... OF PROCESSING ON THE MOVEMENT OF OIL IN THE RICE ...L AND ITS RELATION TO THE OIL CONTENT OF PADDY AND THE YIELD OF OIL FROM RICE BRAN.

BY

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ABSTRACT.

The ether extractable matter (mostly oil) present in paddy ranges from less than 2% to over 4.5%, depending on variety. The commercial varieties of south India generally contain 2.0 - 3.5%. The major part of this oil is located, at a concentration of 20% or more, in a stable condition, in the outer (aleurone) layers of brown rice. The oil-rich layers will correspond to about 10% of the weight of brown rice. When milled, in the raw state, and polished to the extent of 5%, only 40 - 50% of the total oil present in the paddy is removed with the bran. When the same variety of paddy is parboiled and then milled to the same degree of polish, 50 - 60% of the total oil passes into the bran.

The studies described in the present paper have sh... that as the result of parboiling, there is some movement of oil from the lower layers, towards the surface, so that the top layers get correspondingly enriched. Parboiling causes

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the germ to shrink in size, but the oil present in it does not come out. As the germ generally gets admixed with the bran, its contribution to the oil content of the polishings from both raw and parboiled rice may be regarded as being about the same.

When paddy is merely soaked in hot or cold water and then dried or when dry paddy is steamed, there is a small increase in the oil content of the bran when brown rice is polished to the extent of 5%. When the time of soaking is extended and the paddy then steamed, the yield of oil from the bran is increased to 35 - 40%, the extent of such increase depending largely on the time of soaking. Prolonged steaming does not, however, cause any further increase. Parboiling under pressure minimises the time of soaking and the oil content of bran tends to approach that obtained after prolonged soaking. Incipient germination of paddy or direct soaking and parboiling of brown rice do not lead to any distinct improvement.

By suitable combination of favourable conditions, it has, so far, been possible to raise the oil content of bran to about 40% which is about twice the average yield as obtained from bran of good quality. With some varieties, about 80% of the total oil present in paddy can be removed with 5% polish. With other varieties, 2 - 3% more polish is required to take out the same percentage of oil.

The present findings, though essentially preliminary, have shown certain practical possibilities which would deserve to be followed up. With better understanding of the mechanism, it may be possible to speed up the operations and to produce qualities of bran which can compete with oil-seeds in respect of oil content. India, which has now an annual production of about 42 million tonnes of rice, but is faced with shortage of vegetable oils, can produce several hundred thousand tonnes of rice oil without having to increase the area under oil-seeds. Rice ,an with an oil content of about 40% will have a high market value and with the prospect of a larger earning from this source, there will also be a greater incentive for millers to make quicker change-over from hullers to sheller cum polishers and Modern Rice Mills. As the oil content of bran is related to the total content of oil in the paddy, there will also be attraction for evolving new varieties, which, in addition to other desirable properties, also contain even twice as much oil as the varieties which are now being raised.

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There are, at present, about 8000 varieties of paddy and several more are being added every year. Out of these, only a few hundreds are considered to be of commercial importance. Most of the latter have been selected or bred for higher yields, with better response to inputs, resistance to disease and other desirable attributes which would meet the requirements of the producer, the miller and the consumer. The oil content of paddy, which forms only a small percentage of the total weight, is, at present, of no special interest to the agricultural scientist or to the producer as it bears no direct relation to the yield or the market value of the crop. It does, however, bring some extra earning to the miller and, still more so, to the oil industry, which pays a good price for the rice bran if it has a high oil and low acid insoluble ash content.

The oil content of paddy is, however, much more important than it may first appear as a percentage of the total weight. The bulk of it is concentrated in a small fraction which is near the surface and a large part of which has to be removed to produce the polished marketable rice. The potentialities are therefore more than what is generally realized.

Added to that, if the oil can also be made to move towards the surface, the yields can be further increased. In view of the growing world shortage of vegetable oils, there may soon be even a necessity to assign a high priority and to provide adequate incentives for the evolution and increasing production of rice varieties with higher oil content than those we have at the present time. Considering the world's production of rice, the potential yield of oil from this source far exceeds that of several of the oilseeds which have to be specially raised for the purpose.

