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Physical properties and nutritive value of a popular Assamese breakfast cereal

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Abstract
The study was carried out to assess the physical properties and nutritional quality of an admired Assamese breakfast cereal i.e. *kumal chawl* as compared to raw rice samples. Two rice varieties i.e. *chowkua* and *bora* paddy were selected for the study. The physical properties of processed samples were found to be different from the corresponding raw rice. Length of all *kumal chawl* samples increased from the raw whereas breadth and thickness were found to increase in some and decrease in some samples. Colour intensity measurements found the a and b values of *chowkua kumal chawl* to range between 3.41-4.74 and 16.15-18.38 respectively and for *bora kumal chawl* between 3.91-3.95 and 17.45-18.54 respectively. The nutrients namely protein, fibre and ash were found to increase whereas fat content was decreased in *kumal chawl* as compared to raw.

Keywords: *Kumal chawl, chowkua, bora*.

1. Introduction

Breakfast cereals plays an important role in a balanced diet (McKevith and Jarzebowska, 2010) [16]. Dietary guidelines state that the high nutrient density of breakfast cereals (especially whole grain breakfast cereals) makes them a significant source of vital nutrients (NHMRC, 2013) [18]. In addition to it breakfast cereals are also potentially imperative sources of antioxidants (Ryan *et al.*, 2011) [23] and phytoestrogens (Kuhnle *et al.*, 2009) [12]. Today, inevitable ranges of breakfast cereals differing in shapes, sizes and flavours are available fortified with vitamins and minerals and play a positive role in maintaining a balanced and healthy diet. Consumption of these type of breakfast cereals are important because people who eat cereals frequently are better off nutritionally than those who eat cereals less often. In modern times with nuclear family becoming the norm, people are depending more and more on these types of convenience foods to manage with time and labour factors.

The rice products of Assam are also convenience foods and are traditionally being consumed as ready-to-eat breakfast cereals. A unique characteristic of these rice products is that they soften and become consumable on simple soaking in water. The principal factor that governs the utilization of different rice products is the amylase to amylopectin ratio. The significant rice products of Assam are *kumal chawl, bhaja chawl, sandahguri* and *hurum*. *Kumal chawl* is parboiled rice made by normal parboiling method and is prepared from both *chowkua* and *bora* paddy. On the other hand, *bhaja chawl* is dry heat parboiled rice, also obtained both from *chowkua* and *bora* paddy. *Sandahguri* is prepared from normal parboiled rice that is roasted and then powdered for which *chowkua* rice is most preferred. *Hurum* is an expanded rice product made from waxy rice. While *kumal chawl* and *bhaja chawl* are soaked in water for softening before consumption, *sandahguri* and *hurum* are straightway eaten. These rice products are traditionally mixed with milk/curd/cream and jaggery/sugar and eaten. A striking feature in all these rice products is that they all are obtained after parboiling.

2. Materials and Methods

2.1 Sample preparation and identification: The four varieties that were selected for the preparation of *Kumal chawl* in the laboratory namely *Saru chowkua*, *Teli chowkua*, *Kola bora* and *Jengoni bora* were coded as SC, TC, KB and JB respectively. Three processing variables for each *Teli* and *Saru chowkua* varieties and one processing variable was followed for both *Kola* and *Jengoni bora* varieties. The processing variables were also coded in brief.

The codes showed the pressure of steaming and the time of steaming. To illustrate, JB-98º(1′)-0-20′ means *Jengoni bora* paddy was boiled for 1 min prior to soaking and parboiled at open steaming pressure of 10 min.

2.2 Physical properties of kumal chawl-

2.2.1 Determination of length, breadth and thickness: The length, breadth and thickness of the samples of *kumal chawl* for both *chowkua* and *bora* varieties were measured along with their raw rice. The length, breadth and thickness of the samples were measured under mobile microscope and their average measurements were expressed in mm.

2.2.2 Colour measurement: The processed *kumal chawl* samples along with their raw rice were tested to determine their colour intensity using three tristimulous filters amber, green and blue in a Color Quest XE (Hunterlab Inc., USA). While testing the colour, observer angle was fixed at 10º and illuminant was D65.the colour scale used in this equipment was CIE LAB. By this machine, *L, a* and *b* were determined. Among them 'L' stands for visual brightness; as the reading goes towards 100 the product is bright, on the contrary if reading is towards zero then the product is dark. The 'a' value denotes redness (positive reading) and greenness (negative reading) and the 'b' value denotes yellowness (positive reading) and blueness (negative reading).

