooking quality and colour. Such rice had a maximum translucence index of 80 per cent. Cooking quality would further improve under milder conditons of steaming, but then the translucence index would be too low.

Initial open steaming of paddy instead of washing or soaking had been suggested as a method[3]. But as the results in Table 2 show, this has no advantage. On the contrary, the rice often showed much grain-to-grain variation in white belly and a high colour.

Attempts to reduce retrogradation: It has been shown by us earlier that quick drying by hot air reduced the retrogradation with concomitant increase in final EMC–S[6]. Several samples were therefore, pressure-parboiled, half of which were shade dried, the remaing half being dried quickly at 60–80°C. The results of EMC–S and M (Table 3) showed, however, that while the final EMC–S did improve by quick drying, thus suggesting reduced retrogradation, there was hardly any difference in the cooking time. The reasons for this anomaly are not clear at this time. Perhaps drying at still higher temperatures, to hasten it further, might be successful.

It can be concluded that no fully translucent pressure-parboiled rice would be acceptable to the consumer. But rice processed by presure parboiling such as to have a translucence index of about 80 per cent could be within limits that could be acceptable. The slightly higher degree of colour of this rice would not be a disadvantage particularly to consumers in Kerala and West Bengal. Such rice would cook like normal severely parboiled rice (say, paddy soaked at

TABLE 1. INCREASE IN MOISTURE CONTENTS OF PADDY ON STEAMING

Variables	Mean increase in moisture content[a] (percentage points) at stage[b]				
	1	2	3	4	5
Pressure of steaming	4.8±1.1	4.8±2.5	5.1±0.6	5.0±0.9	5.4±2.6
Time of steaming	4.2±1.7	4.5±1.5	5.1±1.7	5.5±1.4	—
Initial moisture content of paddy	6.2±2.0	4.4±1.7	5.0±0.7	4.6±0.9	4.4±0.9

[a] Values are mean (± SD) of all results except for the variable studied.

[b] Stages 1 to 5 represent increasing steam pressure, steaming time or initial moisture; see Fig. 2 for actual values.

TABLE 2. EFFECT OF SELECTED CONDITIONS ON QUALITY OF PARBOILED RICE

Soaking time (min) Steam	Moisture content[a] (% w.b.)	Steaming		Water uptake (M) (% of raw)	Translucence index (%)	Colour score
		Pressure (kg/cm^2)	Time (min)			
30[b]	18	1.5	20	85	15[c]	4
		2.0	10	76	50[c]	6
			15	73	60[c]	8
			20	71	60[c]	15
5	19	1.0	10	98	10	3
			20	83	20	4
		1.5	10	90	40	5
			20	73	80	8
		2.0	10	79	60	8
			15	74	90	8
40	21	1.0	10	99	10	2
			15	91	20	3
			20	75	80	5
		1.5	5	98	0	1
			10	87	40	4
			15	75	80	5
		2.0	5	87	40	3
			10	77	80	5
			15	69	100	8

[a] There were slight batch-to-batch variations in the moisture. The data shown are averages.

[b] Not soaked but steamed at 0 kg/cm^2 for 30 min to permit some initial rise in moisture.

[c] The translucence index varied considerably from grain to grain.

TABLE 3. EFFECT OF HOT-AIR (QUICK) DRYING ON STARCH RETROGRADIATION AND COOKING RATE OF PARBOILED RICE[a]

Steaming		EMC–S (% d.b.) after		Water uptake (% d.b.) after	
Pressure (kg/cm2)	Time (min)	Shade drying	Hot-air drying	Shade drying	Hot-air drying
1.0	20	64	84	389	393
1.5	20	94	114	341	343
2.0	10	100	126	361	362
	15	134	141	341	340

[a] Paddy (1.5 kg) soaked in water for 40 min and steamed as indicated.

room temperature, followed by steaming at atmospheric pressure for 1 hr). However, since this rice would have about 20 per cent white belly, it might evoke consumer resistance, for white belly in parboiled rice is normally associated with undersoaked, underparboiled rice[8] having rather too soft and sticky eating qualities[9]. Fortunately, a simple means to differentiate the pressure-parboiled white-bellied rice from normal undersoaked parboiled rice (that is not pressure-parboiled) is that the former is more coloured than the latter. This would ensure to the consumer that the white-bellied product is a pressure-parboiled rice, wherein the white belly is not a disadvantage, but an advantage.

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On Improving the Quality of Soya-fortified Bread

A. SELVARAJ AND S. R. SHURPALEKAR

Central Food Technological Research Institute, Mysore, India

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Though at 12 per cent level, the addition of soya flour adversely affected the quality, a highly acceptable bread comparing well with wheat bread could be obtained by including in the recipe (i) 5 per cent sugar and 5 per cent fat in case of small/cottage scale bakeries and (ii) 5 per cent sugar, 2 per cent fat and 0.5 per cent each of lecithin and GMS in case of commercial bakeries. Depending on the level of yeast (0.5–2.0 per cent), the durations of fermentation and proofing arrived at were 165–105 min and 75–45 min respectively for a 100 g loaf of bread.

Though soya flour has been used extensively for protein fortification of bread, most of the studies reported from the Western countries are based on the use of hard wheat flours[1-3]. A few studies by Indian workers cover only some varieties of Indian wheats[4-6] or imported wheat[7], which are not available to the baking industry.

The preparation of protein fortified bread of acceptable quality often poses problems due to wide as well as frequent variation in quality of commercial refined wheat flour (maida) in India. As the commercial maida often contains lower protein compared to maida milled from imported wheats, more soya flour has to be added for obtaining bread of required protein content. Also the non-wheat flour carrying capacity of medium hard Indian wheat flours in bread making is lesser than that of hard US or Canadian wheats, because of relatively inferior quality of gluten. As such, addition of more soya flour to obtain the required protein content in bread further affects its quality. The results of studies to improve the quality of soya fortified bread through modification of the recipe, processing conditions and use of additives, are presented in this paper.

Materials and Methods

Materials: Commercial refined wheat flour (maida) samples were procured from 6 different roller flour mills. One of these samples having a composition comparable to the mean values, 'Sigma' make soya-lecithin, SSL and edible grade solvent extracted soya flour were used in different bread making studies. Maida-soya flour blends containing 8, 10, 12, 14 and 16 per cent soya flour were prepared by mixing and sieving the blends through 80 mesh.

Chemical analysis: Moisture, protein and total ash in maida as well as soya flour were estimated according to standard procedures of AACC[8].

Farinograph studies: Brabender Farinograph was used to study the dough characteristics of maida-soya flour blends according to AACC[8] procedures.

Bread making trials: 'Re-mix' procedure of Irvine and McMullan[9] was followed for the preparation of breads using the following modified recipe and processing conditions: maida—100 g, dry yeast—2.0 g, sugar—2.5 g, fat—2 g, salt—1.0 g, cereal malt—0.5 g, ammonium dihydrogen phosphate, 0.1 g, potassium bromate—1.5 mg, water—as per farinograph water absorption, mixing time—3.5 min in Hobart mixer

(at speed position 1), bulk fermentation for 165 min at 30°C and 75 per cent RH, knock back followed by recovery time—25 min, proofing 55 min and baking—(a) maida bread for 25 min at 450°F and (b) soya-fortified bread[2] for 20 min at 435°F. In case of soya-fortified bread, proofing of the dough was continued till a constant height of 7.5 cm was attained.

Evaluation of bread: One hour after removing the bread from baking oven, loaf volume was determined by the rapeseed displacement method. The cooled loaves were stored in closed tin containers overnight and were evaluated for crust and crumb characteristics as well as eating quality by a panel of six judges using the scoring system of Pyler[10]. The total score of 100 consisted of: loaf volume—15, crust appearance—15, crumb characteristics (texture, grain and colour)—35, aroma—15 and taste—20.

Effect of varying the levels of ingredients and processing conditions: Sugar (2.5–10 per cent), fat (0–6 per cent) and dry yeast (0.5–2.5 per cent) were tried at different levels in bread making to arrive at their desired level. Similarly, fermentation (85–165 min) and proofing (40–75 min) were also carried out for different periods and additives such as GMS, lecithin and SSL were also added at levels of 0.5 and 1.0 per cent each. Potassium bromate was tried upto 70 ppm. Finally, breads were prepared using optimised recipe as well as processing conditions.

Results and Discussion

Effect of addition of soya flour on the quality of bread: Analysis of 6 commercial samples of maida showed that the ranges and mean values (given in parentheses) for different chemical constituents expressed as percentages were: moisture 11.80–12.80 (12.28); crude protein (N×5.7) 9.15–9.92 (9.68); total ash 0.58–0.82 (0.74). Hence, the sample with moisture 12.10 per cent, crude protein 9.60 per cent, and total ash 0.72 per cent was chosen as a representative commercial sample for different bread making trials. However, its ash content was higher than 0.5 per cent, which is desirable for good quality bread[11]. Moisture, protein and total ash of solvent extracted soya flour used were 7.25, 55.43, 5.76 per cent respectively. (Values expressed on as is basis).

Farinograph studies (Table 1) indicated that water absorption increased by about 1 per cent for every 2 per cent increases of soya flour in the blend. Kiran Surana *et al*[4] have used only arbitrary level of water for the preparation of the dough, while Tsen[12] *et al* have reported that about 1 per cent extra water is required for every 1 per cent soya flour added. When compared with control dough, however no significant changes were observed in the dough development time (5–6 min) and stability (7.5–8.5 min) of dough containing soya flour. Mixing tolerance index of dough containing even 8 per cent soya flour decreased considerably.

The data on the effect of incorporation of increasing levels of soya flour on the quality of bread presented in Table 1 show a gradual adverse effect on the overall quality based on loaf volume, crust and crumb characteristics as well as eating quality. However, bread of satisfactory grade could be prepared by including upto 10 per cent soya flour; any further addition resulted in breads of fair to poor grade. To obtain breads of about 18 per cent protein, which is generally used for feeding programmes in different states, inclusion of 12 per cent soya flour in the recipe was considered necessary and hence this level was chosen for further studies to

TABLE 1. EFFECT OF INCORPORATION OF SOYA FLOUR ON FARINOGRAPH CHARACTERISTICS AND THE QUALITY OF BREAD

Soya flour (%)	Farinograph water absorption* (%)	Mixing tolerance index (BU)	Loaf			Total score	Grade**
			Volume (cc)	Specific vol (cc/g)	Protein+ (%)		
0	64.8	80	640	4.44	11.5	100	Excellent
8	68.0	50	560	3.76	15.4	76	Satisfactory
10	69.1	50	530	3.51	16.5	66	Satisfactory
12	70.1	50	505	3.30	17.8	54	Fair
14	71.0	40	480	3.10	18.9	42	Poor
16	72.2	40	440	2.80	19.8	30	Poor

* Expressed on 14 per cent moisture basis.

** On the basis of total score—Excellent: 91–100; Good: 81–90; Satisfactory: 66–80; Fair: 51–65; Poor: 50 and less.

\+ N x 6.25 on moisture free basis.

TABLE 2. EFFECT OF YEAST ON FERMENTATION AND PROOF PERIODS AND ON THE QUALITY OF BREAD* CONTAINING 12% SOYA FLOUR

Yeast (%)	Fermentation time (min)	Proof time (min)	Loaf vol (cc)	Specific vol (cc/g)	Total score	Grade
0.5	165	75	510	3.38	58	Fair
1.0	155	60	510	3.35	58	Fair
1.5	130	50	505	3.33	56	Fair
2.0	105	45	500	3.30	56	Fair
2.5	85	40	490	3.20	48	Poor

* Receipe contained 2.5% sugar and 2% fat.

TABLE 3. EFFECT OF SUGAR AND FAT ON THE QUALITY OF BREAD* CONTAINING 12% SOYA FLOUR

Sugar (%)	Fat (%)	Loaf vol (cc)	Specific vol (cc/g)	Total score	Grade
2.5	2.0	505	3.34	55	Fair
5.0	2.0	510	3.33	61	Fair
7.5	2.0	515	3.32	62	Fair
10.0	2.0	515	3.26	62	Fair
5.0	0	380	2.48	24	Poor
5.0	1	430	2.82	45	Poor
5.0	2	510	3.36	60	Fair
5.0	3	545	3.59	67	Satisfactory
5.0	4	560	3.66	77	Satisfactory
5.0	5	580	3.77	84	Good
5.0	6	580	3.74	88	Good

* Prepared by using fermentation time of 165 min and proof time of 75 min. Recipe contained 0.5% yeast.

TABLE 4. EFFECT OF ADDITIVES ON THE QUALITY OF BREAD* CONTAINING 12% SOYA FLOUR

Additives (%)	Fat (%)	Loaf volume (cc)	Specific volume (cc/g)	Total score	Grade
Nil	Nil	375	2.50	25	Poor
0.5 GMS	Nil	495	3.29	53	Fair
0.5 lecithin	Nil	500	3.31	55	Fair
0.5 SSL	Nil	505	3.34	68	Satisfactory
Nil	2	510	3.36	62	Fair
0.5 GMS	2	535	3.50	71	Satisfactory
0.5 lecithin	2	540	3.53	76	Satisfactory
0.5 GMS + 0.5 lecithin	2	560	3.64	87	Good

* Prepared by using fermentation time of 165 min and proof time of 75 min. Recipe contained 0.5% yeast, and 5.0% sugar.

improve its quality through modification of recipe, processing conditions and use of additives.

Improving the quality of bread containing 12 per cent soya flour

Level of yeast: Studies on the effect of addition of yeast at various levels showed that increasing the quantity of yeast in the recipe resulted in only insignificant reduction in loaf volume as well as total score; the duration of fermentation and proofing however, decreased considerably (Table 2). Yeast at 0.5 per cent level required 165 min fermentation time

and 75 min proof time, while the corresponding periods for 2 per cent yeast were 105 and 45 min respectively. Use of yeast beyond 2.0 per cent level resulted in poor quality bread.

Sugar and fat: It is evident from Table 3 that 5 per cent sugar gives a bread with a total score of 61, besides overcoming the bland and beany taste due to addition of soya flour. Hence, further trials were carried out with 5 per cent sugar. Fat at 2 per cent level gave acceptable quality bread with a total score of 60, while addition of 5 per cent fat increased the score to 84; also the crumb grain as well as texture were more uniform and nearer to the control bread.

Use of additives: The effect of additives on improving the quality of bread was studied using modified recipe and processing conditions and the data are presented in Table 4. Though Tsen *et al.*[12] and Ofelt *et al.*[13] have suggested increasing the level of potassium bromate for reducing the deleterious effect due to the incorporation of soya flour, the present studies have indicated no improvement in the quality of bread, possibly because, the oxidation requirement of soya flour depends upon the changes in its physical and chemical characteristics due to processing[14]. A level of 0.5 per cent of GMS or lecithin was found optimim as (i) even without fat in the recipe, the quality of bread improved considerably, (ii) along with 2 per cent fat, the beneficial effect increased further and (iii) with 2 per cent fat and 0.5 per cent each of GMS and lecithin, highly acceptable bread comparing favourably with wheat bread or soya fortified bread with 5–6 per cent fat could be obtained.

Though the beneficial effect of 0.5 per cent SSL was comparable to that of GMS or lecithin with respect to loaf volume, the total score of 58 was significantly higher than 56–58 in case of GMS or lecithin, mainly due to better crumb softening effect of SSL. Also keeping in view, the prevention of Food Adulteration (PFA) regulations, a level of 0.5 per cent SSL was considered optimum.