There have been several publications relating to the oil content of paddy (whole grain) and its different components - particularly, the mill polishings known collectively as bran. Some recent data collected by Iengar and Tajudeen at Tiruvarur, with nearly 100 varieties, showed that the ether extractives (mostly oil), as present in whole paddy, vary from under 2% to about 4.5%. The figures for the commercially important varieties, so far examined, range from 2.5 to 3.8% on moisture - free basis.

Among the different components of paddy, the husk which forms 20 - 24% percent of the total weight contains only 0.2 - 0.4% of ether extractable matter. When brown rice (representing 76 - 80% of the weight of paddy depending on variety) is polished to the extent of 10% or more, the polished rice contains only 0.2 - 0.3% of ether extractives. The remaining part of the ether extractable matter (henceforth described as oil) is therefore mostly concentrated in about 10% of the weight of brown rice. When rice is only partially polished, as is done in many countries, about 40% of the total oil content of rice is removed in the polish, while the rest is left behind on the surface layers of the rice as now marketed. In India, however, the proportion of the oil, that is now removed from a large proportion of the milled rice, may be over 50% owing to reasons which will be explained later.

The present production of rice in India is of the order of 42.5 million tonnes. Assuming an average of 2.5% on the weight of brown rice as the oil removable by polishing, the potentially available quantity of oil may amount to over a million tonnes. The quantity actually removed by under-milling, as is largely adopted, may amount to about 500,000 tonnes. The present annual production of oil is however of the order of only about 20,000 tonnes, mostly as industrial oil, with a free fatty acid content of about 50%.

The reasons for the low production of oil are well known and referred to by several authorities including the ECAFE team of experts who toured India during 1969. The major part of the milling in the country is done by hullers of which there are now over 55,000 licensed units (and almost an equal number of unlicensed ones) in the country. The hullers yield a bran which is considerably diluted by the husk and other foreign matter; so much so that the average oil content of the resulting bran is hardly of the order of 4 - 6%, at which concentration it becomes quite expensive to extract it - all the more so because the deoiled bran with its large amount of husk and other silicious matter does not bring any return. The shellers cum hullers also incorporate a part of the husk for polishing; so, the resulting oil content is of the order of 10 - 12%. Sheller cum polishers (numbering a few thousands) and Modern Rice Mills (numbering about 25) yield polishings with oil content ranging from 15 - 28% depending on the variety of paddy and also on whether it is milled in the raw or parboiled condition.

A significant feature about rice processing in India, is that the major part of the paddy produced in the country is parboiled before it is milled. Soft varieties have to be generally parboiled so as to improve their milling performance; but, even hard varieties are now being increasingly milled after parboiling because of popular preference. It is a common experience that raw rice bran, as obtained by milling brown rice in a polisher, (without any admixture of husk) yields 15 - 20% oil; whereas the parboiled rice bran produced with similar equipment yields 23 - 28% oil. There have been reports of batches of parboiled rice bran yielding 30 - 32% oil. Such divergence in oil yields has been generally regarded as being due to varietal differences rather than to any aspect of the processing. While the economic aspects have been well realized by the purchasers and the users of the bran for oil extraction, there has not so far been any systematic attempt to trace the causes and to organise the regular production of bran with consistently high oil content.

The researches described in the present paper were undertaken with the objects of studying, not only the distribution of oil between the different fractions of the paddy, but also the influence of some of the methods of processing on such distribution. They have shown that, under certain conditions, the oil tends to move towards the top layers of brown rice and that with, even with restricted polishing, as is now practised, it may be possible to get more oil in the bran than has so far been possible.

EXPERIMENTAL.

MATERIALS AND METHODS.

The studies described in the present paper were carried some of the important varieties of paddy which are produced in Thanjavur District, which is one of the most intensive rice producing regions of the country. For laboratory studies, the polishings were done with the McGill polisher, whereas in the mill it was done with the Schule type Emery Cone Polisher. In order to obtain comparative data, only head rice was used for polishing. As the polishings invariably contained varying proportions of finely powdered broken rice, the bran was separated by sieving and winnowing. Except when necessary, the germ was invariably included with the bran and treated as a part of it, as is usually done in milling practice. In order to ensure uniform drying and to avoid cracks, the drying of all experimental samples of paddy was done in the shade at the laboratory temperature (28 - 35°C). Oil was extracted in Soxhlets with food grade hexane and the extractives dried at 100°C to remove the last traces of solvent and moisture. The moisture contents of all the specimens were determined and the yields calculated on moisture-free basis.