2.2.3 Sensory evaluation of kumal chawl- The six samples of *kumal chawl,* three each from *Saru* and *Teli chowkua* were subjected to sensory evaluation on an evaluation sheet by a panel of semi trained judges with the help of 7-point Hedonic scale. On the basis of the evaluation only one *Chowkua* variety i.e. TC-98º(1′)-1-10′ was selected further for nutritive value estimation corresponding to its raw variety. On the contrary, in case of *bora kumal chawl,* KB-98º(3′)-0-20′ was selected for nutritive value calculation along with its raw counterpart.

2.2.4 Determination of nutritive value

2.4.1 Determination of protein- The protein determination was assessed by the method given by Lowry *et al.* (1951).

2.4.2 Determination of fat- Fat was estimated as crude ether extract of the dry material and the procedure to calculate fat was done as per A.O.A.C. (1970) [1].

2.4.3 Determination of crude fibre- The method of A.O.A.C. (1970) [1] was followed to determine crude fibre.

2.4.4 Determination of total ash- To determine the total ash content, A.O.A.C. (1970) [1] method was followed.

2.4.5 Determination of carbohydrates-by-difference- Percentage of carbohydrate was calculated by substracting the sum of percentage values in dry basis of protein, crude fat, crude fibre and total ash from hundred and were reported as "carbohydrates-by-difference". The calculation was done according to Gopalan *et al.* (2000) [10].

2.4.6 Determination of energy value- Energy was estimated by multiplying the calorific value of carbohydrate, fat and protein with their amount present in 100g of sample on dry basis. The energy value was expressed in Kcal. The estimation was done according to Gopalan *et al.* (2000) [10].

2.5 Statistical analysis- All the data of the physical tests and sensory evaluation were statistically analysed by following the methods given by O' Mahony (1986) [19].

Results and Discussion:

3.1 Length, breadth and thickness measurement: From the Table 1 it can be seen that the physical dimensions of *kumal chawl* were different from the corresponding raw rice. The raw rice of *Saru chowkua* had mean length of 6.07mm, mean breadth of 2.44mm and mean thickness of 1.92mm. The three *kumal chawl* samples made from *Saru chowkua* following different processing conditions showed changes in the physical dimensions. While length increased in all the three samples, breadth and thickness of *kumal chawl* decreased in a few samples and increased in the rest. Similar observations were made for *kumal chawl* processed from *Teli chowkua.* The mean length of raw *Teli chowkua* was 6.26mm, mean breadth 2.68mm and mean thickness was 2.01mm. The three samples of *kumal chawl* prepared from *Teli chowkua* showed increase in length and decrease in breadth in all the samples. Thickness was less than the raw for one variable. It was noted that the length of *chowkua kumal chawl* from both varieties increased negligibly where as breadth band thickness either increased or decreased considerably. A dissimilar trend in the percent increase or decrease of breadth and thickness between *kumal chawl* processed from *Saru chowkua* and *Teli chowkua* may be an effect of varietal difference.

Table 1: Mean length, breadth and thickness of raw and *kumal chawl* samples

Method variables	Mean length (mm)	Mean breadth (mm)	Mean thickness (mm)
Raw Saru chowkua	6.07	2.44	1.92
SC-98º(1′)-0.75-10′	6.18(+1.81)	2.54(+4.09)	2.09(+8.85)
SC-98º(1′)-1-10′	6.23(+2.64)	2.46(+0.82)	2.03(+5.73)
SC-98º(3′)-0.5-20′	6.11(+0.66)	2.19(-10.25)	1.77(-7.81)
Raw Teli chowkua	6.26	2.68	2.01
TC-98º(1′)-0.75-10′	6.60(+5.43)	2.49(-7.09)	1.78(-11.44)
TC-98º(1′)-1-10′	6.32(+0.96)	2.60(-2.99)	2.29(+13.93)
TC-98º(3′)-0.5-20′	6.35(+1.44)	2.62(-2.24)	2.25(+11.94)
Raw Kola bora	5.97	2.59	1.63
KB-98º(1′)-0-20′	6.29(+5.36)	2.85(+10.04)	1.83(+12.27)
Raw Jengoni bora	6.15	2.59	2.03
JB-98º(1′)-0-20′	6.67(+8.46)	2.76(+6.56)	1.97(-2.96)

Value in parenthesis indicate percent increase or decrease from corresponding raw rice

In case of *kumal chawl* prepared from *bora* paddy, there was only one set of processing variables that was followed, as this was selected as the best among the variables followed by a semi trained panellists. Therefore, the trend regarding the changes in physical parameters couldnot been observed. The mean length, breadth and thickness of raw *Kola bora* were

