BIOCHEMICAL AND NUTRITIONAL INVESTIGATIONS ON RICE AND RICE PRODUCTS OF EAST PAKISTAN

Part V.—Differential Spectrophotometric Investigation on the Iodine Complex Formed with the different Varieties of Raw and Parboiled Rice Starches

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The spectrophotometric study of the starch-iodine complex of seventeen varieties of raw and parboiled starch has been carried out within the range of wave length from 400 m.μ. to 650 m.μ. In case of raw-rice starch the λmax was noted in the range of 570 to 610 m.μ. Due to parboiling treatment in eleven varieties of paddy, depression of λmax by 10-30 mμ. accompanied by increase of percent transmission was noted and this was ascribed to partial conversion of amylose to amylopectin by attachment of some branches. In other six varieties a decrease of percent transmission without any shift of λmax was noted and this was ascribed to partial debranching of some amylopectin fraction. The probable enzymes involved in the process have been discussed.

Introduction

In the previous communication from this Laboratory by Qudrat-i-Khuda, De, Haque and Rahman,[1] on the study of the changes of physical and chemical characteristics of starches in rice due to parboiling treatment it was shown that there is great difference in the colour tint of the starch-iodine complex, the extent and nature of which depend on the variety of rice. It was also hypothesised there that this change in the colour-tint due to parboiling might be related with the shift of the amylose-amylopectin ratios in the starch constituents.

The amylose and amylopectin contents of some varieties of rice [2,3] have been found to be 15-20 percent. Whistler and Smart, [4] in generalising the distribution of amylose and amylopectin in all starches except in the glutinuousa ones [5] have shown the ratio in the proportion of one part by weight of amylose to four parts by weight of amylopectin. This is a broad generalisation for all starches but it is not unusual that starches of the different varieties of plant products belonging to the same family may have different ratios of amylose and amylopectin as has been reported by De, Yasin and Rahman [6] in their studies on the biogenesies of starches in the two varieties of potatoes—Red-skin and White-skin. It is, therefore, not improbable that the different varieties of rice available in this region might have varying proportions of amylose and amylopectin.

There is information in the literature about the action of acid, alkali and of autoclaving [7–13] on the change of amylose, but there is hardly any information about the changes which the starches may undergo during parboiling treatment of whole grain like paddy where the starch granules are locked up in the cell structure along with different enzyme systems closely related with the synthesis and degradation of starch. It will, therefore, be worthwhile to study the ratios of amylose and amylopectin in different varieties of rice and the shift in these ratios due to parboiling treatment of paddy as practised in this region.

Experimental

The distribution of amylose and amylopectin contents of starch, their molecular size and unit chain length and other physical characteristics are evaluated by potentiometric titration of bound iodine,[7,8,14] and the spectrophotometric study of the iodine colour complex. [15,16] Both the classical methods have been applied in the series of the investigations on the above aspects. The present paper only presents the results of the spectrophotometric study of the iodine complex of the starches extracted from different varieties of raw and parboiled rice. Seventeen varieties of paddy were collected from the Government Agricultural Farm, Dacca. From each of these varieties, raw and parboiled rice were prepared according to the usual technique described in the previous papers by Qudrat-i-Khuda, De and Rahman[1] and Qudrat-i-Khuda, De and Debnath.[17]

The starches from the raw and parboiled rice were then extracted by crushing and repeated washing with water and finally separated by centrifugation. For spectrophotometric study, the starch samples were washed thrice with absolute alcohol so as to remove other contaminants.

In the present study, the starch concentration of 0.01% was used throughout the course of the

investigation and working iodine solution of 0.1% concentration with iodine and potassium iodide in the proportion 1:1.5 were used for colour development. Unicam spectrophotometer S.P. 500 was used in the present investigation and the establishment of the calibration curve with this instrument was again made by use of the sweet Potato, Tapioca and Shati starches in the concentration varying from 0.01% to 0.04% by adopting the techniques as reported by McCready and Hassid,[18] Kerr [19] and Radley [20] and described by Qudrat-i-Khuda, De, Haque and Rahman.[21]

Results

The results of the wave length peak at maximum absorption (λ max) and the percent transmission values at that wave length peak of the iodine complexes of starches extracted from raw and parboiled rice are shown in Table 1a and 1b.