It was realized that in an evaluation of the above type, the figures for oil content would be somewhat higher than those obtained for commercial specimens. The latter are evaluated without correction for moisture or the associated powdered rice, husk and other foreign matter. This would be particularly the case with raw rice, especially when soft varieties are milled. At the same time, it was felt that the true figures would not be comparable if the other fractions and foreign matter, which are variable in proportion, are included. Moreover, as the moisture content of bran is variable, it was considered desirable to compare the oil contents only on moisture-free basis.

Oil contents of bran from raw and parboiled rice of the same variety when the polishing is done to the same extent in each case

For these determinations, representative specimens from the same batches of paddy were used. For parboiling, the paddy was first soaked for minimum period of time (4½ hrs) at 65°C and then given open steaming at low (about 3 lbs.) pressure.

Polishing was done till bran corresponding to about 5% of the total weight of brown rice was obtained in each case. The object of the experiment was only to compare the percentages of oil as present in the top portions of the aleurone layer before and after parboiling.

TABLE - I.

Source of bran	Oil percent on moisture free basis Variety		
	IR - 8	GEB-24	CO-33
Raw paddy	26.1	30.2	27.2
Parboiled paddy	32.9	34.0	36.0

The above figures, especially for raw rice, are distinctly higher than those that would be actually obtained from mill samples. The latter generally contain some finely powdered rice, husk and other foreign matter and this would be particularly so in the case of a variety like IR-8 which tends to break considerably during raw milling. In the case of parboiled rice, the kernel is invariably more resistant to breakage and hence the bran will contain less of powdered rice and other foreign matter than in the case of raw rice. Even if we do not take these into account, it may still be seen that the top layers of parboiled brown rice - which are removed during polishing - contain more oil than the corresponding specimens from raw rice. The actual differences will be even greater - of the order of 8 - 10% - in the case of mill samples.

Comparative trials have shown that mere wetting or steaming of bran followed by drying do not produce any difference in the figures for the oil content. As there is yet no evidence of any synthesis of oil by other means, a logical inference would be that the higher oil content of the bran from parboiled rice may be due to the upward movement of some of the oil from the lower strata of the aleurone layer. This was sought to be elucidated by further series of experiments.

Contribution of the germ to the oil contents of raw and parboiled rice bran.

One possible explanation of the above difference would be that the germ, which forms 1.5 - 3.0% of the weight of brown rice / (depending on variety) may break up during parboiling and that the oil present in it may get dispersed to a greater extent in the parboiled rice bran. Careful examination of the germ from different varieties, before and after parboiling, showed that the germ does not get detached or broken up during parboiling. There is however a distinct shrinkage in size of the germ after parboiling. In order to determine the effect of this on the oil, the following trial was carried out.

Though the germ gets detached during milling, it generally suffers considerable amount of damage in the process. This is more so in the case of some varieties than others. In order to avoid this, only one variety (ADT-27) in which the germ is of fair size was selected and the germ from identical weights of raw and parboiled brown rice separated with a scalpel. The proportionate weights of germs and the corresponding oil contents were determined.

T A B L E - II.

Starting material	Percentages	
	Yield of germ	Oil in germ
Raw (brown) rice	3.4	35.7
Parboiled (brown) rice	2.1	45.8

The results show that while the germ gets reduced in weight during parboiling, there is also an increase in its oil content. The increase is not proportional to the change in weight, but it shows nevertheless that most of the original oil is retained by it. As the germ gets fully removed during 5% polishing of brown rice, it may be assumed that its contribution to the oil content of bran is almost the same when raw and parboiled rice are milled to the same extent.

Effect of different degrees of polishing on the oil contents of the bran and the residual kernel from raw and parboiled rice.

Three varieties of paddy were milled to the same extents in the raw and parboiled condition. The oil contents of both the bran and the residual rice kernel were determined in each case and the results recorded correct to the first decimal place.

TABLE - III.