5.97mm, 2.59 mm and 1.63mm respectively. The raw rice of *Jengoni bora* had mean length of 6.15mm, mean breadth of 2.59 mm and mean thickness of 1.97mm. While all the three dimensions increased for *Kola bora* based *kumal chawl,* only length and breadth increased in *Jengoni bora kumal chawl.*

Changes in the physical dimensions of both *chowkua* and *bora kumal chawl* that were processed with similar variables did not follow similar trend. This may be due to the characteristic of rice starch in *chowkua* and *bora.*

Pillaiyar (1988) [20] while studying grain dimension of 23 varieties representing low, medium and high GT groups, found that the mean length, width and thickness of milled parboiled rice ranged from 5.2 to 7.0mm, 2.0 to 2.8 mm and 1.5 to 1.8 mm respectively; while the corresponding dimensions for raw milled samples were 4.9 to 6.7mm, 1.8 to 2.8mm and 1.4 to 1.9mm. The results of the present study are within the range of values reported by Pillaiyar (1988) [20]. However, the effect of parboiling on length, breadth and thickness of rice grain in reported studies does not categorically state only to increase or decrease.

Kurien *et al.* (1964) [13] and Raghavendra Rao and Juliano (1970) [22] found that uncooked parboiled rice itself had a lowered length-breadth ratio than raw rice and their shape difference was further accentuated after cooking. Dimopoulos and Muller (1972) [7] however, observed an increase in length of rice after parboiling. Bhattacharya and Ali (1985) [5] opined that the greater width in parboiled rice was due to slightly lower degree of milling because of the harder parboiled rice grain. In this context, the consistent increase in length of *kumal chawl* samples which is contrary to most of the reported studies may probably be the effect of 1 min or 3 min boiling prior to soaking and steaming of paddy. Such a boiling treatment prior to soaking is not given to paddy that is normal parboiled.

3.2 Colour measurement Estimation of colour intensity was done by an instrument named Color Quest-XE. All the processing variables of *Kumal chawl* along with their raw rice were tested for their colour intensity.

Table 2: Estimation of colour intensity of raw and laboratory processed *kumal chawl* samples

Processing variables	*L*	*a*	*b*
Raw *Saru chowkua*	69.51	2.81	16.26
SC-98°(1′)-0.75-10′	59.46	3.41	16.79
SC-98°(1′)-1-10′	58.47	3.76	17.43
SC-98°(3′)-0.5-20′	60.55	3.68	18.38
Raw Teli chowkua	71.01	2.78	15.45
TC-98°(1′)-0.75-10′	56.89	4.58	16.15
TC-98°(1′)-1-10′	57.47	4.74	16.66
TC-98°(3′)-0.5-20′	57.67	4.22	16.28
Raw *Kola bora*	72.76	2.22	16.11
KB-98°(1′)-0-20′	59.08	3.95	17.45
Raw *Jengoni bora*	78.04	1.51	14.22
JB-98°(1′)-0-20′	60.26	3.91	18.54

L-brightness *a*- redness *b*-yellowness

From the table it can be observed that the brightness decreased in all the *kumal chawl* samples than its raw form, in other words on processing the rice grain become less white. It was also observed that the redness and yellowness of *kumal chawl* increased than the raw rice. Further, while only slight increase in yellowness of was observed from the readings in all the parboiled rice as compared to the raw, there was considerable increase of redness in all the parboiled rice than their raw rice. SC-98°(1′)-1-10′ was more yellow and red than SC-98°(1′)-0.75-10′ that may probably be due to the severity of steaming pressure. The deep yellowness in SC-98°(3′)-0.5-20′ may be combined effects of prolonged boiling time of 3 min and longer steaming time of 20 min. Similar pronounced effect of boiling time, steaming time and steaming pressure was seen in the development of red colour in the *Teli chowkua kumal chawl* samples. Like this study Mohandoss and Pillaiyar (1978) [17] reported that the temperature and duration of soaking had an adverse effect on development of colour. Pillaiyar and Mohandoss (1981) [21] found that colour of parboiled rice depends on temperature of soakingand parboiling. Cold soaking method has the least colour inducing effect on rice while the hot soaking method has the most; which may be due to more leaching out of sugars and amino acids in the cold-soaked samples (Anthoni Raj and Singaravadivel, 1980) [2]. Raghavendra Rao and Juliano (1970) [22] observed that the parboiled rice colour varied from yellowish to brown or light tan to deep amber. While comparing *Teli chowkua* with *Saru chowkua* it was noticed that they followed a similar trend in brightness, redness and yellowness with slight variations. This might be due to varietal difference between the samples. *Teli chowkua* husk being darker than the husk of *Saru chowkua* in colour, the increase in the intensity of redness was severe in *Teli chowkua.*