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Effects of Date of Sowing and Harvesting on Characteristics and Fatty Acid Composition of Sunflower Seeds

P. BHATTACHARYYA, R. C. SAMUI AND S. K. DAS GUPTA*
Faculty of Agriculture, Bidhan Chandra Krishi Viswa Vidyalaya, Kalyani, Nadia, W. Bengal–741 235, India
and
T. CHANDRASEKHARA RAO AND G. LAKSHMINARAYANA
Regional Research Laboratory (CSIR), Hyderabad–500 009, India

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The effects of date of sowing and harvesting were investigated on characteristics and fatty acid composition of sunflower seeds (Var. 'EC 68414') grown at Kalyani (West Bengal) in pre-*kharif*, *kharif* and *rabi* seasons. With advance in harvesting date in all the seasons, the 100-seed weight increased and the contents of moisture decreased, oil increased, oleic acid decreased and linoleic acid increased. The 100-seed weight, oil content and linoleic acid content were highest for the longer duration (118 days) *rabi* (fourth week of November) crop than for the other two crops of shorter duration (99 days). Protein content did not vary significantly. Sowing from third week of April to third week of May yielded oleic-rich oil. Sowing in first week of June yielded lowest oil content.

Sunflower was introduced in India a decade ago as a drought-resistant oilseed crop to augment vegetable oil resources. Various factors such as environmental temperature and water availability, which in turn depend on the region and season, are known to affect seed yield, oil content and composition[1–5]. It is therefore, necessary to study the sunflower cultivation in different parts of the country. The present investigation deals with the effects of date of sowing and harvesting of seeds grown in West Bengal during pre-*kharif*, *kharif* and *rabi* seasons on seed characteristics and fatty acid composition.

Materials and Methods

Sunflower seed (Variety 'EC 68414') was sown during the pre-*kharif* (mid-April, May 1st week), *kharif* (May 3rd week, June 1st week) and *rabi* (November 4th week) seasons of 1978, in randomised block with 4 replications at the university farm. Gross plot sizes were 4.0×4.0 m. The seeds were sown in lines 50 cm apart with distance of 15 cm between plants. The fertilizer inputs were 60, 40 and 40 kg/ha of N, P_2O_5 and K_2O respectively. The pre-*kharif* and *kharif* crops were rain-fed and the *rabi* crop was twice irrigated. Seeds were collected from each plot from flower heads having same diameter and same date of flowering, at 6-day intervals starting from the 75th day after sowing (DAS) for the pre-*kharif* and *kharif* crops and at 7-day intervals starting from the 90th DAS for the *rabi* crop. Chemical and physical analyses were done in duplicate and averages are reported.

Moisture content was determined by heating in an air-oven to a constant weight and oil content estimated by extraction with n-hexane in a Soxhlet apparatus. Protein content was estimated[6] by multiplying N content, as obtained by the kjeldahl method, by factor of 5.53. Fatty acid composition (wt.%) was determined using a Toshniwal Gas Chromatograph equipped with a hydrogen flame ionisation detector. A stainless steel column (2.4 m×3.2 mm) packed with 10% EGSS-X/Gas Chrom Q (80–100 mesh) and maintained at 190°C was used. The detector and injection port were maintained at 250°C, and 260°C respectively. The flow of carrier gas, nitrogen, was 40 ml/min. Peak areas, representing wt.% composition, were calculated by multiplying peak height with peak width at half-height.

Results and Discussion

The effects of date of sowing and harvesting on 100-seed weight and contents of moisture, oil and protein in sunflower seeds and on fatty acid compo-

**Present Address:* Agronomist and Scientific Liaison Officer, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru–502 324, A.P.

sition are shown in Table 1. The 100-seed weight on dry basis continually increased during maturation in all the seasons, though the increase was more for the *rabi* crop than for pre-*kharif* and *kharif* crops. It was, highest for the crop sown in the 4th week of November and lowest for the crop sown in the 1st week of June. This is not surprising since the cloudy weather in *kharif* season does not contribute to the high rate of photosynthesis as in *rabi* season. The duration was also longer for the *rabi* crop than for the pre-*kharif* and *kharif* crops, which could be another contributing factor. These results are in agreement with those of earlier workers[3]. The moisture content decreased continuously during maturation, up to 10 to 13 per cent irrespective of the season.

Bulk of the protein was synthesized in the early stages of seed maturation. Significant variations with season were not found in the protein content of mature seeds, confirming the observations made in an earlier study[3].

Oil content in mature seeds was more and the oil accumulation period was longer in the longer duration

TABLE 1. EFFECTS OF VARYING SOWING AND HARVESTING DATES ON CHARACTERISTICS AND FATTY ACID COMPOSITION OF SUNFLOWER SEEDS

Sowing time	Harvesting (days after sowing)	Moisture (%)	100-Seed wt. (g)	Oil* (%)	Protein* (%)	Fatty acids (Wt. %)				UFA/ SFA**	Oleic/ linoleic
						16:0	18:0	18:1	18:2		
April											
3rd week	75	75	3.94	17	19.4	4.5	9.5	75.4	10.6	6.14	7.11
	81	65	4.88	24	19.9	—	—	—	—	—	—
	87	57	5.48	33	20.5	6.8	10.0	57.6	25.6	4.95	2.25
	93	29	5.65	36	21.0	5.9	5.9	61.5	26.7	7.47	2.30
	99	12	5.70	39	22.1	6.5	5.9	65.0	22.6	7.06	2.87
May											
1st week	75	61	3.77	19	16.6	5.7	4.8	79.3	10.2	8.52	7.77
	81	51	4.72	27	20.5	3.6	5.2	77.5	13.7	10.36	5.65
	87	43	4.89	31	21.6	5.7	8.0	70.8	15.5	6.29	4.57
	93	27	5.30	35	22.1	5.4	1.1	74.1	19.4	14.38	3.82
	99	13	5.50	38	22.1	6.0	5.2	65.1	23.7	7.92	2.75
May											
3rd week	75	73	2.69	19	18.2	3.2	6.6	78.8	11.4	9.20	6.91
	81	70	3.34	21	18.8	5.6	6.9	68.1	19.4	7.00	3.51
	87	45	4.61	27	19.9	5.1	5.1	66.5	22.7	8.26	2.93
	93	23	5.10	36	21.0	5.1	7.8	68.0	19.1	6.75	3..56
	99	13	5.21	38	21.6	5.6	6.6	65.1	22.7	7.19	2.87
June											
1st week	75	75	2.35	19	16.6	—	—	—	—	—	—
	81	59	3.00	24	17.7	5.3	5.0	63.3	26.4	8.71	2.40
	87	—	—	—	—	4.7	4.1	49.5	41.7	10.36	1.19
	93	19	4.50	34	19.4	6.9	5.1	44.7	43.3	7.33	1.03
	99	10	5.01	34	19.4	11.4	8.3	38.1	42.2	4.07	0.90
November											
4th week	90	68	4.05	25	16.6	7.1	9.3	36.8	46.8	5.09	0.79
	97	51	4.93	29	18.8	6.8	7.1	38.3	47.8	6.19	0.80
	104	39	5.80	30	19.4	6.5	8.2	37.5	47.8	5.81	0.78
	111	22	6.19	38	21.0	—	—	—	—	—	—
	118	11	6.30	42	22.1	7.8	4.7	24.5	63.0	7.00	0.39

* Dry weight basis.

** UFA, total unsaturated fatty acids; SFA, total saturated fatty acids;.
Values are averages of duplicate determinations.

rabi crop than in the shorter duration pre-*kharif* and *kharif* crops, as was generally observed by Sen *et al.*[7]. The highest oil content (42%) was observed for the November 4th week sowing and the lowest (34%) for the June 1st week sowing.

The ratio of unsaturated to saturated fatty acids during seed maturation does not show a definite trend, particularly for May 1st week and June 1st week crops, due to variations in total saturated fatty acid contents which are small. The ratio of unsaturated to saturated fatty acids in mature seeds is rather constant, irrespective of the sowing date, except for the June 1st week-sown crop for which the environmental temperatures prevailing during seed maturation period (August-September) are usually between those of pre-*kharif* and *rabi* seed maturation periods (June–July, March). The absence of considerable variations in this ratio was also observed by other workers[4,5,7-9]. However, large variations were observed in the oleic to linoleic acid ratio. This ratio generally decreased with maturation. The linoleic acid content was more for the November 4th week-sown *rabi* crop than for the other two crops. This may be due to lower environmental temperatures during seed maturation period for the November 4th week-sown crop Lower temperatures are known to be conducive for formation of more linoleic acid and higher temperatures for formation of oleic acid[1,7,9].

For oleic acid-rich sunflower seed oil, suitable as cooking and salad oil, sowing during pre-*kharif* and *kharif* seasons; and for linoleic acid-rich oil, valued in nutrition and in surface coating formulations, sowing during *rabi* season are recommended in the humid regions of West Bengal. Within the *rabi* season late November sowing yielded linoleic acid rich-oil compared to late December and January sowings due to lower temperatures prevailing during seed maturation period in the former case than in the latter[8]. Harvesting of pre-*kharif* and *kharif* crops about 99 days after sowing and *rabi* crop after about 118 days is recommended for higher oil yield.

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Fatty Acid Composition of Oil of Different Varieties of Soybean

KAUSHALYA GUPTA AND KULDIP SINGH DHINDSA

Central Quality Testing Laboratory, Department of Chemistry and Biochemistry, Haryana Agricultural University, Hissar–125 004, India

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Five varieties of soyabean viz 'HM–1', 'Bragg', 'Ankur', 'PK 71–6', and 'PK 71–21' and two crosses viz 'H–19' (HM–1× Bragg) and 'H–20' (HM–1×Ankur) were analysed for fatty acid composition and free fatty acids. Free fatty acids and total unsaturated fatty acids ranged from 0.5 to 1.4 and 84.0 to 92.4 per cent respectively. Palmitic, stearic and linoleic acids varied from 5.6 to 11.0, 1.7 to 6.0 and 7.6 to 18.0 per cent respectively. 'HM–1' contained the highest amount of oleic acid.

Soybeans contain large amount of protein and oil[1]. Storage stability of soybean oil is poor due to the presence of linolenic acid, which is largely responsible for rancidity[2]. Flavour changes may be caused by the

enzymic oxidation of polyunsaturated acids in the beans[3,4] and linolenic acid in particular. Attempts have been made to breed plant materials with low linolenic acid content. Level of lipoxygenase of soybean varieties have been reported to be variable and may be under genetic control[6,7]. The Haryana Agricultural Univesity has developed two crosses of soybean namely, 'H-19' (HM-1 × Bragg) and 'H-20' (HM-1 × Ankur). An attempt has been made to evaluate these crosses, their parents and other varieties of soybean for fatty acid composition of the oil.

Materials and Methods

Five varieties of soybean namely, 'HM-1', 'Bragg', 'Ankur', 'PK 71-6' and 'PK 71-21' and two crosses, 'H-19' (HM-1 × Bragg) and 'H-20' (HM-1 × Ankur) were procured from the Department of Plant Breeding, Haryana Agricultural University, Hissar. Samples were dried in an hot air oven at 60°C and ground to pass through 100 mesh sieve. Oil was extracted by keeping flour in petroleum ether solvent (60-80°C) overnight at room temperature. The extract was filtered and the solvent was evaporated on boiling water bath.

Free fatty acid content in the oil was determined[8]. Fatty acid methylesters were prepared using 0.4 N sodium methylate by the method of Luddy *et. al.*[9]. These were separated by gas liquid chromatography using AIMIL NUCON model—5500 series gas chromatography under the following operating conditions:

Column: Stainless steel tube (1/8" O.D. and 2 m length) packed with 15 per cent diethylene glycol succinate on 60-80 mesh chromosorb W.

Fixed temperatures of: Column 190°C; flame ionisation detector 250°C; injector port 240°C.

Gas flow: Carrier gas nitrogen 20 ml/min; fuel gas hydrogen 30 ml/min and air just minimum flow to maintain the flame (275 to 300 ml/min).

The fatty acids were identified by comparing the retention times with those of authentic standards. Peak areas were calculated by triangulations and expressed as per cent.

Results and Discussion

Fatty acid composition of soybean oil from different varieties is given in Table 1. 'H-19' showed higher amount of free fatty acids (0.8 per cent) as compared to its parents (HM-1 and Bragg). The amount of free fatty acids present is reported to indicate the age and quality of the fat[3]. 'Bragg' contained the least amount of free fatty acids, while 'Ankur' contained the highest amount of freee fatty acids. Total unsaturation ranged from 84.0 to 92.4 per cent amongst these varieties of soybean. Palmitic and stearic acids varied from 5.6 to 11.0 and 1.7 to 5.9 per cent respectively. Palmitic acid is low in all the varieties when compared to other reports[2]. The differences may be due to environmental or agronomical conditions. Stearic acid content in these varieties is in good agreement with the results of other workers[1,2].

Both the crosses 'H-19' and 'H-20' contained lesser amount of oleic acid as compared to their parents. Similarly, the amount of linoleic acid was lower in 'H-19' as compared to its parents, whereas 'H-20' had higher (53.3 per cent) amount of linoleic acid than its parents. Other workers[1] reported the variation in fatty acid composition as follows:

Palmitic acid 17.4 to 9.3, stearic acid 7.0 to 2.2; oleic acid 29.6 to 15.2; linoleic acid 59.6 to 33.8 and linolenic acid 15.0 to 4.3 per cent in soybean seeds. 'H-19' and 'H-20' contained slightly higher amount of linolenic acid i.e. 18.4 and 15.2 per cent respectively as compared to their parents. The other varieties 'HM-1' 'Bragg' and 'Ankur' contained 7.6, 15.1 and 14.0 per cent linolenic acid respectively.

TABLE 1. FATTY ACID COMPOSITION AND FREE FATTY ACIDS CONTENT OF OIL OF DIFFERENT VARIETIES OF SOYBEAN

Variety	Palmitic	Stearic	Oleic	Linoleic	Linolenic	Total unsaturation (%)	Free fatty acids (%)
H-19	8.1	3.8	22.0	48.1	18.0	88.1	0.8
H-20	8.1	2.0	21.4	53.3	15.2	89.9	0.8
HM-1	10.1	5.9	26.6	49.8	7.6	84.0	0.6
Bragg	10.9	2.4	22.8	48.8	15.1	86.7	0.5
PK 71-6	5.6	2.0	23.8	51.0	17.5	92.4	1.3
PK 71-21	5.6	2.3	21.2	55.5	15.5	92.5	0.6
Ankur	8.2	1.7	24.5	51.6	14.0	90.1	1.4

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Effect of Age on the Fatty Acid Composition of Tilapia *(Tilapia mossambica)*

K. G. Ramachandran Nair and K. Gopakumar
Central Institute of Fisheries Technology, Cochin-682 029

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The changes occurring in the fatty acid composition of *Tilapia mossambica* during growth were studied. Fish grown in the same environmental conditions were fed an artificial diet. Fatty acid composition of the body and intestinal fat of fish at the age of 1, 6, 12 and 24 months was determined. The polyunsaturated fatty acid content was found to increase upto 6 months and to slowly decrease thereafter, and this was particularly marked in the 22:6 fatty acids of Tilapia muscle lipids. Statistical analysis showed that provided other factors like diet and environment, etc., remain unchanged, age has little influence on the overall fatty acid composition of fish fats.

The influence of environment, dietary lipids, sex and spawning on the fatty acid composition of many species of fish have been reported by a number of workers[1-4] and also the effect of temperature, starvation and stress[5-8]. Ota[9] reported changes in the lipid content and fatty acid composition of muscle lipids of juvenile masu salmon in the early stages of sea-water life. Sasayma & Takahashi[10] worked on the development of the pituitary gland of *Tilapia mossambica*, and Nakumara & Takahashi[11] on the sexual development of *Tilapia mossambica*. The effect of age on the fatty acid composition of *Tilapia mossambica* is now reported.

Materials and Methods

Matured Tilapia were brought to the laboratory and grown in fresh water tanks with provision for continuous aeration. The temperature of the water was $27 \pm 4°C$ (depending on atmospheric conditions). The fish were allowed to breed in the tank and the young ones were separated and put in different tanks containing fresh water. The fish were fed a standard diet (Feed No. IV), whose formula and fatty acid composition have been reported earlier[12]. Sixty fish were caught when they reached an age of 30 days, killed, minced and the total lipids extracted as per Bligh and Dyer[13] method. As the fish were small, intestines were not separated.

The fish were allowed to grow in the same environment for 2 years. Samples were taken when they were 6, 12 and 24 months of age. In each instance, lipids were extracted separately from the muscle and intestines.