Material	Oil percentage on moisture free basis Variety IR-8		GEB-24		CO-33	
Whole paddy.	2.0		2.8		2.7	
Brown rice (raw or parboiled)	2.4		3.2		3.4	
Bran after polishing to	Raw	Parboiled	Raw	Parboiled	Raw	Parboiled
2%	24.1	32.2	30.2	32.9	26.4	30.6
5%	25.4	34.2	30.2	34.0	27.2	36.0
8%	22.5	30.1	26.9	29.1	27.3	34.0
Residual kernel after removal of bran.						
2%	2.0	1.8	2.3	2.1	3.0	2.9
5%	1.1	0.7	1.5	1.1	1.8	1.7
8%	0.6	0.2	0.7	0.3	1.3	0.9

The results show that, at each level of polishing, the parboiled rice bran contains more oil than the corresponding product from raw rice. This is also reflected in the oil content of the polished rice at each stage. There is some varietal difference in respect of extent of response to parboiling. Thus, though IR-8 contains less of total oil than the other varieties, a higher proportion of it passes into the bran, even at a lower level of polish than in the case of others. About 8% polish is required to remove the major part of the oil in all cases. The percentages of total oil removed from brown rice are given in the following table :-

T A B L E - IV.

DEGREE OF POLISH	Percentage of oil removed by polishing					
	IR-8		GEB-24		CO-33	
	RAW	PARBOILED	RAW	PARBOILED	RAW	PARBOILED
2%	20.1	27.0	19.0	20.8	15.5	18.0
5%	53.0	71.2	47.6	53.6	40.0	50.7
8%	75.0	88.0	67.9	73.4	64.2	80.0

EFFECT OF DIFFERENT STEPS IN PROCESSING ON THE OIL CONTENT OF BRAN EFFECT OF MOIST HEAT ON DRY PADDY.

Steaming of dry paddy prior to cold soaking, is adopted in many parts of India as it helps to reduce the time of soaking and to minimise the smell of the final product. In order to study the effect of this step, the paddy was given open steaming for 30 mins and then dried and milled to obtain 5% yield of bran from brown rice. The effect of steaming dry paddy is not very pronounced as may be seen from the following table.

T A B L E - V.

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TABLE - V.

Source of Bran.	Oil percent on moisture-free basis VARIETY	
	IR - 8	GEB - 24
Raw paddy (Control)	26.1	30.2
Steamed paddy	28.7	30.4

INDIVIDUAL CONTRIBUTIONS OF SOAKING AND STEAMING TO THE OIL CONTENT OF BRAN.

Though both the above operations are necessary for the production of parboiled rice, it was considered necessary to determine the effect of each step on the oil content of the bran. The procedure was the same as in the previous experiments except that one set of samples was dried after hot soaking for minimum period, while the other was dried after steaming. The stage of completion of soaking was determined by the brine test as described in an earlier communication.

TABLE - VI.

Starting material	Oil percent in bran on moisture free-basis (5% polish) VARIETY.		
	IR-8	GEB-24	CO-33
Raw paddy	26.1	30.2	27.0
Soaked paddy	28.7	30.5	32.5
Soaked and steamed paddy	32.9	34.0	36.0

The results show that soaking alone leads to some increase in the oil content of bran. A more pronounced effect is seen only after the same paddy is steamed.

Effect of steaming for varying periods of time.

In this experiment, the time of soaking was kept constant (65°C, 4½ hrs) while the period of steaming was varied. The results with only one variety have been cited to show that prolonged steaming had no pronounced effect on the oil content of bran.

TABLE-VII.

VARIETY	Oil percent in bran on moisture-free basis (5% polish)				
	Time of steaming in minutes.				
	30	60	90	120	240
IR-8	32.9	33.5	33.8	33.8	33.6

Effect of prolonged soaking.

For this series, the time of steaming was maintained constant, while the period of soaking (at 50°C) was changed. The temperature of soaking was maintained at a lower level so as to eliminate the opening of the paddy during soaking.

T A B L E - VIII.

VARIETY	Oil percent in bran on moisture free basis (5% polish)			
	Time of soaking in hrs.			
	16	48	72	96
IR-8	32.9	36.7	38.3	--
Co-25	33.0	38.3	40.5	40.0
GEB-24	34.0	36.5	37.4	38.7
Co-33	34.5	36.4	38.5	39.8

The results have shown that as the result of extension of time of soaking, there is a further increase in the oil content of bran when parboiled brown rice is polished to the extent of 5%. This would represent an increase of at least 10% as compared with raw rice polished to the same extent.

