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

Part II.—Differential Autoamylolytic Activity of Parboiled and Unboiled Rice* for Evaluation of their Storage and Cooking Character

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Several varieties of homepound unboiled and parboiled rice samples, referred to in Part I of this series of paper were examined in respect of their autoamylolytic activity. In every variety the parboiled sample showed less reducing sugar content in the original grain before incubation and also after incubation for 5 hours. The milled samples collected from the market also showed similar low values for parboiled milled rice as compared to unboiled milled samples. The milled products both unboiled and parboiled showed lower values as compared to homepound products. The significance of these data in explaining the longer storage life and better cooking properties of parboiled rice and sweeter taste of homepound products vis-a-vis the milled products has been discussed in the light of difference in the autoamylolytic activities in their grains.

Introduction

In the previous paper[1] the results of photomicrographic (both coloured, and black and white) investigations on the changes of the starch constituents of rice as effected by parboiling treatment were reported. The changes were discussed along with those that occurred in the size of the grains due to such treatment. The present paper records the results of the differential amylolytic activity in unboiled and parboiled rice.

The observations in the different laboratories compiled by F.A.O. and by others,[2] that milled parboiled rice is less easily attacked by insects etc. than milled unboiled rice, and has better keeping qualities, suggest that though the parboiled rice is richer in vitamin B_1 content and other nutrients, than the unboiled samples as was observed by Aykroyd et al.,[3] yet they probably lack in some other nutrients which are required for growth and multiplication of insects and moulds. The observation of Williams and Bevenue[4] that free reducing sugar is present in the raw rice to the extent of 0.05 to 0.19% and of another group of workers, Houston et al.,[5] that during storage of rough rice at different moisture and temperature conditions, the growth of mould is partly related to the production of reducing sugar at a critical moisture content and storage temperature, suggests the possibility of the involvement of reducing sugar as one of the causative factors for infection by moulds, pests, insects and other micro-organisms. Since the production of reducing sugar may be conceived as due to autoamylolytic degradation of starch of the grains, it is expected that the study of this autoamylolytic activity in parboiled and unboiled rice from different varieties of paddy will throw new light to explore the factors for longer storage life of parboiled rice; and with this point in view the present work was undertaken. The autoamylolytic activity of milled samples of some unboiled and parboiled rice was also investigated to study the effect of milling on the above aspect of rice storage. The present investigation will also help to judge the differential cooking behaviour of the unboiled and parboiled rice under milled and homepound conditions.

The work so far done in this line mainly dealt with the study on unboiled rice. Sreenivasan[6,7] in explaining the improved cooking quality of old unboiled rice has attributed this to lowering of the amylase activity due to storage. Deshchikar and Subhramanyan[8] in their study of the culinary properties of milled unboiled rice have observed the destruction of the amylase content during first 5 minutes of cooking. In all the above observations the amylase activity was measured by using external substrate, the starch and hence their results do not actually indicate the autoamylolytic activity in the rice grain. In the present observations this aspect has been studied more precisely by allowing the amylase of the grains to act on their own substrate, the starch, which is present in larger quantities in the grains of both unboiled and parboiled rice. Similar technique was also adopted in the determination of autodehydrogenase activity in fish tissue by Qudrat-i-Khuda, De and Khan.[9]

* 'Unboiled' rice, as discussed in this paper, refers to the 'raw' rice prepared by dehusking the paddy which has not been parboiled.

Experimental

The following two series of experiments were arranged for the present investigation.

1. In the first series of experiments, sixteen strains of improved varieties of paddy (*Oryza sativa*, var *indica*) as mentioned in Part I were employed. One part of sample from each variety was parboiled as described in the previous communication and another part was kept as raw unboiled. Both these samples after drying in the open sun were dehusked by homepound process, retaining the pericarp portion.

2. In the second series of experiment, investigation was carried out on milled samples of both unboiled and parboiled rice collected from the market, in order to study how far the milling process affects this autoamylolytic activity.

For the study of the autoamylolytic activity of these rice grains, 5 g. replicate samples of unboiled and parboiled rice, including the milled products, were homogenised in a conical flask with 23 ml. of water and 2 ml. of phosphate buffer of pH 7.2. The flasks were then incubated at 37°C. for 5 hrs. at the end of which the amylase activity was stopped by addition of trichloroacetic acid. The contents after centrifugation were analysed for reducing sugar contents by Lane and Eynon method.[10] The initial reducing sugar value of the samples was determined from similar batches of 5 g. each, before incubation. Since it was noted that in every variety the parboiled sample showed lower reducing sugar content, both before

TABLE 1.—REDUCING SUGAR VALUE OF HOMEPOUND UNBOILED RAW AND PARBOILED RICE BEFORE AND AFTER AUTOAMYLOLYTIC DIGESTION FOR 5 HRS. AT 37°C.