TABLE 1 a.—INDICATES THE RESULTS OF ELEVEN VARIETIES OF RICE STARCH WHICH SHOW DE-CREASE OF λMAX WITH SIMULTANEOUS INCREASE OF PERCENT TRANSMISSION DUE TO PARBOILING.

Name of the variety of rice	λmax (mμ)		Percent transmission	
	Raw rice	Parboiled rice	Raw rice	Parboiled rice
Balam	620	590	49.8	76.2
Birohi	580	560	74.1	88.0
Boaljhury ..	600	590	57.5	63.7
Dharial	600	580	62.8	77.0
Dholasaithya ..	610	590	32.7	45.6
Dudsar ..	620	600	57.8	78.0
Kataktara ..	590	580	53.0	63.9
Kataribhog ..	590	580	58.4	65.2
Nagra	600	570	37.8	50.3
Panbira	610	600	44.8	59.0
Patnai	610	590	59.6	66.0

SPECTROPHOTOMETRIC DATA OF THE IODINE COMPLEX WITH STARCHES EXTRACTED FROM THE RAW AND PARBOILED RICE

TABLE 1 b.—INDICATES THE RESULTS OF SIX VARIETIES OF RICE STARCH WHICH SHOW INCREASE OF THE PERCENT TRANSMISSION WITHOUT ANY CHANGE OF λmax DUE TO PARBOILING.

Badshabhog ..	600	600	51.0	43.9
Dular	600	600	47.4	40.2
Hashikalmi ..	610	610	53.2	44.7
Kumari	600	600	46.8	40.1
Latisail	600	600	56.4	48.3
Nigarsail ..	610	610	47.5	41.2

Table 1 a indicates the result of ten varieties of rice starch, the wave length peak of which shifted due to parboiling treatment and Table 1 b presents the results of the rest of the six varieties of rice starch the wave length of which at maximum absorption peak remained unchanged due to same treatment.

When the λ max values of all the raw rice starches of Table 1a and 1b are considered it is noted that these range within the limit of 570 to 610 m μ. Baldwin *et al.* [15,16] in their classical work on the absorption spectra of iodine complex of amylose and amylopectin extracted from different starches have noted the λmax for amylose in the range of 620-680 mμ and those of amylopectin in the range of 520-580mμ. Since the λmax value recorded in the present investigation lies between the above two ranges, it appears that starches of the raw rice consist of the mixtures of amylose and amylopectin of different unit chain-lengths in varying proportions.The possibility of the presence of small amount of transient substances whose structures and properties are intermediates between the above two cannot be overruled as viewed by Radley[20] in his review on the characteristics of different starch constituents.

While discussing the effect of parboiling of eleven varieties of rice as shown in Table 1a, it will be apparent that there is depression of the λmax by about 10 to 30 mμ due to parboiling and this is also accompanied by the increase of the percent transmission. This is well represented by Fig. 1 for Balam Rice. This phenomena may be

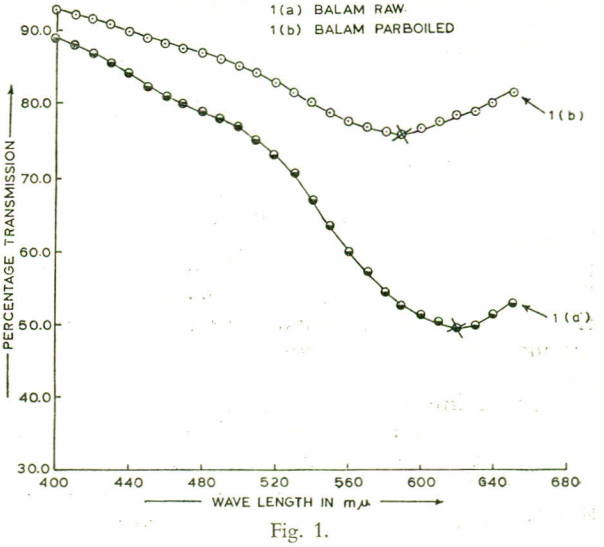

Fig. 1.