For production of parboiled rice, the paddy is generally given an initial soaking either in cold water or in hot water at a temperature not exceeding about 70°C. Steaming or other method of heating of paddy follows as the next step. Under such conditions it is the time of soaking which seems to have a major influence on the oil content of bran.

When parboiling is done under pressure, the soaking time can be either reduced or even eliminated. The following studies were carried out to determine the effect of pressure parboiling under different conditions on the oil content of bran. The trials were mostly carried out with one variety of paddy; but two other varieties were also tried, with limited number of changes in the conditions.

TABLE -IX.

VARIETY	Material and pre-treatment	Conditions of parboiling	Percentage of polish.	Oil per cent on dry weight basis.
Karuna (Co-33)	Whole paddy ground and extracted	--	--	2.9
"	Raw brown rice ground and extracted	--	--	3.6
"	Husk, powdered	--	--	0.5
"	Raw rice bran	--	5.7	27.7
"	Paddy soaked in cold water for 30 hrs	Parboiled under pressure at 15 lbs per square inch (PSI) for 20 mins.	3.9	38.8
"	Paddy soaked in boiling water for 20 minutes.	Pressure parboiled at 15 PSI for 20 mins.	3.6	33.9
"	Paddy soaked in boiling water for 20 minutes.	Pressure parboiled 15 PSI for 10 mins.	3.7	33.8
"	Paddy soaked in boiling water for 30 minutes	Pressure parboiled at 15 PSI for 20 mins	4.0	37.6

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VARIETY	Matierial and pre-treatment	Conditions of parboiling	Percentage of polish	Oil per-cent on dry weight basis.
Karuna (Co-33)	Paddy soaked in boiling water for 25 minutes.	Pressure par-boiled at 15 PSI for 25 mins.	6.8	35.4
"	Paddy soaked in cold water for 24 hrs	Pressure par-boiled at 15 PSI for 25 minutes.	6.0	34.9
"	Mini silo treat-ment, paddy cold soaked with periodical wett-ing and drainage of excess water for 72 hrs.	Steamed at low pressure (about 3 lbs) for 20 minutes	4.4	35.0
Co-25	Minisilo treat-ment - Same as above for 120 hrs.	Pressure par-boiled at 15 PSI for 20 minutes.	5.5	36.5
"	Soaked in cold water for 120 hrs.	Pressure par-boiled at 15 PSI for 20 mins.	5.5	36.5
IR-8	Paddy soaked in boiling water for 30 minutes.	Pressure par-boiled at 15 PSI for 20 minutes.	5.0	32.4
"	Paddy soaked in boiling water for 45 minutes.	Pressure par-boiled at 15 PSI for 20 minutes.	5.2	28.4
"	No soaking	Pressure par-boiled direc-tly with sufficient water 15 PSI for 30 minutes.	4.5	30.3

The results show that, under certain conditions, soaking in boiling water for short periods, followed by pressure parboiling, would yield results approaching those obtained by prolonged soaking at lower temperatures followed by steaming. Prolonged cold soaking, combined with pressure parboiling, has yielded consistently good results. Prolonged soaking in boiling water or pressure parboiling without any soaking have not given encouraging results; but further studies are required to elucidate this aspect.

Effect of sudden cooling or evacuation of paddy after parboiling on the oil content of bran.

Ordinarily, parboiled paddy remains in a condition for some time before it is dried. As the present trend of evidence would point to some movement of oil towards the surface, it was considered possible that such movement may be influenced by conditions like sudden cooling or quick evacuation which may result in cooling. The results of some preliminary studies are given in the following table.

TABLE - X.

VARIETY	Method of soaking	Conditions of parboiling	Treatment after parboiling.	Percentage of polish	Oil percent on dry weight basis.
IR-8	Soaked in boiling water for 30 mins.	Pressure parboiled at 15 PSI for 20 minutes.	Quickly cooled in running cold water before drying.	4.8	33.0
"	Do	Do	Quickly cooled by immersion in ice cold water and temp brought down to 10°C	5.0	30.6
"	Do	Do	Partially evacuated 15 inches and then cooled to room temp.	5.2	33.3

As compared with some of the earlier results, there is no appreciable increase in the oil content of bran as the result of the above treatments. Some of the treatments have given lower results than those obtained without any cooling or evacuation. Further study of these aspects will be of interest.