Name of improved strains of rice variety (*Oryzae sativa* var *Indica*)	Reducing sugar before incubation				Reducing rice after incubation				Increase in reducing sugar due to incubation			
	unboiled rice (g. p.c.)	Parboiled rice (g. p.c.)	Diminution due to parboiling		unboiled rice (g.)	Parboiled rice (g. p.c.)	Diminution due to parboiling		unboiled rice (g. p.c.)	Parboiled rice (g. p.c.)	Diminution of the increase due to parboiling	
			Total (g.)	As percent of raw rice value			Total g.	As percent of raw rice value			Total g.	As percent of raw rice value
Kumari ..	0.065	0.043	0.022	33.5	0.54	0.15	0.39	72.8	0.475	0.107	0.368	77.3
Kataktara ..	0.074	0.047	0.027	36.5	0.36	0.11	0.25	69.4	0.286	0.063	0.123	43
Dular ..	0.087	0.057	0.030	35.4	0.21	0.13	0.08	39.2	0.123	0.073	0.50	40.6
Khasia Panja	0.091	0.053	0.038	40.0	0.380	0.102	0.278	73	0.289	0.040	0.240	80
Jhingasail ..	0.094	0.057	0.037	39.9	0.33	0.22	0.110	33.3	0.236	0.163	0.073	30.9
Nigersail ..	0.104	0.082	0.022	21.1	0.34	0.20	0.14	41.2	0.236	0.118	0.118	50.0
Patnai ..	0.116	0.073	0.043	37.0	0.77	0.17	0.60	78.0	0.654	0.097	0.557	83.6
Panbira ..	0.130	0.082	0.048	29.4	0.67	0.17	0.50	73.1	0.540	0.085	0.452	84
Dharial ..	0.130	0.108	0.012	16.9	0.54	0.41	0.13	24.0	0.410	0.302	0.118	26.3
Hashikalmi ..	0.132	0.101	0.031	23	0.68	0.31	0.37	54	0.548	0.209	0.339	61.8
Dudshar ..	0.134	0.121	0.013	7.7	0.224	0.20	0.02	9.1	0.094	0.08	0.01	15.3
Basmati ..	0.136	0.114	0.022	15.4	0.60	0.49	0.11	18.3	0.464	0.376	0.088	19.2
Latisail ..	0.140	0.092	0.048	34.3	0.54	0.21	0.33	63	0.40	0.118	0.282	71
Badshabhog	0.140	0.094	0.046	32.8	0.90	0.18	0.72	80	0.76	0.086	0.674	88.7
Dholashaita	0.142	0.094	0.048	33	0.77	0.18	0.59	74.1	0.628	0.086	0.542	86.5
Nagra ..	0.174	0.042	0.128	75.3	1.08	0.14	0.94	89.0	0.906	0.098	0.808	89.1

and after incubation, as compared to unboiled ones, the effect of parboiling on the above values has been more precisely evaluated by calculating the total and per cent diminution of the initial, and final reducing sugar values and also of the value of the increase due to incubation as affected by parboiling treatment. All these results on homepound unboiled and parboiled rice samples are presented in Table 1. For the results of Table 2 of milled unboiled and parboiled rice samples, the above values of diminution due to parboiling has not been calculated as the parboiled samples in these cases were not prepared from the same paddy but collected from the market along with some milled raw samples of other varieties.

Results

Survey of the results presented in Table 1 shows that before incubation the initial reducing sugar content of the raw rice ranged from 0.074 to 0.174% and of parboiled from 0.042 to 0.114%. Due to parboiling there is total diminution of the value by 0.012 to 0.128% or 7.7 to 75.3% with respect to the value of raw rice. The lower diminution values of 7.7%, 15.4% and 16.9% were noted in case of Dulswar, Bhasamanik and Dhariwal, respectively. In other varieties diminution was above 20%.

