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A NOTE ON THE LOSS OF EMBRYO ON MILLING RAW AND PARBOILED RICES

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t has been generally supposed that parboiled rice has a greater nutritive value than raw rice and that even on polishing its antineuritic value s not lost considerably as with raw rice (McCarrison and Norris, 1924). ndeed, evidence has been presented to show that during parboiling, the endosperm absorbs vitamin B_1 at the expense of the germ and pericarp and hat therefore milling does not result in the removal of the vitamin to the same extent as with untreated rice (Douglas, 1930; Aykroyd, 1932; Ghosh and Dutt, 1933 (Acton, Ghosh and Dutt, 1933; Codd and Peterkin, 1933). More recently, it has also been shown that parboiling results in a movement n part of the protein and mineral constituents originally present in the aleurone layers of the raw rice, into the interior towards the endosperm Sreenivasan and Das Gupta, 1936). The extent to which parboiling preserves the essential nutritive constituents of rice on polishing depends however on the variety of rice and in particular on the thickness of its bran layer and he extent of parboiling (Subrahmanyan, Sreenivasan and Das Gupta, 1938). n commercial practice, only the coarser, the long-grained and the coloured varieties (which are generally classed as inferior) are used for parboiling. These have invariably thick bran layers (Ramiah, 1936) and contain more proteins and minerals than the white and smallgrained varieties (Sadasivan and Sreenivasan, unpublished data). Besides, since parboiling yields a coloured product even after some polishing and is largely consumed by the poorer classes, it is not generally polished to the same extent as raw rice. These two causes, together with the fact that parboiling toughens the grain and hence makes the removal of the pericarp more difficult, are primarily responsible for the richness of commercial samples of parboiled rice in regard to both proteins and minerals as compared with the samples of raw rice available on the market (Sreenivasan, 1938).

In contrast to the foregoing circumstances which render parboiled rice nutritively superior to raw rice, it has been suggested (Iliffe, 1928—29) that in the milling process parboiled rice loses its germ or embryo more easily than raw rice and that in consequence it becomes very much devoid of its nutritive value. This question of the relation of parboiling to the embryo content of rice grains appeared to merit further study and the present enquiry was therefore undertaken.

Experimental. A number of bazaar specimens of both raw and parboiled rices (some of them, well known varieties) were obtained. Practically all the samples were found to have been fairly well-washed, so that there

was none in which even a single grain had retained the embryo intact. From out of each sample, a number of whole grains were picked in lots of hundred and these were then separated into those containing a part at least of the germ intact and those from which the germ was entirely removed. Counts of these were taken and in Table I are given, with the name and nature of rice, the percentages of grains retaining at least a part of the embryo in grain.

TABLE I.

Examination of commercial rices for loss of germ on milling.

Raw Rice Specimens.		Parboiled Rice Specimens.	
Description of Rice	Number of grains per 100 with germ	Description of rice	Number of grains per 100 with germ
Kadur rice—red undermilled	58	Delhi Bhog—highly milled	16
Coimbatore Sanna—milled	36	Seetha Sala—highly milled	nil
Raj Bhog—milled	32	Bazar specimen—undermilled	35
Rama Sagara—highly milled	10	Big rice—under milled	42
Kempa Sanna—highly milled	10	Bazar specimen—milled	8
Bazar rice--hand pounded	51	Bazar red rice—milled	18
Delhi Bhog—highly milled	nil	Rangoon rice—milled	nil
Molagurukulu—highly milled	14	Bazar red rice—highly milled	16
Rangoon rice—highly milled	5	Nellore rice—milled	7
Jeeraga Sanna—milled	24	Guntur rice—milled	5

It may be seen from the above that there is not sufficient evidence to conclude that parboiled polished rice loses more of the embryo than raw rice. Under the ordinary conditions of polishing in mills, almost all the germ is completely removed together with the bran coats. This is particularly so with the specimens examined previously (Iliffe, *loc. cit.*). It is therefore difficult to know from bazar samples alone the extent to which they have been milled in the different cases or the relative ease with which the germ in raw and parboiled rices is removed in the milling process. A better idea could however be obtained by comparing the same variety of rice, both raw and parboiled, and under comparable conditions of milling. Accordingly, specimens of raw and parboiled rice from the same variety (Adt. 11) were milled to the same extent in the hand polishing machine described elsewhere (Subrahmanyan *et al.*, *loc. cit.*). 100 g. lots of both the raw and parboiled rices were milled in the machine until 3, 5, 7, 10 and 15 per cents. respectively of the original weight of the rice were removed as polishings. The polishings in each case were passed through a 40 mesh sieve and from the coarse fractions, the germs were carefully separated by hand and then weighed. From the rice polished to different extents as above, a number of 100 g. lots were taken at random and these were sorted into those with germ (whole or in part) and those with no germ. In Table II are given the results.