Effect of polishing with deoiled bran to remove the unextracted oil from under-polished rice.

In countries like India, rice is generally under-polished so as to conserve as much of the foodgrain as possible. It has been observed that, when parboiled rice prepared under some of the conditions described in the present study, is left under-polished (3 - 4% on the weight of brown rice), there is not only a high percentage of oil in the top layers of the grain, but there is also some oil at the surface of the rice itself. Such a condition will have an adverse effect, not only on the appearance and small, but also the keeping quality of such rice. While further polishing and pearling would be one method of ~~such-rice.~~ ~~While~~ dealing such a condition, it was also considered possible that the extra oil could be adsorbed on deoiled bran without sacrificing any large quantity of the kernel material. This was expected to yield an acceptable polished rice and at the same time to enrich the deoiled bran so as to facilitate its use for extraction of oil. The experiments were done with Kilogram lots of the same batch of Karuna (Co-33) paddy which was first soaked in boiling water for 30 minutes and then pressure parboiled at 15 PSI for 20 minutes. After an initial polish, deoiled bran (100 g) as obtained after solvent extraction was added to each lot of polished rice and the polishing further continued. The degree of polishing at each stage, as also the percentage of oil extracted at each stage are given after correction for the residual oil present in deoiled bran.

PARTICULARS	Experiment No. I	II	III
Percentage of first polish as on wt. of brown rice.	3.7	4.0	4.6
Oil percent in first polish.	35.0	36.2	35.4
Percentage of oil in second polish after addition of deoiled bran.	8.5	6.3	7.8
Yield of polished rice as percentage of wt. of paddy.	68.5	68.5	68.0
Percentage of total oil in brown rice as removed with the two polishings.	76.8	68.8	80.9

Extended studies leading to possible further improvement in yield of oil without sacrificing the yield of polished rice are in progress.

DISCUSSION.

The results of the present investigation, though essentially preliminary, have brought out sufficient evidence to show that the processing methods associated with the parboiling of paddy are chiefly responsible for the higher oil content of bran from parboiled rice, as compared with the bran from a similar batch of paddy as milled in the raw state. The true difference between the oil contents of the two types of bran, when polished to the extent of about 5%, may be of the order of 5 - 7%; but, in actual practice, it would be more because there is generally more breakage and powdering of raw rice than of parboiled rice. Some of the powdered rice passes along with the bran, with the result that the result that the raw rice bran gets more diluted with non-oil fractions than parboiled rice. The actual difference in the oil contents of mill samples (as obtained from modern rice mills or sheller-cum-polishers) may be of the order of 10%, if not more. Such a difference will naturally make the parboiled rice bran more valuable as a source of oil than raw rice bran from the same source of paddy.

The oil in the rice kernel is mostly concentrated in the aleurone layer which forms 8 - 10% of the weight of brown rice. The husk and the polished kernel which represent about 90% of the total weight of paddy contain less than 0.5% oil. During polishing, the aleurone layer is removed to varying extents depending on the degree of polishing. In the case of raw rice, which represents the natural condition, the oil is present at nearly the concentration at each level; so much so that the proportion of the total oil removed as bran is roughly proportional to the degree of polishing. The concentration of oil is linked in some way with the total oil content, though it is not strictly proportional to it. In the case of parboiled rice, however, the concentration of oil is generally at a maximum in the portion of the bran representing between 2 and 5% polish; but with some varieties the same concentration is maintained almost upto 8%. Such concentrations are always higher than those obtained with raw rice bran when polished to the same extent. These results are reflected, though not quantitatively, in the corresponding oil contents of polished rice.

The higher oil content of parboiled rice bran is not due to the disintegration of the germ. The latter only shrinks in size but does not lose any appreciable quantity of oil when the paddy is parboiled. As the germ is fully removed with the bran when the brown rice is polished to the extent of 5%, its contribution to the oil content of bran may be regarded as being about the same in the case of both raw and parboiled rice bran.