Preparation of methyl esters: The chloroform-methanol extract was concentrated in a rotary flash evaporator and methyl esters prepared using BF_3 methanol reagent[14]. The methyl esters were sealed in ampoules under nitrogen and stored at -14°C pending further analysis. Fatty acid composition was determined by gas-liquid chromatography.

Gas-liquid chromatography: The methyl esters were analysed in a gas chromatograph (Toshniwal, India

Ltd.) fitted with a flame-ionisation detector and strip chart recorder (10 mv, Varian Techtron) at a chart speed of 30 cm/hr. The column used was stainless steel, 6 ft ×0.25-inch (o.d.) packed with Anakrom ABS (110–120 mesh), coated with 10 per cent silar 10C. The operating conditions were: column temperature 196°C, injection temperature 250°C, detector temperature 275°C and carrier gas nitrogen at 40 ml/min. Identification and quantitation were done as reported earlier[15]. The fatty acid composition (weight per cent) is presented in Table 1.

Statistical analysis: The individual acid percentages for body fat of one month old fish were plotted on a graph in decreasing order of magnitude; then the composition of body fats of other age groups were also plotted in the same graph as shown in Fig. 1. As the figure shows a logarithmic trend in the measurement, the natural logarithm of the weight percentage were used to get a linear trend. The log percentages show significant correlations (Table 2A & 2B) with the fatty acids arranged from 0 to 24 according to the order of magnitude. To judge whether the composition of the fatty acids remain the same for all age groups, it is only necessary to see whether the linear relationship

TABLE 1. EFFECT OF AGE ON THE FATTY ACID COMPOSITION OF *TILAPIA MOSAMBICA*

Fatty acid	1 month	6 months		12 months		24 months	
	Whole	Body	Intestines	Body	Intestines	Body	Intestines
			Saturated				
8:0	—	—	2.50	—	—	—	—
10:0	0.10	0.40	0.20	—	—	—	—
12:0	0.50	1.20	0.30	1.59	1.70	0.88	1.1
13:0	0.40	0.30	0.30	—	—	—	—
14:0	4.87	8.90	6.90	5.23	5.79	7.84	7.57
15:0	2.38	1.10	0.96	2.14	1.37	1.26	0.53
16:0	23.56	17.80	17.10	26.07	24.24	25.35	19.23
18:0	8.97	5.00	5.30	7.85	8.62	9.10	9.26
24:0	—	1.70	0.80	—	—	—	—
	40.78	36.40	34.36	42.88	41.72	44.43	37.69
			Monounsaturated				
16:1	13.85	8.60	8.90	10.86	11.01	11.62	12.33
18:1	22.36	28.90	32.60	28.41	25.21	27.00	32.40
20:1	—	2.20	1.90	—	0.50	1.00	0.61
22.1	—	1.00	0.30	—	—	0.22	0.31
	36.21	40.70	43.70	39.27	36.72	39.84	45.65
			Polyunsaturated				
18:2	6.93	6.70	11.90	6.61	6.91	5.94	6.98
18:3	3.62	0.60	0.80	2.80	4.10	1.47	3.61
18:4	1.08	1.30	1.40	0.47	1.38	1.26	0.98
20:2	0.27	—	—	0.19	0.59	1.26	0.50
20:3	0.59	—	—	0.31	0.53	—	—
20:4	2.46	1.30	0.50	1.79	1.92	1.54	0.98
20:5	0.98	2.40	1.00	0.39	0.59	0.78	1.14
22:2	0.34	0.60	—	—	—	0.28	0.31
22:3	0.39	0.50	0.30	0.78	0.59	—	—
22:4	1.13	0.50	0.30	0.52	0.46	0.56	—
22:5	1.06	2.60	2.35	1.12	1.34	0.70	0.93
22:6	4.18	6.00	2.98	2.87	3.34	1.96	1.18
	23.03	22.50	21.53	17.85	21.75	15.75	16.61

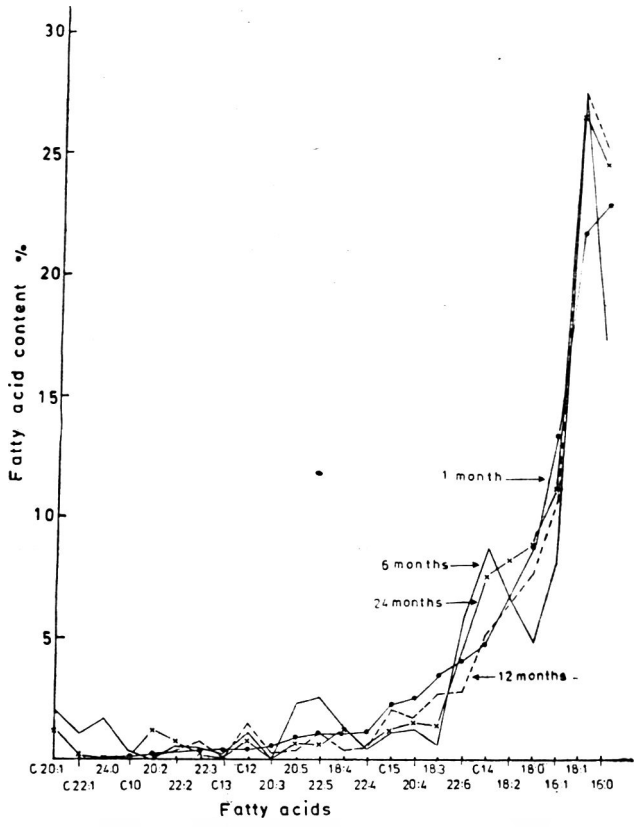

FIG. 1. Fatty acid content of *Tilapia mossambica* of different age groups arranged in ascending order of magnitude in respect of one month old fish.

TABLE 2A. REGRESSION EQUATIONS AND CORRELATION COEFFICIENTS FOR THE DIFFERENT AGE GROUPS (BODY FATTY ACIDS)

Age group (month)	Regression line	Correlation coefficient
1	Y = —.51623 + .12929X	0.94582**
6	Y = —.05001 + .09572X	0.75947**
12	Y = —.57510 + .12762X	0.00066**
24	Y = —.41059 + 11513X	0.83136*

TABLE 2B. REGRESSIONS AND CORRELATION COEFFICIENTS FOR THE DIFFERENT AGE GROUPS (INTESTINAL FATTY ACIDS)

Age group (month)	Regression line	Correlation coefficient
6	Y = —.048141 + .12476X	0.92295**
12	Y = —.026452 + .10794X	0.78869**
24	Y = —.40720 + .11187X	0.78026**

Y - Natural log of measurements of fatty acids.
X = Codes of fatty acids as mentioned.
**Highly significant (P > .001).

for the different age groups is the same. This can be done by the method of analysis of co-variance[16]. The equations to the straight line regressions for the different age groups and the analysis of co-variance are given in Tables 2A & 3A for body fats and in Tables 2B & 3B for intestinal fats.

Results and Discussion

Lipid content of body and intestines were maximum in fish aged 6 months, after which it decreased gradually. Intestinal lipid was highest at 6 months (41.7 per cent) and lowest at 12 months (6.25 per cent).

Saturated fatty acids: In body lipids, saturated fatty acid deposition was maximum in 12-year old fish (44.4 per cent), and the major fatty acid was always 16:0. The saturated fatty acid content was minimum at 6 months (36.4 per cent). Palmitic acid (16:0) was highest in one year old fish (26.1 per cent) and lowest at 6 months (17.8 per cent) and 18:0 acid was highest in 2 year fish (9.1 per cent) and least at 6 months (8.0 per cent). Myristic acid (14:0) was maximum at 6 months (8.9 per cent) and minimum at one month (4.9 per cent).

In intestinal lipids, 16:0 was highest at one year (24.2 per cent) and least at 6 months (17.1 per cent); 14:0 was highest at 2 years (7.6 per cent) and least in the 1 year old, fish. Traces of 15:0 were also present in all samples.

Monounsaturated fatty acids: There was no significant variation in the total monounsaturated fatty acids in the body lipids of all age groups studied. Individual fatty acids showed slight variations. The highest concentration of the major acid, 18:1 was seen in the 6 month old (28.5 per cent) and least in the 1 month old (22.4 per cent); 16:1 acid was maximum in one month old (13.9 per cent) and minimum in the 6 months old (8.4 per cent). Both 20:1 and 22:1 acids were below detectable levels in the body fat of one-month and one-year old fish. Fish of other age groups contained traces of these acids.

The deposition of monounsaturated acid was highest in the intestines of two-year old fish (45.7 per cent), followed by 6-month old fish (43.7 per cent). The largest individual monenoic acid, 18:1 was at a maximum at 6 months and 2 years of age (32.6 and 32.4 per cent respectively) and minimum at one month (22.4 per cent). The 16:1 acid was maximum at two years (12.3 per cent) and minimum at 6 months (8.9 per cent).

Polyunsaturated fatty acids: Deposition of the two polyunsaturated fatty acids, 22:5 and 22:6 was greatest in the early stages of life. The concentration of 22:6 increased from one month of age (4.2 per cent) to six months (6 per cent) and then slowly decreased to 2.0

TABLE 3A. ANALYSIS OF CO-VARIANCE (BODY FATTY ACIDS)

	f	ΣX^2	ΣXY	ΣY^2	b	f	Σd^2	M.S
1 month	24	1300	168.0787	24.29211	.129229	23	2.56099	.11135
6 months	24	1300	124.4375	20.65066	.09572	23	8.73936	.37997
12 months	24	1300	165.9019	26.09980	.12762	23	4.92792	.21426
24 months	24	1300	149.6735	24.93244	.11513	23	7.70001	.33478
Within						92	23.92828	0.26009
Reg. coeff.						3	0.93608	0.31203
Common	96	5200	608.0916	95.97501	.11694	95	24.86436	0.26173
Adj. means						3	0.27051	0.09017
Total	99	5200	608.3016	96.29465		98	25.13487	

Diff. between slopes: $F = \frac{.31203}{.26009} = 1.9997$ N. S. f - 3,92

,, ,, elevations: $F = \frac{.09017}{.26173} < 1$ N. S. f - 3,95

TABLE 3B. ANALYSIS OF CO-VARIANCE (INTESTINAL FATTY ACIDS)

	f	ΣX^2	ΣXY	ΣY^2	b	f	Σd^2	M.S
6 months	24	1300	162.1855	23.40713	.12476	23	3.17318	.13796
12 months	24	1300	140.3190	24.34843	.10794	23	9.20272	.40012
24 months	24	1300	145.4367	26.72532	.11187	23	10.45468	.45455
Within						69	22.83058	.33088
Reg. coeff.						2	0.20124	.10062
Common	72	3900	447.9412	74.48088	.11486	71	23.03182	.32439
Adj. means						2	0.13163	.06581
Total	74	3990	447.9412	74.61251		73	23.16345	

Diff. between slopes: $F = \frac{.10062}{.33088} < 1$ N.S f - 2,69; Diff. in elevations: $F = \frac{.06581}{.32439} < 1$ N.S f = 2,71

f - degrees of freedom, ΣX^2, ΣY^2 and ΣXY are the corrected sums of squares and cross products.

b - reg. coeff., d - deviation from regression and M.S - Mean square, N.S means not significant.

per cent in 2 years. This is in agreement with earlier results[9].

More or less the same trend was observed in the intestinal lipids also for polyunsaturates.

Statistical analysis: The straight lines in Table 2A do not show significant differences in slopes and elevations, and the four straight lines can be considered identical. This means that the overall fatty acid composition of the body fat of fish of the four age groups can be considered identical. Table 2B shows an identical trend for the fatty acid composition of intestinal fat of different age group of *Tilapia* fish.

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Studies on the Composition and Characteristics of Indian Radish Seed Oil

P. SENGUPTA AND B. R. ROY
Central Food Laboratory, Calcutta, India

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Different varieties of radish seed (*Raphanus sativus*) L) were analysed for oil content and the oil extracted therefrom for chemical characteristics, fatty acid composition by GLC, glyceride composition by pancreatic lipase hydrolysis and GLC, essential oils and phospholipids. The study showed that the oil is similar in composition to mustard oil; this indicates its use as a possible substitute for, or an adulterant in, mustard oil. It has less of erucic acid than mustard oil, but is comparable to mustard oil in pungency.

Radish seed (*Raphanus sativus* Linn.) contains glucosidically bound mustard flavours of which allyl methyl and isopropyl isothiocyanates and sulphoraphene have been reported in different varieties[1]. Schmid and Karrer[2] isolated from the seed sulphoraphene which occurs as glucoside. The radish seed yields an oil apparently similar to those obtained from other cruciferous plants mainly, mustard and rye. It is a non-drying oil, light yellow in colour with a pungent smell and contains considerable amount of sulphur.

The radish plant is cultivated in all parts of India and can be grown throughout the year. As some seeds and oil are also available (quantum and potential not known with certainty), the present study was undertaken to know more of the oil.

Materials and Methods

Neutral lipids: Different varieties (red and white) of radish seeds (*Raphanus sativus* L) belonging to West Bengal, Meghalaya, Assam and Bihar were procured from the National Seeds Corporation of India. The air dried and ground seeds were extracted with n-hexane in Soxhlet extractor for 12 hr. The residue was again extracted with a mixture of chloroform and methanol in equal volumes. From this extract solvent, were removed and the residue was re-extracted with

n-hexane. This hexane extract was mixed with the first hexane extract. Solvents were removed by distillation and the oil content of seeds were determined.

Physical and Chemical characteristics: B. R. reading, smoke point, sap. value, iodine value, etc. were estimated according to the standard methods of IUPAC[3].

Fatty acid composition: Methyl esters were prepared from the oil according to AOCS method[4]. Gas chromatography was carried out using a Pye Unicam GC versatile gas chromatograph with a flame ionization detector (FID). The detector was set at 250°C, column temperature at 190°C and injector port at 240°C. The stainless steel column (6 ft. × 1/4 inch) was packed with 10% polyesters of diethylene glycol adipate on 60–80 mesh Gas chrom Z. The flow of carrier gas was 40 ml/min. The fatty acids found were identified and quantified with reference to known concentration of standard fatty acids.

Glyceride analysis: The triglycerides from the oil were isolated by column chromatography according to Quinlin and Weiser[5] and then the positional distribution of the fatty acids within the glycerides were determined by a combination of enzyme hydrolysis, TLC and GLC[6]. Pancreatic lipase (Sigma, U.S.A.) was used to effect the lipolysis of the fatty acids at the 1 and 3 positions. The monoglycerides were separated by preparative TLC and fatty acid composition of the recovered 2-monoglycerides was determined by GLC.

Essential oil determination: The essential oil of the radish seed was separated by steam distillation and estimated by chloramine T method[7]. It was further studied by GLC[8] (10% PEGA on 100–120 mesh diatomite, detector 240°C, injection 200°C and oven 125°C, N_2 30 ml/min., FID) and UV spectrophotometry comparing with known available standards.

The ultraviolet absorption spectrum of the thiourea derivative of radish seed oil was carried out according to Ettlinger *et al*[9].

Phospholipid determination: Phospholipids were extracted from the seeds after removal of free neutral lipids from the seed with petroleum ether in Soxhlet apparatus. The material in the thimble used for the extraction of free lipids, after complete removal of petroleum ether extract, was re-extracted with chloroform to methanol ratio of 2:1. The solvent was filtered to remove any particles, evaporated under reduced pressure and weighed. About 95% of phospholipid content was found to be present in the bound fat fraction. Hence this fraction was used for the determination of phospholipid constituents. The phospholipid was then separated from less polar and mono and diglycerol sulpholipids by silicic acid column chromatography[8]. One part was used for the determination of phospholipid content of the seeds by Marinetti procedure[10] and another portion was subjected to TLC analysis for characterisation of different phospholipids.

Results and Discussion

Oils from different varieties of seeds compared closely and showed narrow ranges of variation in their characteristics (Table 1).

Fatty acids: The fatty acid composition of the oil (Table 2) is comparable to the earlier findings[11-15]. Some variations observed particularly in the erucic acid and oleic acid content may be attributed to genetic, environmental and cultural variations.