explained as perhaps due to the decrease of amylose with simultaneous increase of the amylopectin contents due to parboiling on the basis of the classical work of Baldwin *et al.* (*loc. cit.*) who noted higher range of λ_{max} with less percent transmission for amylose as compared to those of amylopectin. Direct estimation of amylose by potentiometric titration of the bound iodine lends support to this possibility.[22] This conversion of amylose to amylopectin by parboiling treatment may appear to be very much striking, but its mechanism may be forelighted by discussion of the enzymatic synthesis of different fractions of starch.

It is an accepted fact that various organic constituents in any organism are associated with the enzymes which synthesise or degrade these and on the basis of this phenomena it may be conceived that rice grains contain the enzymes like Q-enzymes,[23–25] R-enzyme [26] and other enzymes in addition to α-amylase and phosphorylase which are involved in the synthesis and breakdown of amylose and amylopectin. This possibility is substantiated form the views of Peat *et al.*[27] about the universal presence of Q-enzyme in all starch-forming organisms alike to that in potato, pea etc.

With the above background of knowledge gathered so far it may be hypothesised that the above ten varieties of rice as in Table 1a perhaps contain sufficient quantities of Q-enzyme which became activated at the initial stage of parboiling process when the temperature rises to the optimum level for enzyme activity with the net result of the gradual conversion of amylose to amylopectin with attachment of some branches. This possibility of the conversion of amylose to amylopectin by Q-enzyme is fully substantiated by the observation of Barker *et al.*[28] and Rees [29] that Q-enzyme extract of *Polytomella coeca* and Potato on incubation with pure amylose may synthesise amylopectin.

Quite a different picture is noted in case of six varieties of rice as per Table 1 b which shows a decrease in the percent transmission without any shift of the λ_{max} unlike the other eleven varieties. Fig. 2 represents such characteristic of Latisail Rice. This peculiar phenomena may however, be explained on the basis of the action of R-enzyme, [26] which might be present predominantly in these varieties, the function of which is mainly directed towards debranching of the amylopectin by hydrolysis of the α-1:6 glucosidic linkage. This debranching by R-enzyme is accompanied by rise of Blue Value (B.V) *i.e.*, decrease of precent transmission without any synthesis of the long-chain fraction *i.e.*, amylose. Perhaps in the same manner as mentioned above the R-enzyme already present in the grains of the six varieties of rice became activated at the early stage of parboiling and cause debranching of some of the amylopectin for which the decrease of percent transmission without alternation of λ_{max} occurs.

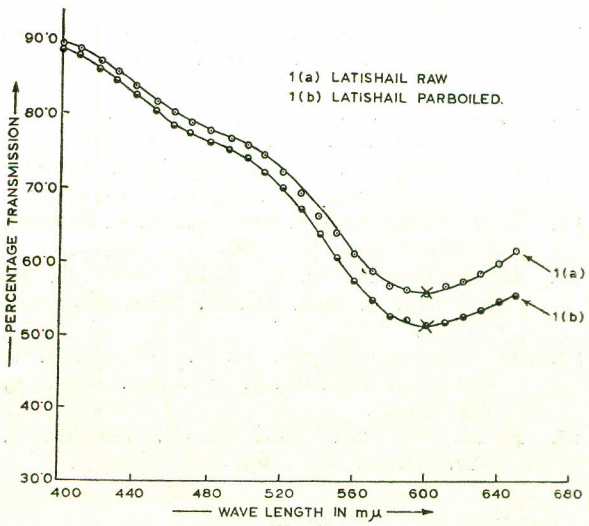

Fig. 2.

Further work on the effect of parboiling on the changes in starch and nitrogen constituents are in progress and the results will be communicated in due course.

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