The available evidence would show that, as the result of parboiling, there is some movement of oil from the lower to the higher strata of the aleurone layer ie towards the surface of the rice kernel. As the surface layers are first removed during polishing, the higher concentration of oil as observed in the case of parboiled rice bran as compared with raw rice bran when both are milled to the same extent. The movement of oil is assisted in some manner by extending the time of soaking. In this manner it has been possible to raise the oil content of parboiled rice bran to about 40% which is nearly double the oil content of raw rice bran. Prolonging the time of soaking, however useful, may present some practical problems; but if we can get a clearer picture of the actual changes that take place during extended soaking, we may then be a in a better position to both improve upon and to simplify the operations.

The other operations associated with parboiling do not, by themselves, seem to have any pronounced effect on the oil content of bran. Pressure parboiling simplifies the operations and the results make a near approach to those obtained by extended soaking followed by steaming. Even in that case paddy which has had longer soaking in water gives a more consistent result and generally a higher figure than paddy which has been given only a short period of treatment with boiling water.

More scientific information is required about the manner in which the oil is present in raw rice and the changes which X bring the oil into a more mobile condition as the result of parboiling. At the same time, there should be outer barrier because the oil does not normally come out of brown rice. This barrier, which may be the outer membrane may also be retarding the free movement of oil towards the surface of the brown rice.

It may even create a back pressure under certain conditions.

In the interests of grain economy, it would be desirab[le] to get the maximum amount of oil in 5% polish from brown rice. In the case of some varieties, however, it may be more paying t[o] polish to the extent of even 8%. In countries like India, it may be possible to adjust the polishing in such a manner asto make it more paying than under milling. In addition to the return from the bran or the resulting oil, the better polished rice will always fetch a higher price on the open market than the undermilled product. At the same time, it may be equally satisfactory and in some ways even more profitable to adsorb some of the oil on deoiled bran without losing any appreciable part of the rice kernel.

There is need for more intensive study of the relation of the oil content of the bran to the total oil content of the paddy. It may be possible to get a variety of paddy which may yield 30% or more of oil even in the raw state. In that case, even the usual method of parboiling may yield a bran with 40-45% oil. Such a bran will deserve to be classed with some of the oilseeds in respect of its importance and price structure. The variety of paddy yielding such a bran - if it also combines other desirable properties - will deserve a higher price than the commoner varieties containing less oil. It may not be difficult to select or to evolve a variety of paddy with 5 - 6% or more of oil. When the economic benefits come to be better realized, there will be incentives for not only introducing such varieties, but also making it worth while for the farmers to produce them.

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Shri S. Sundaram with best wishes [illegible]

An epitaph to a life of blundering, numerous failures and a few occasional successes, which will soon be forgotten. 2/12/75

ASPIRATIONS, ACHIEVEMENTS AND HOPES FOR THE FUTURE

The welcome news about the celebration of the Silver Jubilee of the CFTRI rouses a variety of memories and mingled ~~xxxx~~ emotions in a person who had to go through the processes of planning, starting and directing the work of the institution for over fifteen years. During this period, the CFTRI, starting with a staff of three, grew to be the biggest and one of the most important, multi-disciplined institutions for the study of food science [and] technology in the whole World, with a staff of over eleven hundred. This achievement was possible through the good will [and] active support of several national leaders, starting with the then Prime Minister, Shri Jawaharlal Nehru; the succession of Director-Generals, starting with Dr. Bhatnagar, and also other senior executives of the CSIR; the Chief Ministers of Mysore, starting with Shri K.C. Reddy, and other authorities of the State; and more than any thing else, the dedication and concentrated ~~eff~~ efforts of the staff of all categories who identified themselves with the interests of the institution.

The Shunmugam Chetty Committee had assigned the highest priority for the setting up of a national laboratory devoted to food technology. It is, however, still a mystery why Dr. Bhatnagar, with his rare acumen, did not think it necessary to appoint a Planning Committee. The entire responsibility of planning, selecting the location and the starting of the Institute was left to a person, whose main qualification was that he was a biochemist with interest in agriculture and in food processing. Whatever subsequently happened was symbolic of the keen interest and generosity of all concerned - with the completion and acceptance of the plan in two months; the welcome gesture of the State in offering the beautiful Cheluvamba Palace and its extensive grounds for the location of the Institute; the formal acceptance and take over by the Prime Minister; and the starting of scientific work, early in 1949 - all within about seven months after commencement of the Planning. These were possible because there was a strong background of good will and confidence; and red tape that was sufficiently loosened to suit the needs.