Glyceride composition: Glyceride composition of the radish seed oils was calculated from the fatty acid composition (mol%) of the triglycerides and the corresponding 2-monoglycerides using the assumption of

TABLE 1. CHARACTERISTICS OF OIL OF RADISH SEED (*R. SATIVUS* L.)

	West Bengal		*Meghalaya & Assam*	*Bihar*
	Red. var.	*White. var.*	*White var.*	*White. var.*
Yield %	38	40	42	35
B. R. at 40°C	58.8	60.8	61.0	60.4
Smoke point °C	240	240	242	240
Sap. value	179.0	180.0	178.6	181.0
Iodine value	102.8	104.0	106.8	104.0
Unsap. matt %	0.3	0.5	0.5	0.4
F. F. A. (as Oleic acid %)	0.18	0.4	0.58	0.3
Essential oil %	0.03	0.04	0.05	0.04
Phospholipid %	0.12	0.15	0.14	0.15

Values are means of 5 samples except var. from Meghalaya & Assam which is the mean of 4 samples.
Colour of the oil was straw yellow in all cases.

VanderWal[16] and Coleman[17]. Results are presented in Tables 2, 3 and 3a. It is found that oil is composed of SSS 0.10, USU 3.3, USS 1.0, SUS 1.5, UUS 21.1, and UUU 73.0%; percentage of the chief components of the glycerides are OOO (monoenes) 26.9, OOL 16.6, SLO 6.2, OLO 13.9 and OLL 8.6. It is found that the oil is particularly rich in glyceride type OOO and OOL. Similar results were obtained by Osman and Fiad[18], only difference being that they found arachidic acid as the predominant saturated acid in the oil.

Table 2. FATTY ACID COMPOSITION, TRIGLYCERIDE AND 2-MONO-GLYCERIDE CONTENT OF RADISH SEED OIL

	Radish Oil		
Fatty acids	Fatty acids (% wt.)	Triglyceride	Monoglyceride
C14:0	Trace	—	—
C16:0	5.6	6.9	0.7
C16:1	—	—	—
C18:0	1.7	4.2	3.7
C18:1	18.0	19.0	53.4
C18:2	11.5	12.4	21.3
C18:3	10.9	11.9	11.3
C20:0	2.4	—	—
C20:1	12.0	11.7	3.4
C22:0	—	—	—
C22:1	38.0	33.9	6.2
C24:0	Trace	—	—
C24:1	—	—	—

Table 3. TRIGLYCERIDE COMPOSITION IN RADISH SEED ESTIMATED ACCORDING TO VANDER WAL METHOD[16]

SSS	0.10
SSU	1.00
SUS	1.50
USU	3.30
SUU	21.10
UUU	73.00

S = represents saturated fatty acids; U = represents unsaturated fatty acids.

Table 3A TRIGLYCERIDE COMPOSITION IN RADISH SEED ESTIMATED ACCORDING TO COLEMAN[17]

SSS	0.10	OOO	26.90
SSO	0.80	OOL	16.60
SSL	0.30	LOL	2.50
OSO	1.90	SLS	0.70
OSL	1.20	SLO	6.20
LSL	0.20	SLL	1.90
SOS	1.30	OLO	13.90
SOO	12.00	OLL	8.60
SOL	3.60	LLL	1.30

S = Total saturated acid; O = Total monoenoic acid; L=Linoleic and remaining unsaturated acid.

Volatile essential oil: The volatile essential oil component in the oil ranges from 0.03 to 0.05% as determined by chloramine T method[7]. The GLC analysis of volatile essential oil shows four peaks; two of them were identified. One corresponds to n-butenyl isothiocyanate and another to allyl isothiocyanate. The UV spectral curve of the thiourea derivative of volatile essential oil showed maximum absorption peak between 241 and 243 nm which corresponds to that of pure samples of 4-methyl-thio-3-butenyl thiourea.

Phospholipids: Phospholipids content of the oil was determined[10] both in free and bound lipids. Methanol fraction of free lipids do not contain any phospholipid, but that from bound lipid had phospholipids from 0.14 to 0.15%. Lecithin and cephalin identified by TLC were 16.2 and 8.8 mg% respectively.

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Changes in the Chemical Composition of Papaya (Thailand Variety) During Growth and Development

Y. SELVARAJ AND D. K. PAL
Indian Institute of Horticultural Research, Bangalore-80, India

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Fruits of 'Thailand' variety of papaya harvested at various developmental stages were analysed for sugars, vitamins, minerals and respiration. The fruit pulp was mostly composed of water 87.6-93.8 per cent and carbohydrates 1.2–8.4 per cent at different developmental stages. Sucrose, glucose and fructose formed 10.8–41.6; 19.9–66.5 and 17.5–37.5 per cent respectively of total sugars during fruit ontogeny. Dry matter content which remained more or less at the same level increased in pre-ripe and ripe stages. During this period vitamin C, vitamin A, tannins, calcium, phosphorus and potassium contents also increased. Iron content showed little change during fruit development. Respiration pattern followed a typical climacteric rise.

Papaya (*Carica papaya* L) grown luxuriantly under tropical climate, is an important source of vitamins and minerals in addition to papain extracted from raw materials. Comprehensive studies on physico-chemical and biochemical changes during the growth and development of papaya varieties were done earlier[1-3]. The present paper describes the changes in sugars, vitamins, minerals and respiration during the growth and development of 'Thailand' variety of papaya.

Materials and Methods

One year old healthy papaya plants grown at the Experimental Station, Hessaraghatta were used for this study. Twelve such trees were selected[1]. Fruits were collected at thirteen stages in the development and were analysed for various constitutents. For chemical analysis the pulp portion was composited. A known amount of fruit pulp was extracted with 80 per cent ethanol in a Soxhlet extractor. The alcohol insoluble residue was used for estimating starch[4]. After evaporating alcohol the extract was used to estimate sugars[5]. For measuring acidity, a known weight of sample was blended with distilled water and made upto a known volume after filtering. An aliquot was titrated against standard NaOH and acidity expressed as grams of citric acid per cent. Tannin content was estimated by A.O.A.C. method[4]. Vitamin C was measured using 2, 6 dichlorophenol-indophenol dye titration method[4]. β-carotene was estimated using solvent extraction procedure and vitamin A content was calculated from β-carotene values[4]. Fruit samples dried at 70°C were used for nitrogen estimation by Kjeldhal's method[4]. A known amount of dried fruit sample was digested with tri-acid mixture and the digested material was used for estimation of minerals[6,7]. Phosphorus content was determined by vanadomolybdate yellow colour method[7], and potassium and calcium by flame photometric methods[6]. Iron content was estimated by orthophenonthroline colorimetric method[6]. Respiration measurements were made by tissue slice method using Warburg technique[8].

Results and Discussion

The data on carbohydrate constituents and acidity

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TABLE 1. SUGARS AND ACIDITY IN DEVELOPING PAPAYA FRUIT VAR. THAILAND

Days after anthesis	Alcohol insoluble solids (%)	Starch (%)	Total sugars (%)	Sucrose (%)	Glucose (%)	Fructose (%)	Acidity (as citric acid) (%)	Sugar/acid ratio	Total soluble amino acids (mg%)
15	4.78	0.14	1.20	0.23	0.75	0.21	0.155	7.7	869
30	4.12	0.14	2.78	0.30	1.85	0.61	0.139	20.0	587
45	4.16	0.17	3.27	1.07	1.08	1.06	0.091	35.9	262
60	3.06	0.09	3.70	0.90	1.73	1.02	0.077	48.1	221
75	3.30	0.04	3.76	0.77	1.77	1.18	0.057	66.0	119
90	3.25	0.12	4.95	0.78	2.30	1.83	0.072	68.8	205
100	2.24	0.09	5.01	1.00	2.08	1.88	0.062	80.8	137
110	2.34	0.13	5.16	0.86	2.60	1.65	0.048	107.5	333
120	2.72	0.12	5.23	1.18	2.20	1.79	0.048	109.0	392
130	2.52	0.09	5.60	1.25	2.19	2.09	0.048	116.7	185
140	2.22	0.11	7.38	2.84	1.94	2.46	0.048	153.8	217
150	2.32	0.07	7.38	3.07	1.47	2.68	0.049	150.6	155
160	1.92	0.09	8.43	3.41	1.74	3.10	0.046	183.3	107

are given in Table 1. The fruit pulp was mostly composed of water 87.60—93.83 per cent and carbohydrates 1.20—8.43 per cent, together forming 59.03—96.03 per cent at different developmental stages. The principal carbohydrates were sugars (sucrose, glucose and fructose) with starch constituting minor proportions. Alcohol insoluble solids decreased from anthesis to ripe stage. Starch content was low and very little changes were observed in their concentrations during fruit development. In common with other fleshy fruits, total sugars increased progressively from anthesis up to 130 days, and thereafter, the increase was at a higher rate till the ripening of fruit. Sucrose, glucose and fructose formed 10.8—41.6; 19.9—66.5 and 17.5 to 37.5 per cent respectively of total sugars during the ontogeny of papaya fruit. Sucrose content which did not show much variation upto 110 to 130 days of fruit growth increased three fold thereafter. This increase coincided with the colour break stage of papaya fruit. The predominant sugars upto 130 days were glucose and fructose. However, at pre-ripe and ripe stages sucrose content was more than fructose and glucose. Similar results were recorded with 'Coorg Honey Dew', 'Pink Flesh Sweet' and 'Sunrise' varieties[2]. Fructose content was more than glucose in pre-ripe and ripe stages. Earlier developmental stages had either more of glucose than fructose or at the same level as that of fructose.

Compared to other fleshy fruits, the total titratable acidity–a measure of all neutralisable acidic groups, was considerably low in papaya fruit throughout ontogeny. Total acidity decreased gradually till 130 days of fruit growth and then remained more or less at the same level. Sugar to acid ratio on the contrary increased upto ripe stage. Papaya fruit had very low tannins (3.1 to 50.3 mg%). Perhaps the low acid and tannin content accounted for the pleasant sweet taste of papaya. Total soluble amino acids ranged from 869 mg per cent in 15-day old samples to 107 mg per cent at harvest. The paper chromatographic separation of soluble amino acids indicated no qualitative changes in their pattern. The amino acids tentatively identified were alanine, amino butyric acid, asparatic acid, aspargine, citrulline, cysteine, glutamic acid+glutamine, glycine, isoleucine+leucine, lysine, serine, threonine, tryptophan, tyrosine and valine. Similar results were obtained with four varieties of papaya[2].

The data on vitamins, minerals and respiration are given in Table 2. Papaya fruits are reported to be an excellent source of vitamins A and C. Vitamin A values calculated from β-carotene data, were low upto 130 days of fruit growth and then increased four fold at ripe stage. This sudden increase in vitamin A content also coincided with colour break stage. Compared to other four papaya varieties studied earlier[2], the variety 'Thailand' recorded lowest vitamin A level at ripe stage. Vitamin C content was maximum in 15-day old samples. It decreased abruptly in 30-day old sample and remained more or less at the same level upto 150 days of fruit growth and then increased considerably till ripe stage.

Dry matter content remained more or less at the same level from early development stage to 140 days of fruit growth, thereafter it increased considerably. Protein content was more in 15-day old sample and decreased gradually upto 130 days. A marginal

TABLE 2. VITAMINS, MINERALS AND RESPIRATION IN DEVELOPING PAPAYA FRUIT VAR. THAILAND

Days after anthesis	Vitamin A (I.U./100g)	Vitamin C (mg%)	Drymatter (%)	Crude protein (%)	Phosphorus (mg %)	Potassium (mg %)	Calcium (mg %)	Iron (mg %)	CO_2 evolved (μl/hr/100g)
15	262	65.0	8.54	1.46	4.93	376	59.8	0.43	4600
30	312	25.0	7.47	0.88	4.55	209	29.9	0.24	3590
45	363	26.9	8.14	0.89	4.24	205	29.3	0.19	1700
60	338	20.0	7.40	0.62	4.02	233	20.7	0.11	1190
75	363	19.4	7.65	0.60	3.40	212	29.1	0.20	1040
90	390	13.7	6.57	0.58	3.11	263	34.1	0.11	960
100	363	17.1	6.65	0.56	3.24	254	32.1	0.10	710
110	363	13.1	6.70	0.43	2.36	268	30.0	0.14	590
120	338	13.1	6.73	0.48	1.50	203	23.2	0.10	630
130	496	11.9	6.17	0.45	1.24	202	22.5	0.14	670
140	701	15.6	7.73	0.60	2.33	244	25.5	0.18	1130
150	1219	20.6	10.00	0.62	2.74	230	25.0	0.15	1000
160	2199	46.5	12.40	0.57	2.28	211	24.6	0.18	890

increase in protein concentration was observed in 140 and 150–days old samples. Our earlier studies with four papaya varieties[2] and two grape varieties[9] indicated similar increase in protein content which coincided with the enhanced enzyme activity. Phosphorus, potassium and calcium contents were higher in early developmental stage and decreased gradually upto 130 days of fruit growth. Their content again increased in 140 days and remained at that level till ripe stage.

Very little changes were observed in iron content during the developmental stages. Similar type changes in mineral composition were observed in our earlier studies in pineapple[10], grape[11] and papaya varieties[2].

Respiration rate which was high at 15 days decreased considerably at 120 days of fruit growth. It started increasing at 130 days of fruit growth and climacteric peak in respiration was reached between 130 and 150 days after anthesis i.e. at the colour break stage. Though papaya fruit contained very little starch, it showed a climacteric respiration pattern during ripening. In conclusion, it could be said that the ripening period in 'Thailand' variety of papaya is characterised by an increase in sucrose content rather than glucose and fructose, increases in vitamins A and C, drymatter, tannins, phosphorus, potassium and calcium contents. Fruit tissue showed a typical climacteric rise in respiration, but no marked changes were observed in the contents of other chemical constituents studied.

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Toxicity of Some Petroleum Fractions Used in Pesticidal Emulsions to Albino Rats

MURALIDHARA, M. K. KRISHNAKUMARI, H. P. RAMESH AND S. K. MAJUMDER
Infestation Control and Pesticides, Central Food Technological Research Institute, Mysore-570 013, India

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Three petroleum fractions viz., solvent C IX, Deobase and kerosene were intragastrically administered to adult female albino rats to determine the acute oral LD_{50} values. Solvent C IX proved relatively more toxic, its LD_{50} being 6.3 ml ≡ 5629.2 mg/kg body weight. Kerosene caused 33.3% mortality at the dosage of 15 ml≡12,750 mg/kg body weight (minimum lethal dose, MLD), whereas Deobase did not prove lethal at a similar dosage. The petroleum fractions elicited typical signs of central nervous system depression in rats. Liver showed minor histopathological alterations in solvent C IX poisoned rats.

Various petroleum fractions either in the crude state or as treated fractions are being employed as pesticide diluents or carriers because of their intrinsic insecticidal potencies, physical properties as well as inherent solvent and stability characteristics[1]. Extensive use of such fractions alone or in pesticide emulsions has always caused concern as they often possess herbicidal properties[2,3] and involve hazards to non-target species including man. The toxicity of new petroleum fractions such as Iomex(R) and Aromex (R) to albino rats have been reported earlier[3-5]. This study reports the single dose toxicity of fractions such as solvent C IX, Deobase and kerosene to adult female albino rats.

Materials and Methods

Animals and Diet: Adult female albino rats (*Rattus norvegicus*, Wistar-CFTRI strain) weighing 175–200 g were grouped by randomized block design and assigned to different petroleum fractions. Caged individually, they were conditioned for two days by feeding on uncooked basal diet[6] and water *ad libitum*.

Petroleum Fractions: The petroleum fractions, solvent C IX and Deobase were of proprietary grade and obtained from M/S Volrho Ltd., Andhra Pradesh, India. Kerosene (commercial) was purchased from the local market. Some of the physico-chemical constants of the fractions used are outlined in Table 1.