On incubation for 5 hrs. with water and buffer of pH 7.2 at 37°C., the reducing sugar content of the raw rice showed an increase to the range of 0.21 to 1.08 mg. per cent and those of parboiled samples to a lower range from 0.102 to 0.41 mg. per cent. The diminution of these incubation values due to parboiling treatment ranged from 0.08 to 0.94 mg. or 9.1 to 89.02% with respect to the value for raw rice. The increase of the values due to incubation ranged from 0.123 to 0.906 in case of raw rice but a lower range from 0.049 to 0.376 mg. for parboiled samples. Diminution of the values of the increase due to incubation as affected by parboiling ranged from 0.014 to 0.808 mg. or 15.3 to 89.1%, when calculated on the basis of the values of unboiled samples. It was surprisingly observed that Dudswar, Dharial and Bhasamanik, which showed less diminution of the reducing sugar values at the initial stage before incubation, maintained almost similar trend of comparatively less diminution in the values after incubation and also in the values of the increase due to incubation.

Survey of the results of Table 2 indicates that milled parboiled samples collected from the market also showed similar lower range of all the above values as compared to those of milled unboiled samples collected from the same source. Comparison of the results of Tables 1 and 2 shows that the milled samples of both raw and parboiled rice contain lesser quantity of the above values and in some cases like Barisal, Balam and Boyaljhuri, almost nil value as compared to those of unmilled homepound samples.

TABLE 2.—REDUCING SUGAR CONTENT OF SOME MILLED UNBOILED (RAW) AND PARBOILED RICE BY AUTOAMYLOLYTIC DIGESTION FOR 5 HRS. AT 37°C.

Name of variety	Raw (unboiled) or parboiled	Reducing sugar gm. %		
		Before incubation	After incubation	Increase due to incubation
Kalijira	Raw milled	0.043	0.481	0.438
Gobindabhog	,, ,,	0.068	0.321	0.253
Badshabhog	,, ,,	0.052	0.492	0.440
Chinigura	,, ,,	0.058	0.394	0.336
Burma Atap	,, ,,	0.062	0.523	0.461
Boyaljhuri	Parboiled milled	Trace	0.092	0.092
Barisal Balam	,, ,,	Trace	0.116	0.092
Kartiksail	,, ,,	0.042	0.132	0.090
Birahi	,, ,,	0.031	0.118	0.087
Aus	,, ,,	0.026	0.084	0.058

Discussion

It would appear from the results that in each variety at the ordinary stage there is diminution of the reducing sugar content due to parboiling. This diminution may be either due to diffusion of the soluble reducing sugar during parboiling or due to lower amylase content. On incubation for 5 hrs. at 37°C., there is increase of the reducing sugar content in both unboiled and parboiled rice samples of each variety but the increase was higher in unboiled sample than in the parboiled ones. This indicates the probability of the presence of higher concentration of amylase, in the unboiled samples for which even at the initial stage, a higher value of reducing sugar, as compared to those in parboiled sample, is noted. Thus the parboiling process appears to effect a partial destruction of the amylase content of the raw paddy for which less sugar is generated in the parboiled rice products.

This rate or degree of destruction or inhibition of the activity of amylase is partly dependent on the variety, as is evident from comparatively less diminution in the reducing sugar values before and after incubation due to parboiling treatment of Dullswar, Dharial and Bhasamanik paddy, in relation to other thirteen varieties.

However, this partial inhibition or destruction of the autoamylolytic activity due to parboiling treatment leading to lower production of reducing sugar in the parboiled grains may be one of the causative factors for longer storage life of the parboiled paddy and rice against invasion by insects, moulds, etc., which perhaps require the reducing sugar as an essential nutrient for their growth and multiplication. Moreover, the better-cooking quality of the parboiled rice may be due to its low amylase content for which the grains are not quickly dextrinised and clump together like unboiled rice where the amylase content is high.

Observations of the lower values of the reducing sugars of the milled samples of unboiled and parboiled rice collected from the market, as compared to those of the homepound samples prepared in the laboratory indicate that due to milling there is additional inhibition, loss or destruction of the amylase activity. This offers an explanation as to the observations in the different laboratories compiled by F.A.O. that milled products are less infested than the unmilled ones.

Sweeter taste of the homepound sample whether cooked or uncooked, vis-a-vis the milled samples, as experienced by the people of the rural area of this region is probably due to higher autoamylolytic activity of the homepound sample where more sugar is generated in the ordinary condition on storage or during cooking for the preparation of the meal.

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