The partition of India brought many sorrows; but, in an unique way, it was also a source of good fortune to the CFTRI because it led to the merger of the Indian Institute of Fruit Technology whose experienced staff provided an excellent nucleus for the new Institute. Before long, talented scientists, technologists and engineers, from both within the country and abroad, joined the ranks of the Institute. A happy feature of those days was that every discipline had all the space, freedom, funds and

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facilities it then required. In a very short time, ~~w~~ extra resources and assistance came from various external sources. At the time of formal inauguration by Rajaji on October ~~21st~~ 20, 1950, the Institute was already working in full swing, with healthy competition among the different disciplines for quick achievement for the benefit of the people.

Looking back on the contributions of the Institute, it was not so much the mass of work as the creation of new lines of thinking and approach which brought it World-wide recognition. Many of the latter, ~~then~~ first appeared to be unorthodox and even led to a great deal of controversy, chiefly from within the country. It did not take long however for the clouds to disappear; so much so, that many of the subsequent programmes, and even several of the current ones started in India and elsewhere came to be based on the work done at the CFTRI. As an example, one may cite the field of protein-rich foods in which every important step in advance, right upto the stage of the production and utilisation of the isolates came from the CFTRI. After one of his visits to India, Dr.Autret, the Director of the Nutrition Division of the FAO, made the generous observation that the CFTRI was doing more useful work and also making greater application of the practical findings than any other single institution in the World.

It is rather characteristic of the conditions which then prevailed - and which, still continue to be there - that any concept or work which does not follow the patterns set in other parts of the world is viewed with scepticism and often dubbed as being wrong or crazy. While new ideas have been welcomed and given every opportunity for pursuit in other parts of the World, there have always been sustained attempts, particularly from these in positions of power to discourage them. It requires a large amount of confidence and persistent struggle to hold on to one's efforts. One should at the same time be cynical enough to realize that when there is ultimate success, the earlier struggles are either forgotten or that others step into claim the credit. This feature is not however unique to India.

The concept of bold, creative thinking has often been received with derision. There are some who have even openly said that whatever is to be achieved can come from the available lieterature and that no research is needed. We all have high respect for what has been done by colleagues in other parts of the World. At the same time, it is virtually axiomatic that any fresh advance, which will earn World respect, can come only from within, through persistent endeavour to find what others may have seen but not thought of.

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In every branch of study, there is vast scope for the development of a simplified line of technology which will not involve the use of heavy or expensive machinery and instrumentation; which will make the maximum use of human labour and skill; and which will produce the desired results, while at the same time distributing the benefits to a large section of the people. Such advances are, by no means, of a routine type. They require a great deal of original thinking, planning organisation and sustained effort for improvement. We have to think in similar terms in respect of food preservation and processing which are vital to our needs. We have to select promising lines and concentrate on team effort to carry the findings to the stage of application with demonstrable benefits. Such contributions will be of lasting benefit not only to India, but also to many other parts of the World.

While practical applications require team effort under common leadership, original thinking always comes from individuals. Irrespective of the status, it should be the aspiration of every worker to open up a field which others have not though of. It is only such work that brings recognition to the individual and to the institution. Even one or two well proven ideas in the course of two or three years will help to sustain the reputation of an institution. It will be the responsibility of those in positions of power to welcome new ideas and to encourage their active pursuit.

The CFTRI has, today, wonderful facilities for high class thinking and work. There is also vast scope for exchanging ideas with colleagues in allied disciplines and carrying the findings to the stage of practical application. If an elder scientist can take the liberty of offering any advice to the younger generation, it will be that one should keep on thinking about one's work - both within and outside the laboratory - with constant effort to look beyond the beaten track. There are certain to be several mistakes and many initial failures. If, however, one is on the right track, success is ultimately bound to follow. Human memory is short, but a good effort will survive and be of lasting benefit.

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