Experimental design: The rats were starved overnight prior to the oral intubation of the petroleum fractions. Six rats were included in each group. The range of dosage employed for each fraction is outlined in Table 2. The control group received distilled water at the dosage of 15 ml/kg body weight (b.w.) The individual doses were calculated according to the body weights of rats. Treated animals were not fed on the day of intubation.

Observations for onset of any noticeable symptoms were made and mortality was recorded. Survivors were maintained for a period of 3 weeks, recording the daily food intake (7 days) and weekly body weights. At termination, survivors were autopsied after a chloroform anaesthesia. After recording the fresh weights of liver, kidney, heart, spleen and adrenals, portions of them were fixed in 10% neutral formalin. Paraffin embedded sections (6μ) were prepared and stained with haematoxylin and eosin for histopathological examination. The mortality data was statistically analysed by probit analysis[7] to arrive at LD_{50} and LD_{90} values in case of solvent C IX and only minimum lethal dose (MLD) was computed for kerosene.

Results

Mortality: The mortality expressed as per cent has been presented in Table 2.

Solvent C IX poisoning: Lower dosages of 3.0 and 4.0 ml/kg b.w. did not evoke any noticeable symptoms or proved lethal. However, beyond 4.0 ml/kg b.w. symptoms manifested were: initial prolonged state of dullness, severe lacrimation, nasal discharge, severe diarrhoea and ataxic hind limbs. Deaths occurred after coma and within 48–72 hr.

Deobase and kerosene poisoning: Dosages upto, 10 ml/kg b.w. did not evoke any noticeable symptoms, beyond which rats appeared very dull, drowsy and showed unsteady gait. In kerosene poisoned rats, deaths (33.3%) occurred only at the dosage of 15 ml/kg b.w. No diarrhoea was observed at any of the dosages employed.

TABLE 1. SOME PHYSICO-CHEMICAL CONSTANTS OF THE PETROLEUM FRACTIONS

	Solvent C IX	Deobase	Kerosene
Distillation Range (°C)	160—210	200—300	200—300
Flash point (°C)	24	65—85	65—85
Specific gravity	0.89	0.81	0.85
Aromatics (% by vol.)	Min. 85	—	—
Kinetic viscosity (Centipoise units)	3.0	1.0	1.0

TABLE 2. DOSAGE SCHEDULE AND MORTALITY RESPONSE OF RATS ORALLY ADMINISTERED PETROLEUM FRACTIONS

Fraction	Dosage (ml/kg b.w.)	Mortality %	Remarks
Solvent C IX	4.0	0.0	
	5.0	16.6	
	6.0	33.3	
	7.0	66.6	Deaths
	8.0	83.3	within
	9.0	100.0	48–72 hr
Deobase	15.0	0.0	Not lethal
Kerosene	10.0	0.0	Deaths
	12.0	0.0	within
	14.0	0.0	48 hr
	15.0	33.3	

Food intake and body weight: Anorexia was observed during the first three days of post-treatment and the rats also consumed significantly less food (<25% of controls). However, food consumption resumed to normal thereafter. A slight decrease in the absolute body weights of treated survivors was observed at the end of first week, but they regained weight *on par* with controls during subsequent weeks. No significant difference in body weights was observed at the end of third week among the treated survivors and controls.

Organ weights and microscopic examination: No gross alterations were observed in any of the vital organs and the fresh relative organ weights of treated rats were comparable to those of controls. Liver sections of solvent C IX administered rats showed mild cellular hypertrophy, mild vacuolisation at lower dosages, whereas few necrotic changes could be observed at higher dosages. Kidney sections showed slight desquamation of tubular epithelium. Liver sections of Deobase and kerosene poisoned rats showed slight cellular infiltration and mild vacuolisation, whereas kidney tubules were slightly dilated.

TABLE 3. ACUTE ORAL TOXICITY VALUES OF PETROLEUM FRACTIONS TO ADULT FEMALE ALBINO RATS

Petroleum fraction	LD_{50}	ml/kg b.w.		LD_{90}
		95% confidence limits		
		Lower	Upper	
Solvent C IX	6.3 (5629.2)	5.4 (4798.2)	7.3 (6534.4)	8.9 (7931.7)
Deobase	15.0* (12,150)	—	—	—
Kerosene	15.0** (12,750)	—	—	—

Values in parentheses are in mg/kg b.w.

* Not lethal upto this dosage.

** Minimum lethal dose (MLD)—33.3% mortality.

Mortality: The statistically computed LD_{50} values and LD_{90} values for solvent C IX and minimum lethal dose (MLD) for kerosene and Deobase have been presented in Table 3.

Discussion

On intragastric administration, the petroleum fractions induced typical signs of central nervous system depression in rats. The depressent action of petroleum fractions in various mammalian species has been well documented[1,5,8]. Solvent C IX poisoned rats showed severe lacrimation and nasal discharge pointing out that the fraction could be spreading rapidly over the mucosal layer of mouth causing irritation due to its low surface tension. From its LD_{50} value, solvent C IX appears to be more toxic than the other fractions. However, repeated dosing trials would provide more data on the inherent toxicity of this fraction.

Rats tolerated kerosene upto 14 ml/kg b.w. without showing any severe symptoms except drowsiness. The tolerance of rats and rabbits to single and repeated doses of kerosene without any pulmonary injury[8] and pneumonia in animals dosed orally with large amounts (15–36 ml/kg b.w.) of kerosene[9] has been shown. In the present study, the total volume of the petroleum fraction administered was 3 ml/rat (15 ml/kg b.w.) as large dosage would cause regurgitation and aspiration since the stomach becomes distended. Further, it would be physiologically more sound to keep the volume dosed at a minimum. In fact, a volume corresponding to 5% body weight has been suggested as an excessive load for rats and mice in their acute oral toxicity studies[10]. The obtained MLD value is in conformation with the earlier reports and kerosene has been rated in the class of relativity harmless chemicals since its LD_{50} is reported to be 15 g/kg b.w. or greater[11].

Deobase appeared to be safer as rats tolerated dosage upto 15 ml/kg b.w. without any clinical poisoning or lethality. It has more advantages than commercial kerosene as it is specially processed to eliminate the disagreeable odour which is of prime importance for household and agricultural applications.

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RESEARCH NOTES

CHANGES IN TOTAL PHENOLICS DURING DEVELOPMENT AND MATURITY OF SUB-TROPICAL PEARS

Total phenolics were estimated from the developing fruit of sub-tropical pear cv. 'Patharnakh' (*Pyrus pyrifolia*) and 'LeConte' (*Pyrus communis*×*P. pyrifolia*). Phenolic content was very high during the first 20 days after full bloom, which fell down to 30 days after full bloom and then maintained at that level with minor fluctuations till harvest. The total phenolics were high in cv. 'Patharnakh' than cv. 'LeConte' during development and maturity.

The phenolics are known to affect the level of auxins at all stages of fruit development, thus controlling the fruit growth. Relatively high tannin and polyphenolic contents were observed during the early stages of pear fruit development, followed by a concurrent decrease thereafter[1]. Smock and Neubert[2], however, observed a continuous increase in the tannin content upto 75 days after full bloom and a decline thereafter upto maturity. As the level of phenolics in pear fruit has been reported to vary greatly with species, variety, season and location[3], the present investigations were, therefore, initiated to know the level of total phenolics at different stages of fruit development in cvs. 'Patharnakh' and 'LeConte'.

Thirteen year old trees of 'Patharnakh' (*P. pyrifolia*) and 'LeConte' (*P. communis* × *P. pyrifolia*) pear cultivars, uniform in vigour and having been subjected to uniform cultural practices and fertilizer application, at the Regional Fruit Research Station, Bahadurgarh of the PAU, Ludhiana were used for the studies during 1979-80. The fruits were collected randomly from all sides including internal and peripheral areas of the trees. The first sample was collected after ten days of full bloom and the subsequent were taken at the same intervals till harvest. Duplicate samples of the fruit flesh weighing 10 g were preserved in 80 per cent methanol and stored in a deepfreeze till analysis. The total phenolics were estimated by the method of Swain and Hillis[4] by developing colour with Folin and Ciocalteu's phenol reagent. The absorbance of the developed colour was measured at 630 nm using red filter. The results are expressed as mg gallic acid/100 g of the fruit flesh.

In 'Patharnakh' cultivar during 1979, the total phenolics increased after fruit set and reached the highest level (690 mg/100 g) at 20 days after full bloom (Table 1). There was a sharp decline in its level at 30 days after full bloom and with minor fluctuations, this level was maintained through the remaining development period. The mature fruit contained total phenolics of 147.5 mg/100 g flesh. During 1980, however, the highest level of total phenolics were observed 10 days after full bloom. Its level declined ten days later and more or less this level prevailed during the remaining part of the fruit development. In 'LeConte', the level of total phenolics were low in both the years as compared to 'Patharnakh' at all stages of fruit development. The highest level was reached (480 mg/100 g) during 1979 at 20 days after full bloom and thereafter, the level fell down sharply and remained nearly constant till final harvest when a level of 52.5 mg/100 g flesh was recorded. As in 'Patharnakh', the total phenolics in 'LeConte' were high at 10 days after full bloom during 1980 and its content decreased continuously towards the maturity.

Similar variation in the total phenolic content within varieties and season has also been reported by Buren[3]. The results of Ryugo[1] and Tewari[5] on the content of total phenolics in the developing fruits of *P. pyrifolia* and *P. pashia* are also in line with the present findings. The synthesis of total phenols, tannins, total flavonoids,

TABLE 1. TOTAL PHENOLICS CONTENT IN THE FLESH OF 'PATHARNAKH' AND 'LECONTE' PEAR FRUIT DURING DEVELOPMENT IN 1979 AND 1980

Days after full bloom	Total phenolics content (mg/100g flesh)			
	'Patharnakh'		'LeConte'	
	1979	1980	1979	1980
10	410.0	425.0	290.0	287.5
20	690.0	280.0	480.0	250.0
30	230.0	175.0	290.0	181.2
40	260.0	212.5	180.0	168.7
50	260.0	212.5	140.0	162.5
60	270.0	231.2	140.0	143.7
70	240.0	206.2	140.0	143.7
80	210.0	187.5	140.0	125.0
90	165.0	106.2	84.0	112.5
100	105.0	112.5	77.5	106.2
110	137.5	150.0	67.5	81.2
120	135.0	131.2	60.0	73.0
130	135.0	126.5	55.0	56.0
135			52.5	37.5
140	130.0	121.8		
150	147.5	118.7		

hydrocinnamic esters, chlorogenic acid, catechin and flavonols was reported to be very active in young fruits of cv. 'Passe-Crassane'[6]. Since the 'LeConte' fruit contained less phenolics than 'Pathernakh' fruits at harvest maturity, it was more sweet than 'Pathernakh'. The decrease in total phenolics has been reported to be due to their dilution by other materials[2] and hydrolysis into component sugars, acids and other compounds[7].

Department of Horticulture,
Punjab Agricultural University,
Ludhiana, India.

SOHAN SINGH
B. S. DHILLON

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ELECTROPHORETIC AND SOLUBILITY CHARACTERISTICS OF PROTEINS IN SOYBEAN VARIETIES

Two hybrid varieties of soybean 'H-19' (HM-1×Bragg); 'H-20' (HM-1×Ankur) along with their parents and two other varieties ('PK 71-21' and 'PK 71-6' were studied for their seed protein fractions. 'H-20' variety contained the highest amount of albumin. Globulin content ranged from 4.7 to 12.6 per cent, while prolamine varied from 1.8 to 3.7 per cent. Proteins were separated by polyacrylamide gel electrophoresis and scanned in a Beckmann spectrophotometric scanner at 600 nm. Maximum number of bands (11) were obtained in 'H-19' and 'Bragg', while 'Ankur' contained only 8 bands.

Nutritive value of pulses can be predicted by studying the protein fractions[1], since globulin is known to be resistant to digestion[2-3]. Bajaj *et al.*[4-5] were able to demonstrate the importance of water soluble proteins as indicators of protein quality since these contributed to superior nutritional value. In the present investigation, two crosses, 'H-19' (HM-1 × Bragg) and 'H-20' (HM-1 × Ankur) newly evolved by this university were studied along with their parents and other soybean varieties 'PK 71-21' and 'PK 71-6' for protein components.

Newly evolved varieties of soybean along with other varieties of soybean were procured from the Department of Plant Breading of the University. Samples were dried in a hot air oven at 60°C and were ground to pass through 100 mesh sieve and stored in air tight containers. Depending upon the solubility characteristics, albumin, prolamine and gluten fractions were separated by the method of Osborne and Mendal as modified by Naik[6]. Nitrogen in different extracts was determined[7] and converted into protein by multiplying with 6.25. Anionic system of polyacrylamide gel (7.5 per cent) electrophoresis was employed to separate the soluble proteins.

Soluble proteins were extracted in 0.05M tris buffer, pH 7.6, containing 5 m mole β-mercaptoethanol and measured by the method of Lowry *et al.*[9] Equal amount of protein (200 μg) was applied on each gel column and all the samples were run concurrently. Electrophoresis was conducted in cold for about 90 min at 5 mA current per gel column. After completion, gels were stained in one per cent amido black in 7 per cent acetic acid. Rf of each band was determined by comparing against reference dye. Gels were scanned at 600 nm with the help of scanner using a Beckman spectrophtometer.

Results on protein fractions viz. albumin, globulin, prolamine and glutelin content in soybean varieties are

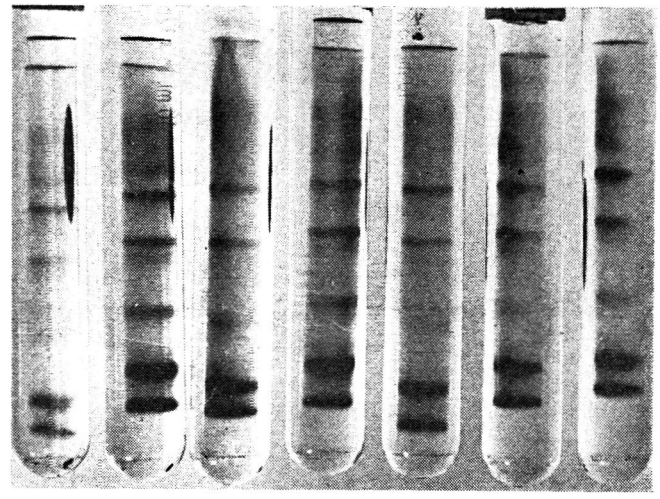

FIG. 1: Seed protein bands of soybean varieties separated by acrylamide gel electrophoresis