TABLE II.

Extent of loss of germ on milling to different equal extents.

Per cent. polished	Raw Rice			Parboiled		
	Germ removed per cent. g.	Per cent. grains with germ by number.	Per cent. grains with germ by wt. g.	Germ removed per cent. g.	Per cent. grains with germ by number.	Per cent. grains with germ by wt. g.
3	0·5	44	46	0·5	48	48
5	0·8	25	23	0·8	29	22
7	1·1	15	15	1·0	16	15
10	1·2	5	4	1·2	3	4
15	1·2	nil	nil	1·3	nil	nil

It was observed that with parboiled rice, the germ was always removed from the bran layers in parts, whereas in raw rice, it was generally knocked off in entirety. The percentage weight of germ removed was about the same in both the cases with the same degree of milling. The number of grains retaining the germ at least in parts were somewhat higher in parboiled specimens. But when the weight of these over hundred original grains was determined, they were nearly the same in both the cases. Thus, whereas in raw rice the germ is usually lost in whole or not lost at all, in parboiled rice, it is invariably lost only in part. In other words, in raw rice fewer grains lose the germ but do so entirely, whereas in parboiled rice, a larger number of grains lose, but only in part.

It is probable that the greater breakages during milling of the embryo of parboiled rice grains is due to the changes in fat content as a result of parboiling. In the raw rice, the germ is very rich in oil and contains nearly one-fifth to one-sixth of the total rice oil. As a result of parboiling, the fat content of rice is reduced to a certain extent (cf. Table III, also Sreenivasan and Das Gupta, *loc. cit.*). Besides there is a considerable movement of the fat constituents from the germ into the bran

TABLE III.

Distribution of rice oil in the grain.

Variety.	PART OF GRAIN						Total extractive per cent. of grain.
	Germ.		Bran.		Endosperm.		
	Wt. per 100 g.	Ether extractives in g.	Wt. per 100 g	Ether extractives in g.	Wt. per 100 g.	Ether extractives in g.	
Adt 11, Raw	1·2	0·38	9·3	1·52	89·5	0·36	2·26
,, Parboiled	1·3	0·31	9·2	1·60	89·5	0·32	2·23
Adt 7, Raw	1·3	0·42	14·5	1·07	84·2	0·48	1·97
,, Parboiled	1·2	0·34	14·2	1·09	84·6	0·46	1·89
Co 9, Raw	1·4	0·46	11·8	1·37	86·8	0·42	2·25
,, Parboiled	1·3	0·38	11·5	1·41	87·2	0·41	2·20
Adt 3, Raw	1·5	0·64	13·6	1·26	84·9	0·70	2·60
,, Parboiled	1·4	0·54	13·3	1·20	85·3	0·68	2·42

layers. This renders the former more brittle and consequently more liable to breakage during milling than the germ of raw rice which is comparatively soft and pliable on account of its higher fat content.

Summary. 1. During milling, parboiled rice does not lose the embryo to any greater extent than raw rice. In raw rices, the germ is usually removed as a whole; in parboiled rice, it is removed only in fractions

2. The breakages of the embryo during milling of parboiled rice is due to its lower content of ether-extractives compared to the embryo of raw rice.

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A NOTE ON THE CRACK FILLING EXPERIMENT, AGRICULTURAL RESEARCH STATION, NANDYAL

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In recent years great prominence has been given by research workers to the role of soil Physics in the production of crops. The relation between physical properties of soil and cropping power is now known to be of paramount importance.

In the taluks of Nandikottur, Nandyal, Koilkuntla and Siruvel in Kurnool district a number of different types of clay soil are to be found. In appearance some of these resemble typical heavy black soil land in Bellary district. The figures of mechanical and chemical analyses of typical dryland on the stations at Hagari and Nandyal which are shown below indicate their common properties.