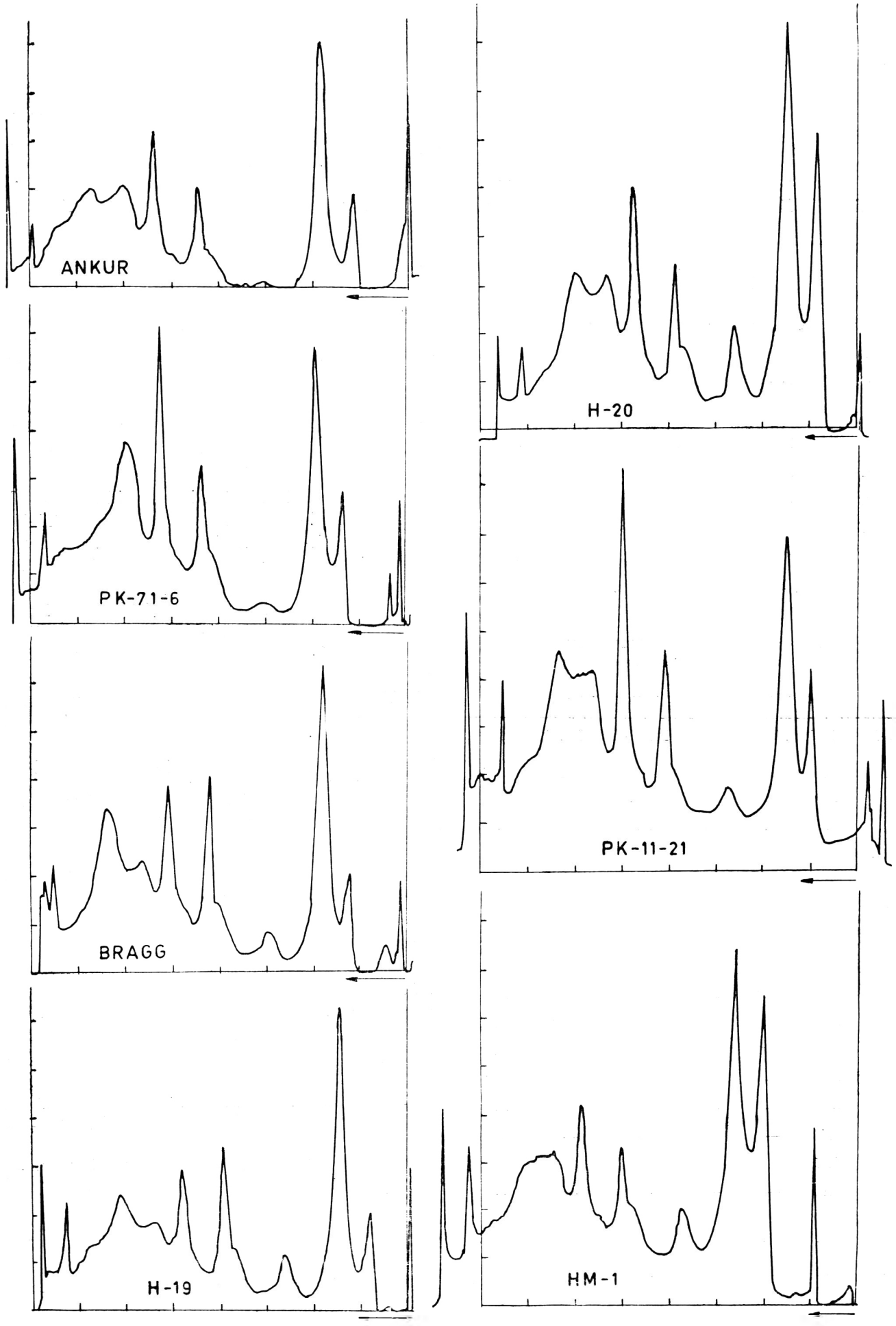

FIG. 2: Scan of seed protein bands of soybean varieties separated by acrylamide gel electrophoresis

shown in Table 1. The cross, 'H-20' (HM-1 × Ankur) contained the highest amount of albumin fraction. A significant variation in albumin content among these varieties of soybean was noted. There was a significant difference in the content of globulin and prolamine among the cross and their respective parents. Prolamine and globulin content ranged from 1,8 to 3.7 and 4.7 to 12.6 per cent respectively. Crosses contained the highest amount of globulin, which however, is known to be resistant to digestion. Thus, the globulin content of beans could be of value in predicting the nutritive value[2,3].

TABLE 1. PROTEIN FRACTIONS (PER CENT OF TOTAL PROTEIN) IN SOYBEAN VARIETIES

Variety	Albumin	Globulin	Prolamine	Glutelin
H-19	35.6	12.6	2.8	25.1
H-20	40.6	12.4	3.7	24.8
HM-1	33.2	10.4	2.7	26.1
Bragg	36.8	8.2	2.2	22.4
PK 71-6	33.7	7.6	2.5	22.7
Ankur	28.8	4.7	1.8	30.4
PK 71-21	37.8	6.7	2.2	20.2
Mean	35.21	8.94	2.56	24.53
S.E	± 1.43	± 1.12	± 0.22	± 1.23

TABLE 2. *Rf* VALUES OF SOLUBLE PROTEINS IN SOYBEAN VARIETIES

Rf values of indicated soybean varieties						
H-19	H-20	HM-1	Bragg	PK 71-6	PK 71-21	Ankur
0.18	0.18	0.18	0.18	0.18	0.18	0.18
—	—	—	—	—	0.22	—
0.24	—	—	—	—	—	—
—	—	—	—	0.26	—	—
—	—	0.28	0.28	—	—	—
0.30	0.30	0.30	0.30	0.30	0.30	0.30
0.34	—	—	—	—	—	—
0.38	0.38	0.38	0.38	0.38	0.38	0.38
—	0.43	0.43	—	0.43	—	—
0.48	—	—	0.48	—	0.48	0.48
—	0.54	0.54	0.54	—	—	—
0.58	—	—	0.58	0.58	0.58	0.58
—	—	—	—	—	0.62	—
0.68	0.68	—	—	—	—	—
0.75	0.75	0.75	0.75	0.75	0.75	0.75
—	0.80	—	—	—	—	—
0.89	0.89	0.89	0.89	0.89	0.89	0.89
0.93	0.93	0.93	0.93	0.93	0.93	0.93
—	—	—	0.95	—	0.95	—

Rf values of soluble proteins of different soybean varieties separated by gel electrophoresis are presented in Table 2 and the pattern of proteins in anionic system scanned by Beckmen spectrophotometer at 600 nm is shown in Fig 1 along with visual photograph of gels, and with the migration of proteins bands and polarity of electrodes (Fig. 2).

Bands of *Rf* values 0.18, 0.30, 0.38, 0.75, 0.89 and 0.93 were common in all these soybean varieties, whereas differential bands of *Rf* values of 0.26 in 'HM-1' and 'Bragg'; 0.43 in 'H-20', 'HM-1' and PK 71-6'; 0.54 in 'H-20', 'HM-1' and 'Bragg' and 0.58 in 'H-19', 'Bragg', 'PK 71-6', 'PK 71-21' and 'Ankur' were noted. Thus, it shows that presence or absence of a particular band could be under genetic control[10]. Similarly, bands of *Rf* values of 0.24, and 0.34 are found only in the cross 'H-19' and that of 0.68 is observed in 'H-19' and 'H-20', while *Rf* value of 0.95 was noted in 'Bragg' and 'PK 71-21'.

In Fig. 1 and Fig. 2 the number of peaks in scan coincide with the number of bands observed. Maximum number of 11 bands were obtained in 'Bragg' and 'PK 71-21', 10 in 'H-19' and 'H-20'; 9 in 'HM-1'; 8 in 'PK 71-6' and 'Ankur'. Thus, the genotype could be screened for quality by determining the soluble protein fractions.

Department of Chem & Biochemistry,
Haryana Agricultural University,
Hissar 125 004, India

KAUSHALYA GUPTA
KULDIP SINGH DHINDSA
D. S. WAGLE

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A SIMPLE WAY TO PRESERVE POTATO FOR CHIPS MAKING

Potato tubers were stored successfully upto one year in a solution containing 0.6% acetic acid and 0.2% potassium metabisulphite. Chips prepared from these tubers retained better colour during storage as well as after frying.

Recent studies carried out in our Institute showed that vegetables such as cucumber, cauliflower, peas and turnip can be easily preserved upto one year by steeping the material in water containing 5 per cent salt, 0.1 per cent potassium metabisulpite and 1.2 per cent glacial acetic acid[1]. As potato is an important commercial crop and is consumed extensively, it was thought worthwhile to study this method for the storage of potato tubers. Initial studies carried out showed that potatoes could be safely stored by this method for over three years without any morphological or histological changes. However, the preserved tubers even after prolonged refreshing in cold and hot water remained sour and saltish and took considerably longer time for cooking. Steeping the preserved potatoes in sodium bicarbonate for 24 hr or even cooking them in the presence of alkali did not improve the cooking quality. In contrast, alkali treatment imparted an insipid taste, although it helped to reduce the tuber acidity to half of that obtained in steeped tuber.

It is a known fact that salt increases the cooking time of vegetables. Therefore, the acetic acid and salt content of the steeping solution was further reduced. Further studies have indicated that the concentration of acetic acid could be reduced from 1.2 to 0.6% with complete elimination of salt and the solution could still preserve potatoes. No microbial activity was observed either in the stored potatoes or in the steeping solution. Reduction in various chemical constituents of steeped potatoes after 2 month's storage was found to be 24.2 to 22.8% for dry matter; 2.89 to 2.66% for ash; 12.9 to 11.6% for starch; 113.2 to 60.0 mg% for total phenols as tannic acid and 0.3 to 0.1% for reducing sugars. Acidity however, increased from 0.12 to 0.30 per cent as acetic acid. It was observed that the phenolic compounds were leached out of potato tubers into the steeping solution; and during a storage period of one month the quantity leached out was 34 mg/100 ml of steeping solution. Some of these compounds are known to have antimicrobial activity[2]. Phenolic compounds thus played a complementary role in the preservation of potato tubers even at a lower concentration of acid. However, lowering the acid concentration of the steeping medium by half did not improve the cooking quality of potato tubers.

The effects of substitution of acetic acid with citric, tartaric or malic acid in the solution on the cooking quality of steeping potatoes were studied with solutions containing 0.6 per cent of each of the above acids and 0.2 per cent potassium metabisulphite. Storing the samples in these acids for one month affected the cooking quality of tubers in the same way as in acetic acid.

Organoleptic acceptability of the final product was assessed after drying. Potato chips of 2 mm thickness were prepared from steeped potatoes and kept in water for an hour, drained and dried in a cabinet drier at 60–70°C. On storage at ambient temperature (30–34°C), dried chips retained better colour as compared to potato chips prepared from fresh potatoes.

On frying, chips from steeped potatoes retained whiter colour and gave better taste. The two compounds viz. polyphenols and reducing sugars which take part in the browning reaction during storage and processing were leached out. This helped in the preparation of better and whiter product.

This method is simple, cheap and does not considerably affect the quality of the stored product. As such, it can be used to store the potatoes which can be used for the preparation of better quality chips (whiter) having a better storage life.

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Division of Hort. & Fruit Technology,
Indian Agricultural Research Institute,
New Delhi-110 012, India.

J. C. ANAND
S. B. MAINI
BRIJESH DIWAN

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STUDIES ON SHELF-LIFE OF VEGETABLE OILS PACKED IN USED TIN CONTAINERS

Mustard oil, sesame (til) oil and groundnut oil were packed in new as well as once-used and repeatedly-used tin containers and stored under ambient room conditions for a period of about one year. The quality was assessed by organoleptic score, acid value and peroxide value. It was found that the keeping quality of these vegetable oils packed in new tin containers remained generally stable upto one year in case of mustard and til oil and 8 months in case of groundnut oil. These oils when packed in once-used containers retained their stability for 4–5 months and when packed in repeatedly-used containers, they were not acceptable beyond a period of 3 months.

The vegetable oils and fats are packed to protect them from oxygen, moisture and light so as retard or prevent the development of oxidative rancidity. Tin acts as a protective surface in the tin containers. The tin plate steel used in the manufacture of tin containers is coated with a very thin protective layer of tin (approximately 1% of total thickness). The steel base provides the strength and fabrication qualities, whereas the tin coating provides lustre, corrosion resistance and solderability. By repeated use of tin containers for packing vegetable oils, the protective tin layer gets reduced and may give access to the contents, to come in direct contact with rust or iron[1,2]. Most vegetable oils have some degree of unsaturation apart from the presence of various minor constituents. As such, they are susceptible to oxidative rancidity or other types of deteriorations during storage period[3]. There is a likelihood of formation of organic tin salts the toxicity of which is rated very high[4].

The raw vegetable oils (mustard, sesame (til) and groundnut oil samples graded under Agmark and from the same lots) were packed in new, once-used and repeatedly-used tin containers and stored under commercial conditions for about a year. The lids of the containers were opened for periodical sampling of oils. The sensory evaluation was conducted by adopting subjective panel technique. The consumer acceptability test versus organoleptic score was standardized at this laboratory and the following pattern for their quality assessment was adopted.

Consumer acceptance	Organoleptic scores (Out of 100)
Very good (readily acceptable)	75 and above
Good (acceptable)	64—75
Fair (fairly acceptable)	60—64)
Poor (not acceptable	less than 60

The results of the experiment (Table 1) show that the

TABLE 1. CHANGES IN MUSTARD OIL PACKED IN NEW AS WELL AS USED TIN-CONTAINERS DURING STORAGE

Storage period (days)	Organoleptic score of oil in container types			Acid value of oil in container types			Peroxide value of oil in container types (me/kg.)		
	New	Once-used	Repeatedly used	New	Once-used	Repeatedly used	New	Once-used	Repeatedly used
0	78 (R.A.)	78 (R.A.)	78 (R.A.)	1.5	1.5	1.5	0.6	0.6	0.6
31	76 (R.A.)	76 (R.A.)	76 (R.A.)	1.6	1.6	1.6	0.8	0.8	0.8
70	75 (R.A.)	73 (A)	70 (A)	1.7	1.7	1.7	1.6	2.7	7.4
104	75 (R.A.)	71 (A)	68 (A)	1.7	1.7	1.7	4.5	6.0	9.0
130	73 (A)	68 (A)	63 (F.A.)	1.7	1.7	1.7	4.5	6.0	9.8
160	71 (A)	64 (F.A.)	58 (N.A.)	1.7	1.7	1.8	4.5	6.0	10.5
193	68 (A)	59 (N.A.)	55 (N.A.)	1.7	1.7	1.8	4.5	7.5	12.0
258	66 (A)	57 (N.A.)	50 (N.A.)	1.8	1.8	1.9	4.8	9.6	16.3
320	65 (A)	56 (N.A.)	45 (N.A.)	1.8	1.8	2.0	5.0	10.0	18.0
366	65 (A)	55 (N.A.)	40 (N.A.)	1.9	2.0	2.3	5.0	10.5	18.5

The tests for argenome oil, mineral oil, castor oil and linseed oil were found negative. The iodine value, saponification value and B.T.T. did not change much during the storage period.
R.A. = Readily acceptable; A = Acceptable; F.A. = Fairly acceptable; N.A. = Not acceptable.

quality of mustard oil packed in new containers did not significantly deteriorate even at the end of storage period. The Kreis test was found negative. The mustard oil packed in once-used container was acceptable upto a period of 5 months (the Kreis test also showing positive thereafter), whereas those packed in repeatedly-used containers started deteriorating after 3 months and became unacceptable after 4 months (as also evidenced by positive Kreis test). During the subsequent experimental studies for mustard oil packed in used containers, a sharp deterioration occurred in its general quality, rendering the oil unfit for human consumption (Table 1). The oils in once-used and repeatedly-used containers started developing poor flavour which turned into metallic flavour and thereby the oil became unacceptable.

In case of til oil also more or less similar results were obtained except that the Kreis test became responsive at slightly variable stages of storage period (Table 2). Metallic flavour is the typical off flavour developed and is the reason for the non acceptability.

The stability of groundnut oil was found comparatively poor. Groundnut oil packed in new containers was found acceptable only for about 8 months. The quality characteristics of this oil when packed on once-used containers remained acceptable for about 4 months only, whereas those packed in repeatedly-used containers started deteriorating after 2 months and became unacceptable after 3 months. A sharp deterioration was found to occur in case of oil packed in used containers, when assessed at subsequent periods. It was rendered unfit for human consumption due to emission of off-metallic flavour. Kreis test was found positive after 6, 4 and 2 months of storage period for this oil packed in new, once-used and repeatedly-used containers respectively (Table 3).

TABLE 2. CHANGES IN TIL OIL PACKED IN NEW AS WELL AS USED TIN CONTAINERS DURING STORAGE

Storage period (days)	Organoleptic score of oil in container types			Acid value of oil in container types			Peroxide value of oil in container types (me/kg.)		
	New	Once-used	Repeatedly used	New	Once-used	Repeatedly used	New	Once-used	Repeatedly used
0	76 (R.A.)	76 (R.A.)	76 (R.A.)	4.8	4.8	4.8	0.5	0.5	0.5
31	75 (R.A.)	75 (R.A.)	75 (R.A.)	5.0	5.0	5.0	0.6	0.6	0.6
75	75 (R.A.)	75 (R.A.)	73 (A)	5.0	5.0	5.0	0.8	0.8	1.0
104	73 (A)	72 (A)	70 (A)	5.0	5.0	5.0	0.8	0.8	1.0
130	72 (A)	70 (A)	64 (F.A.)	5.2	5.2	5.2	0.8	0.8	1.2
160	72 (A)	64 (F.A.)	58 (N.A.)	5.3	5.3	5.6	1.0	1.0	1.6
193	70 (A)	59 (N.A.)	56 (N.A.)	5.3	5.3	5.6	1.8	2.3	2.7
258	68 (A)	55 (N.A.)	53 (N.A.)	5.7	5.7	6.0	1.9	2.8	4.4
320	66 (A)	52 (N.A.)	45 (N.A.)	5.7	5.7	6.2	5.1	6.8	8.6
366	64 (F.A.)	50 (N.A.)	40 (N.A.)	6.0	6.0	6.3	7.1	9.5	10.2

The tests for argemone oil, mineral oil, castor oil and linseed oil were found negative. The iodine value, saponification value and B.T.T. did not change much during the storage period.

R.A. = Readily acceptable, A = Acceptable, F.A. = Fairly acceptable, N.A. = Not acceptable.

TABLE 3. CHANGES IN GROUNDNUT OIL PACKED IN NEW AS WELL AS USED TIN CONTAINERS DURING STORAGE

Storage period (days)	Organoleptic score of oil in container type			Acid value of oil In container types			Peroxide value of oil in container types (me/kg.)		
	New	Once-used	Repeatedly used	New	Once-used	Repeatedly used	New	Once-used	Repeatedly used
0	75 (R.A.)	75 (R.A.)	75 (R.A.)	2.9	2.9	2.9	2.8	2.8	2.8
26	75 (R.A.)	75 (R.A.)	73 (A)	2.9	2.9	2.9	3.6	3.6	3.6
56	74 (A)	72 (A)	68 (A)	2.9	2.9	3.0	4.0	5.0	6.0
89	70 (A)	64 (F.A.)	59 (N.A.)	3.0	3.0	3.0	6.6	7.2	8.3
154	65 (A)	59 (N.A.)	55 (N.A.)	3.3	3.3	3.5	7.8	8.9	12.0
216	60 (F.A.)	55 (N.A.)	50 (N.A.)	3.3	3.3	3.5	9.6	13.2	17.1
262	56 (N.A.)	50 (N.A.)	40 (N.A.)	3.7	3.7	3.7	11.8	15.9	23.2

The tests for argemone oile, mineral oil, castor oil and linseed oil were found negative. The iodine value, saponification value and B.T.T. did not change much during the storage period.

R.A. = Readily acceptable; A = Acceptable; F.A. = Fairly acceptable; N.A. = Not acceptable.

From these studies, the inference may be drawn that it is not advisable to pack vegetable oils in used tin-containers. The internal environment of such containers may adversely affect the general quality of vegetable oils when packed. The corroded tin coating or exposed steel base readily reacts with moisture/free fatty acids in oil leading to the development of oxidative rancidity or formation of organic tin salts which are rated highly toxic.

Thanks are due to Agricultural Marketing Adviser to the Govt. of India for permitting to conduct this experimental study and publish this paper. The participation of many other independent panelists for consumer acceptability test is also thankfully acknowledged.

Central Agmark Laboratory,
Nagpur-440 010, India.

M. R. GROVER
S. K. BHATTACHARYA
T. V. MATHEW

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CONTAMINANT YEASTS OF SUGAR CANE PRODUCTS OF SRI LANKA

Twenty two strains of yeasts isolated from samples of sugar cane products were characterized and identified using both biochemical and morphological characteristics. The yeasts belonged to six genera viz: *Sporobolomyces* (two strains), *Candida* (three strains), *Torulopsis* (one strain), *Saccharomyces* (three strains), *Brettanomyces* (one strain), *Kluyveromyces* (one strain) and *Hansenula* (one strain). The predominant species was *Saccharomyces cerevisiae* (ten strains).

Sri Lanka produces in addition to sugar and molasses, a number of traditional sugar cane products such as jaggery (crude sugar lumps) and cane syrup (treacle) which are used for the preparation of traditional sweet meats and beverages. The manufacture of jaggery and cane syrup is mainly done on cottage industry scale and the quality of the products vary depending on the conditions of manufacture. Due to adulteration, the sugar contents of these products are often found to be below desirable levels needed for good keeping quality. Spoilage by alcoholic fermentation is common in sugar cane products and therefore, yeasts are expected to play a significant role in their spoilage.

In the present study, 22 strains of yeasts isolated from samples of molasses, jaggery and sugar cane syrups were characterized and identified using both biochemical and morphological characteristics. Yeasts were isolated by plating on a medium which had the following composition (in g/l of distilled water)[1]: glucose 20.0, yeast extract 300, peptone 5.0 and agar 20.0 (pH 3.5). Plating was done by streaking a loopful from enrichment cultures prepared by inoculating small amounts of the sample into tubes containing broth (10 ml) of the same medium. Methods used to study the biochemical and morphological characteristics were same as those described by Jayatissa *et al.*[2] The isolated yeast strains were characterized and identified using the following criteria: fermentation pattern, assimilation pattern, morphology and sporulation. Some of these criteria were represented by codes as described by Beech *et al.*[1] The results and the completed identification codes[1] with the binomial names of the yeasts are given in Table 1.

Various yeasts have been found in sugar, syrups and and molasses; and they can be frequently traced to the original cane[3-5]. Many of the yeasts observed by earlier workers are osmophilic or at least tolerant of high concentrations of sugar. These yeasts are reponsible for the fermentative spoilage of sugar cane products. In Sri Lanka, jaggery and cane syrups are processed at temperatures around 90°C which are usually capable of destroying any yeast present in the juice. Although there have been reports of yeasts tolerant of such high temperatures[4], most of the yeasts found in local sugar cane products appear to be due to contamination taking place after processing. Sugar cane products such as jaggery, syrup and molasses are hygroscopic and surface dilution occurs due to the absorption of moisture from the surroundings. Since no preservatives are used in these products, yeasts contaminating the surface layers bring about active fermentation causing spoilage.

The yeast strains (twenty two) isolated in this study belonged to six genera. They are *Sporobolomyces* (two strains), *Candida* (three strains), *Torulopsis* (one strain), *Saccharomyces* (thirteen strains), *Brettanomyces* (one strain), *Kluyveromyces* (one strain) and *Hansenula* (one strain). The most predominent out of the twelve species isolated was *Saccharomyces cerevisiae*.

Most of the yeast species encountered in this study have been isolated by earlier workers from sugar, syrups or related materials. *Saccharomyces cerevisiae*, *Saccharomuces elegans* and *Hansenula anomala* have

TABLE 1. IDENTIFICATION OF YEASTS IN SUGAR CANE PRODUCTS

Fermentation Sugar Code[a]	Eth	Assimilation Nitrate Code[a]	Sugar Code[a]	Morphology						Completed Code[a]	Strain
				Cell shape	Ascospore	Ps	My	Pe	Code[a]		
O	+	N	1SM	Oviod, cylindrical	—	+	—	+	2/COL	O/N1SM/2/COL	*Sporobolomyces roseus* (M1)
O	+	O	1SM	Oviod, to oblongate	—	+	+	+	2	O/O1SM/2	*Candida mesentrica* (M1)
O	+	N	1S	Oviod, few elongate	—	—	—	—	1/COL	O/N1S/1/COL	*Sporobolomyces odorus* (M1)
D	+	O	1	Ovoid	—	—	—	—	1	D/O1/1	*Torulopsis glabrata* (M1)
MA	+	O	1SM	Spehrical ovoid or cylindrical	Spheroidal or ellipsodal	+	—	—	2B	MA/O1SM/2B	*Saccharomyces bayanns* (M1)
MS	+	N	4	Spherical or ellipsoidal	—	+	—	+	2	MS/N4/2	*Brettanomyces lambicus* (J1)
A	+	O	3	Ellipsoidal to cylindrical	Spheroidal	+	—	—	2B	A/O3/2B	*Saccharomyces elegans* (JS1)
GA	+	O	3	Subglobose ellipsoidal cylindrical	Crescentiform or reniform	+	—	—	2B	GA/O3/2B	*Kluyveromyces marxianus* (JS1)
GA	+	O	4	Spheroidal or ellipsoidal	Spheroidal	+	—	—	1	GA/O4/2B	*Saccharomyces chevalieri* (M1)
GMA	+	O	4	Spheroidal or subglobose	Spheroidal	—	—	—	1	GMA/O4/1	*Saccharomyces cerevisiae* (MI, SS3)
GMA	+	O	4	Subglobose	,,	+	—	+	2	GMA/O4/2	*Sacchcromyces cerevisiae* (M1, JS3, SS2)
GMA	+	N	4	Spheroidal	Hat-shaped	+	—	+	2	GMA/N4/2	*Candida pelliculosa* (FM2)
GMS	+	N	4	Spheroidal	Hat-shaped	+	—	+	2	GMS/N4/2	*Hansenula amomala* (SS1)

Abbreviations: Ps, Pseudomycelium; My, mycelium; Pe, pellicle; M, molassess; J, jaggery; JS, jaggery scum; SS, sugarcane syrup; FM, fermenting molasses; Gl, glucose; Ga, galactose; Su, sucrose; Ma, maltose; Ra, raffinose; Eth, ethanol; KNO_3, potassium nitrate.

Code[a]: (Based on method by Beech *et al*).

Sugar Fermentation. *O*–: No Fermentation; *D*–: Gl; Su, Ma, Ra; *MS*–: Gl, Su, Ma; A–: Gl, Su, Ra; GA–: Gl, Ga, Su; *GMA* +: Gl, Ga, Su, Ma, Ra; *GMS*–: Gl, Ga, Su, Ma.

Nitrate Assimilation: *N* –: Assimilation; *O* – No assimilation.

Sugar Assimilation: 1*SM*–: Gl, Su, Ma, Ra,; 1–: Gl. only; *3* –: Gl, Ga, Su, Ra; 4 –: Gl, Ga, Su, Ma, Ra.

Morphology Code: COL–: Coloured colonies; *1*–: Multilateral budding, No pseudomycelium, No pellicle; *2*–: Multilateral budding, with pseudomycelium, with pellicle; *2B*–: Multilateral budding with pseudomycelium, no pellicle,

been reported by Tilbury[6] among contaminating yeasts of raw sugar. *Saccharomyces cerevisae* has also been reported as a contaminating organism in fresh cane juice.[5]

A strain of *Sporobolomyces roseus* which forms coloured colonies on solid media was isolated in this study from a sample of spoiled molasses. Although, there are no reports of this species of yeast being isolated from sugarcane products or other sugar syrups, Gruss isolated a strain of yeast which he identified as *Amphiernia rubra* (synonymus with *Sporobolomyces roseus*) from flower nectar[7]. The yeast *Sporobolomyces odorus* has not been reported in sugar cane products earlier.

Candida mesenterica which was isolated from a sample of molasses has been isolated earlier from wort

and beer conduit pipes in breweries[8]. *Candida pelliculosa* isolated from fermenting molasses is the imperfect form of *Hansenula anomala*[8]. Another asporogenous yeast *Torulopsis glabrata* which was isolated from molasses in this study has been isolated earlier from concentrated orange juice[9] and from fermenting juice of *Passiflora edulis* by Rao and Pruthi[10]. *Brettanomyces lambicus* which was found as a contaminant in jaggery waste has been recovered earlier by Vander Walt[11] from African grape must.

Saccharomyces bayanus, a common contaminant of wine and beer[12] was isolated from a sample of molasses in this study. A strain of *Kluyveromyces marxianus* which was isolated from jaggery scum has been isolated earlier from sewage of a sugar factory by Saccetti.[13] *Saccharomyces chevalieri*, reported a number of times as a contaminant of wine and toddy[14] was also isolated from molasses in this study.

Industrial Microbiology,
Ceylon Institute of Scientific and
Industrial Research,
P.O. Box 787, Colombo-7, Sri Lanka.
A. W. LIYANAGE
M. R. HETTARCHCHI
P. M. JAYATISSA

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BOOK REVIEWS

Source Book of Food Enzymology: by S. Schwimmer, Avi Publishing Company, 1981, pp. 967; Price: $87.50.

This book consists of ten parts with a total of 39 chapters. The first three parts deal with the scope of the book and the general aspects of enzymes indicating in some detail kinetics, biosynthesis, regulation of activity, purification, affirnity chromatography and immobilized enzymes. There is understandably a definite slant towards food enzymes but there is adequate coverage of the basic aspects. The next part is concerned appropriately with the control of the activity of the enzymes (and micro-organisms) of special significance in foods by blanching, low—temperature, low water-activity, ionizing and non-ionizing radiations and inhibitors-most of these are important in food industries for better storage/conservation/processing. The next five chapters comprising part V deal with food colour *vis-a-vis* enzymes, especially the role of "phenolase", lipoxygenase, chlorophyll degrading enzymes, glucose oxidase and the like which are crucial for colour development. Part VI considers the genesis of aroma and taste (sweet and sour) in various types of foods and beverages, and also the formation of off-odours and bitter taste, particularly in dairy products. The part played by enzymes in the development of a desirable texture in meat, fish and plant foods has been discussed in the next part. Proteases and glycolysis in meat, phospholipases, trimethylamine oxide de-methylase and proteases in fish, pectinases, amylase, invertases and cellulases in plant foods and their action are described in relation to texture. Chapter VIII is concerned with a discussion of the function of enzymes in miscellaneous unrelated processes where a pronounced change occurs in appearance or texture, as in fruit juice manufacture, malting and brewing and the production of bread and cheese. Improvement of functional and nutritional properties of plant proteins, release of toxic components from plant foods during processing /nutrient destruction and possible therapuatic use of enzymes are some topics treated at some length in part IX. The criterion of the presence and concentration of certain enzymes as indicators of quality, senescence, contamination and processing and enzymatic assay of food constituents are dealt with in the last part.

This is perhaps a unique book on food enzymes. Enzymes are viewed more from the angle of raw material, the food, its conservation or its processing i.e, from the food science/technology angle than from a predominently biochemical viewpoint. An integrated view is given of the role of the enzymes in food materials, in their processing, in food analysis and quality assessment, and in the development of sensory qualities such as colour, odour, taste and texture. A brief description of the raw material in terms of its composition and structure is followed by what happens during and after processing in respect of composition and sensory qualities; the changes are considered in depth from an enzymological viewpoint.

The author has largely succeeded in his objective of "comprehensively evaluating and providing a syncretic Ariadne's Thread for food enzymology in its labyrinthine ramifications. This source book on food enzymology is intended as such a compendium". No doubt the author's vast experience over almost half a century in this area of food enzymes whetted by his own perceptions, abiding interest and dedication have contributed to this achievement. The author should be congratulated upon this accomplishment of very informative, instructive and readable encyclopediac work. The book should find a place in every laboratory of food science and is recommended to anyone interested in food enzymes.

There are a few minor comments. Why the chapter (No. 9) on "Enzymology of Sweetener Production" finds a place in part III on "Enzyme production and Related Topics" is difficult to understand. Glucose isomerase, α-amylase and glucoamylase are quantitatively and economically so important that they deserve special consideration. Despite the justification by the author of the use of "phenolase" polyphenol oxidase is a better term than phenolase, although perhaps not the best! Thirdly "metric tonn" has been abbreviated to "MT" which is not standard: M is normally used for mega of 10^6. It is stated that many metabolites including food costituents can be measured at levels as low as 10^{-16} M! This is highly unlikely!

The printing and the get-up of the book are excellent. It is only hoped that the price will not scare away the interested scientist!

M. R. RAGHAVENDRA RAO
C.F.T.R.I., MYSORE.

Food Drying: Proceedings of the Workshop held at Edmonton, Alberta, 6–9 July 1981, published by IDRC, Ed. Gordon Yaciuk, pp. 1–104, Price: $8.00.

International Development Research Centre (IDRC), is a public corporation of Canadian Parliament. It

sponsors research and development work, for application of science and technology, in developing countries. IDRC is supporting research projects wherein solar radiation alone or in combination with combustible agricultural wastes like coffee pulp, paddy husk, etc., is utilised to dry food crops, mainly paddy, coffee beans, fish, etc.

This workshop brings together the research workers, processing the above listed commodities for drying, from countries like Bangladesh, Chile, Egypt, Guatemala, India, Indonesia, Kenya, Korea, Malaisia, Mali Niger, Costarica, Peru, Philippines and Singapore and Thailand., etc.

Majority of the papers cover paddy drying. Mechanical drying of fish also is gaining importance. In the context of global energy crisis, sun/solar drying is also gaining much prominence and a few papers are presented in this area of solar energy utilisation. Papers are grouped under four sections, viz., (i) drying requirements (ii) consumer acceptability, (iii) heat and mass transfer, and (iv) heat sources like sun, petroleum products, agricultural wastes, and firewood.

Drying requirements: Four papers are presented. The 1st paper covers fish drying in India—both sundrying and mechanical drying, packaging aspects and drying conditions are outlined. The 2nd paper covers, vegetable drying in Egypt. A solar dryer is discussed to dry vegetables like Jew's Mallow and Okra.

The 3rd paper covers drying of potatoes in Peru. Mechanical hot air drying is outlined. Drying data is presented for potato strips.

The 4th paper covers paddy drying in Indonesia. Mechanical drying of paddy is discussed along with advantages. This is suggested as an alternative to sundrying during monsoon season, to be economical.

Consumer acceptability: Under section two, four papers are presented. The first paper covers effect of drying on nutritive value on commodities like green leafy vegetables, mango and papaya. The other papers cover: (a) cowpea food products rich in protein for Thailand, (b) banana based weaning food for Costa rica, and (c) dry fish marketing in East Java.

Section three on heat and mass transfer aspects contains good papers covering: (a) paddy drying and (b) fish drying. Basic psychrometric principles are outlined for grain drying. Aspects to be kept in view in evaluating drier performance are outlined. Under fish drying, problems of sundrying are outlined. Hot air drying aspects are covered listing advantages. Air heating by means of LPG, kerosene and paddy husk are outlined and compared. Dryer design aspects are covered.

The fourth section covers heat sources. A good review on solar energy as a source of heat for crop drying is presented, in the first paper. Design aspects, measurement of incidental energy, dryer constructional details are outlined. The second paper covers solar drying and ambient air drying for paddy processing. Solar heat collectors with heat storage units are outlined.

The third paper covers the development of a farm grain dryer for paddy and coffee seeds. Quality aspects of the fast dried product are not covered.

Another paper deals with mechanical drying of paddy in Indonesia. Constructional details of different types of batch dryers are outlined. Economic aspects of mechanical drying and sundrying are discussed and advantages of mechanical hot air dryers are listed.

Areas of research for further work are outlined.

B. S. RAMACHANDRA
C.F.T.R.I., MYSORE.

Food Safety Service: Regional Office for Europe, WHO, Copenhegen, (Edited by R. Johnson) 1981, pp. VII+182, Price: Sw. fr. 14.

The book is the Pub. No. 14, a worthy one, of the illustrious Public Health series in Europe, by the same agency; this incidentally reaffirms food as one of the primary public health concerns. This elegantly bound paper back includes monographs of individual European countries on geography, government, food legislation, food control administration, addresses (of relevant national authorities) and Codex contact points along with a brief foreword and general review. It is very convenient to have the different modes of food legislations (albeit brief) of the advanced countries between two covers, particularly suitable for one in search of one's own model. It is not unwelcome that 'food safety' has been connoted here for comprehensive food control (of quality) rather than narrower but literal meaning 'reasonable absence of health hazards'. It is commendable that the organisation did prior relevant exercises of meeting on mass catering and conference of food control laboratories. Now one wishes the other Regional Offices of WHO do similar work, specially ones in Asia and other developing regions.

The General Review begins with 'The measures that the countries..... take to ensure safety and hygienic quality..... and the services they maintain for this purpose vary considerably, and it is difficult to discern a feature common to them all'. But there is and has to be a unity too. The foreword says, 'All (countries) have organised services to improve food safety, although they have not followed a common pattern in doing so' and 'food safety cannot be guaranteed solely

on a national basis; the standard of food hygiene in one country affects people in other countries'. Though there can be or in all probability will be diversity in the matter of details (organisation, implementation, staffing and scope), unity has to be in basics—that food has to be wholesome, safe and to consumers' preference. Though the Codex Alimentarius Commission of FAO/WHO, Chemicals Safety Programme of WHO and others work on quality and safety of food on a continuing basis there is still a need for work on the basics, for example, on generating political will, on protocols for models of food legislation, inspection and analysis and on minimum quantum for their implementation. The minimum quantum has to be at least according to the requirement of a sample survey, when total check is impossible. Many countries have food control only in name, many though having adequate legislation have inadequate implementation or some check one out of say ten thousand food samples. When food safety in one country is not only a national but international necessity, efforts should be made for it by all concerned quarters. The present compilation is in the right direction; one hopes others in all parts of the world will follow. Then we know the adequate models on the one hand and deficient ones on the other.

B. R. Roy
Central Food Laboratory, Calcutta.

Grain Legumes: Agronomy and Crop Improvemrnt; Processing and Storage: Marketing and Nutrition: Proceedings of the Workshop, New Delhi, January 1981, Published by Protein Foods and Nutrition Development Association of India, Bombay (Edited and compiled by A. S. Aiyer and K. R. Iyer), 1981, pp. 183, Price: Rs. 25.

Pulses are a daily necessity in Indian households contributing to the variety and nutritional value of the diet. Their production has, however, not exceeded 13 million tonnes a year so far, although the foodgrain production has reached a level of more than 130 million tonnes. The task of ensuring adequate supplies of pulses for meeting the needs of the growing population of the country has assumed serious proportions. The present workshop has brought together specialists from various disciplines to discuss the problems faced in raising the production of pulses and stretching their supplies, to meet the national needs. There has been a serious effort to crystallise the immediate tasks for fulfilling these goals.

The deliberations of the workshop have been published in the form of a handy-book.

A unique feature of this publication is a comprehensive overview highlighting the factors limiting per-hectare yield of pulses at farmer's fields, potential of varieties developed in recent years, current cultivation practices and measures needed for improving the production to meet national needs. Development of 'pulse villages' by adoption of a package of technologies has been indicated as a means of elevating pulse production to the level of an attractive venture for small farmers who account for bulk of the production of pulses in this country.

The specialist papers figuring in the publication provide a comprehensive picture of the role of agronomic factors, elite varieties and Rhizobial culture in pulse production, diseases/pests of pulses, processing and marketing aspects and nutritional qualities of pulses specially in relation to processing. The reports of various sessions presented by the respective chairmen and the recommendations arising from the deliberations of the workshop contain a mine of information for research and follow-up for extension and policy reviews at government level.

Appendices have given valuable information on the nomenclature, chemical composition, fertiliser levels and cultivation practices of legumes.

The book should be a valuable addition to libraries of R & D institutions, government agencies and other organisations concerned with stretching pulse supplis in the country. It merits careful reading by planners at all levels.

J. V. Shankar
C.F.T.R.I., Mysore.

Fish Handling, Preservation and Processing in the Tropics. Part I: by I. J. Clucas, Tropical Products Institute, London, ECIR 5DB, 1981, pp. 140, Price: £ 4.05.

This is the first of the two reports from Tropical Products Institute which together represents 52 lectures for an eight week training course for those working at middle management level in both Government and Industry.

The first lecture gives an outline of world fisheries catch, consumption and employment. The second and third lectures deal with the chemical and nutritional aspects of fish. The lecture on physical structure and chemical composition of fish gives information regarding different types of fishes. Chemical composition of a wide range of types and species which are of commercial importance is also given.

Handling and preservation are important steps in the post-harvest technology of this highly perishable

commodity which under tropical weather conditions demands utmost care. The quality of fish reaching the consumer or the processing factories will depend on how the fish is handled on board after the catch, how it is preserved, packed and transported before it reaches the user. The various types of spoilage such as autolytic, microbiological and chemical which take place soon after the death of fish have been dealt with. Ice being the main cooling medium for fish, detailed information is given on the manufacture of different types of ice and its optimum utility. The hygienic aspects of the manufacture of ice are also emphasised.

Freezing is one of the important methods for preservation of food. The lectures on freezing deal with the design of freezing plants, practical aspects of freezing and different methods employed for freezing. The importance of proper freezing and thawing to get good quality product has been stressed. The means of maximising cold store efficiency through its proper use and also the proper design of the cold stores are discussed. The basic information on design construction of fish processing premises and equipments/instruments requied for a fish processing factory is given.

In order to make the course comprehensive the factory hygiene, sanitational requirements and different aspects of packaging have also been highlighted.

As mentioned in the report, it has been produced to help developing countries derive greater benefit from their plant and animal resources. The report can be of practical utility to those who are entrusted with handling and preservation of fish.

T. R. SHARMA
DEFENCE FOOD RESEARCH LABORATORY, MYSORE.

REVIEW

INDIAN FOOD INDUSTRY

(New quarterly Journal of the Association of Food Scientists and Technologists, India)

There can be no better time for launching the new Journal 'Indian Food Industry' than in the Silver Jubilee Year of the Association of Food Scientists & Technologists, a body of professional Food Scientists, Technologists and Engineers, who have been making a valuable contribution to the development and growth of the Food Industry in this country. The A.F.S.T. has been publishing regularly the Journal of Food Science & Technology dealing with the Research & Development aspects of the Food Industry.

For the industry and business community involved in food manufacturing, there has been a long felt need to have information on techno-business aspects in a condensed form. The first issue of the Indian Food Industry appears to have set its goal to fulfil this need.

A journal's usefulness and content can only be enhanced and be widspread by the critical and objective contributions from its readers. I am sure that the very enthusiastic and highly motivated editorial board of this new journal would be able to bring out the kind of information the business and industry community involved in food manufacture would be interested. I congratulate the A.F.S.T. for bringing out the Indian Food Industry Journal and wish them success in their future endeavours.

R. JAYARAM,
BRITANNIA INDUSTRIES LTD.,
BOMBAY.

ASSOCIATION NEWS

Our New Editor

The Executive Committee of the Association of Food Scientists and Technologists (India) is happy to announce the nomination of Dr. K R. Sreekantiah as the New Editor of the Journal of Food Science and Technology. He is taking charge from 1st January 1983 for a period of 3 years.

Dr. K. R. Sreekantiah obtained B.Sc. (Agri.) degree from Mysore University in 1950. After completing the Associateship of Indian Agricultural Research Institute in 1952, he worked as a staff member in that Institution till 1958. He was awarded Ph.D. Degree of the Mysore University for his work on 'Fungal pectinases'.

Dr. Sreekantiah is the principal worker and leader of the project on microbial enzymes production and their application in food industries. Processes for the production of pectinase, amylolytic enzymes, protease, preparation of clarified fruit juices, ethanol production from tuber starches and mahua flowers have emerged from his projects. Many of the processes have been commercialized. He was also actively associated with other projects on the study of active principle of garlic and its antifungal activity.

Dr. Sreekantiah was deputed to Japan as a fellow of UNICEF for one year for specialization in enzymic processing of food. He has nearly 60 scientific publications and four patents to his credit. He is a fellow of the Indian Phytopathological Society. He was honorary treasurer of the Association of Food Scientists and Technologists for the year 1972 and Honorary Executive Secretary for the year 1980. He was Secretary–Treasurer of the Mysore Unit of the Association of Microbioligists of India, during 1970–72. He has been a member of several technical committees of symposia conducted by AFST.

He teaches Industrial Microbiology for M.Sc. Food Technology and has guided many students for Post-graduate degrees.

Trivandrum Chapter

The Annual General Body Meeting of the above Chapter was held on August 9, 1982 and the following Office bearers were elected: President—Dr. C. S. Narayanan, Vice President—Mr. M. R. Mahadevan, Hony. Secretary—Mr. V. Govindarajulu, Hony. Joint Sercretary—Mr. V. P. Sreedharan and Hony. Treasurer—Mrs. Nirmala Menon.

SUMAN FOOD CONSULTANTS TRAVEL AWARD AFST(I)—1982

The Association of Food Scientists and Technologists (India) have instituted a Travel Award in the name of "Suman Food Consultants" to Post-graduate Degree/Diploma students in Food Science/Technology. The Award will be of Rs. 500 (Rupees five hundred only) which will enable the awardee to attend the Annual General Body Meeting and the Technical Seminar/Symposium of the AFST(I) in that year.

The selection for the Award will be based on an essay competition. The subject for the essay "is "ROLE OF BIO-TECHNOLOGY IN AUGMENTING INDIA'S FOOD SUPPLIES". Four copies of the essay are to be submitted to the AFST(I) office, Mysore before 31st January 1983. The essay may contain 15–20 pages of typed matter and comprehensive. A certificate from the head of the department under whom the student is working should be enclosed along with the essay.

Nominations Invited for

AFST(I) Awards for 1982

Prof. V. Subrahmanyan Industrial Achievement Award

The Award consists of a cash prize of Rs. 2500, a citation and a plaque.

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 development of agro-based food science and technology with immediate prospect and (or future potential) for industrial application.
3. The nomination should be proposed by a member of the Association. The biodata 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.

Young Scientist Award

The award consists of a cash prize of Rs. 1000, 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 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.

Best Student Award

There are two awards each comprising a cash award of Rs. 500 and a certificate.

The candidates to be considered for the awards should fulfill the following conditions:

1. They must be Indian nationals.
2. They must be students of one of the following:
   (*a*) M.Sc. (Food Science)/Food Technology
   (*b*) B.Tech., B.Sc. Tech., B.Sc. Chem. Tech in Food Technology
   (c) B.Tech., in food sciences
3. They should not have completed 25 years of age on 31st December of the year preceding the announcement when their names are sponsored.

Heads of Post-graduate Departments in Food Science and Technology may sponsor the name of *one* student from each institution supported by the candidate's biodata, details starting from high school onwards, including date of birth and his postgraduate performance to date.

Nominations or applications for the above awards along with bio-data and contributions should be sent by registered post covers marked "awards" so as to reach Dr. L. V. VENKATARAMAN, Honarary Executive Secretary, Association of Food Scientists and Technologists (India), Central Food Technological Research Institute campus, Mysore-570 013 before 31 January 1983.

Subject Index

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Author Index

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INSTRUCTIONS TO AUTHORS

1. Manuscripts of papers (*in triplicate*) should be typewritten in double space on one side of bond paper. The manuscripts should be complete and in final form, since only minor corrections are allowed at the proof stage. The paper submitted should not have been published or data communicated for publication anywhere else. Review papers are also accepted.

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. Superscripts and subscripts should be legibly and carefully placed. Foot notes especially for text should be avoided as far as possible.

4. **Abstract:** The abstract should indicate the principal findings of the paper. It should be about 200 words. It should be in such a form that abstracting periodicals can readily use it.

5. **Tables:** Tables as well as graphs, 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. They should be typed on separate paper. Nil results should be indicated and distinguished clearly from absence of data, which is indicated by '—' sign. Tables should not have more than nine columns.

6. **Illustrations:** Graphs and other line drawings should be drawn in *Indian ink* on tracing paper or white drawing paper preferably art paper. The lettering should be in double the size of printed letters. For satisfactory reproduction, graphs and line drawings should be at least twice the printed size 16cms (ox axis) × 20cms (oy axis); photographs must be on glossy paper and must have good contrast; *three 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 along with title of the paper should be cited completely in each reference. Abbreviations such as *et al.*, *ibid. idem*, should be avoided.

   The list of references should be included at the end of the article in serial order and the respective serial number should be indicated in the text as superscript.

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

   (*a*) *Research Paper:* Jadhav, S. S. and Kulkarni, P. R., Presser amines in foods, *J. Fd Sci. Technol.*, 1981, **18**, 156.

   (*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 Papers:* Nambudiri, E. S. and Lewis, Y. S., Cocoa in confectionery, *Proceedings of the Symposium on the Status and Prospects of the Confectionery Industry in India*, Mysore, May 1979, 27.

   (*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.

9. Consult the latest copy of the *Journal* for guidance.

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Research Papers

Research Notes

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