The raw *bora* rice samples being opaque grains showed intense brightness with values of 72.76 and 78.04 for *Kola bora* and *Jengoni bora* respectively. In case of *Kola bora kumal chawl* the brightness was decreased whereas redness and yellowness increased than its raw form. Like *Kola bora*, *Jengoni bora* also followed the similar trend. But the intensity of brightness, redness and yellowness differed which may be due to varietal variations. The husk of *Kola bora* was darker in colour than *Jengoni bora* and on parboiling the intensity of redness was higher in *Kola bora.*

Thus the measurement of colour of *kumal chawl* revealed that parboiling process affected redness of the grain more strongly than yellowness. The study also confirmed the well known fact that the gelatinization of rice starch caused reduction in brightness of the kernel.

The *a* and *b* values of *chowkua* and *bora kumal chawl* can be used as quality indicators. In the present study it was seen that the preferred *kumal chawl* samples from *chowkua* paddy had *a* values in the range of 3.41-4.74 and *b* values in the range of 16.15-18.38. Similarly the *bora kumal chawl* that on organoleptically preferred range will have *a* values in the range of 3.91-3.95 and *b* values in the range of 17.45-18.54. These *a* and *b* values lower than this would mean that under parboiling and higher than this would indicate severe parboiling, both of which are indicators of poor quality of *kumal chawl.*

3.3 Estimation of nutritive value of raw and laboratory processed *kumal chawl* samples-

3.3.1 Protein content From the Table 3 it can be observed that the protein content of raw *Teli chowkua* and raw *Kola bora* was 8.9% and 7.2% respectively on dry basis. The protein content of corresponding *kumal chawl* increased to 9.3% and 7.9% respectively. In case of *kumal chawl* prepared from *Kola bora* the percent increase was 9.72%, while the increase in *Teli chowkua kumal chawl* was 4.49%.

Juliano (1966) [11] found the protein content in waxy rice to range from 6.48 to 14.98% and 5.47 to 15.6% on dry basis for non-waxy rice in the polished state. The protein content of rice samples in the present study was within the reported but on the lower side. The protein content was reported to increase from 7.67% in raw rice to 8.14% in parboiled rice by Damir (1985) [6].

The difference of protein content might be due to the varietal differences of rice samples. Dutta and Borua (1978) [8] observed that rice grain is affected by variety, application of nitrogen and method of processing.

The increase and decrease of protein content after parboiling is quite contradictory. Raghavendra Rao and Juliano (1970) [22] found a slightly greater amount of protein in the outer most layers of rice due to less dilution of bran by inner layers during milling after parboiling. Eggum (1979) [9] found that the amino acid composition of rice protein to be more or less unchanged after parboiling.

Table 3: Nutritive value of raw and laboratory processed *kumal chawl* samples on dry basis (g/100g)

Samples	Protein	Fat	Fibre	Ash	Carbohydrate	Energy (Kcal)
Raw *Teli chowkua*	8.9	1.5	0.3	0.6	88.7	403.9
TC-98°(1′)-1-10′	9.3 (+4.49)	1.4(-6.66)	0.4(+33.33)	0.7(+16.67)	88.2(-0.56)	402.6 (-0.32)
Raw *Kola bora*	7.2	2.1	0.2	0.7	89.8	406.9
KB-98°(3′)-0-20′	7.9 (+9.72)	2.0(-4.76)	0.3(+50.00)	0.8(+14.29)	89.0(-0.89)	405.6 (-0.32)

Value in parenthesis indicate percent increase or decrease from corresponding raw rice

3.3.2 Crude fat content From the Table 3 it was observed that the raw rice of *Teli chowkua* and *Kola bora* contained 1.5% and 2.1% fat respectively on dry basis. Processing caused slight decrease in fat content that was between 4.76 to 6.66%. *Teli chowkua kumal chawl* had 1.4% fat and *Kola bora kumal chawl* had 2.0% fat. It can be seen that *kumal chawl* samples had slightly lower fat content than their raw form. A number of workers have also reported the lower fat content in milled parboiled rice (Bhattacharya *et al.*1972; Sondi *et al.,* 1980) [4, 24], although the total fat content in brown rice remained more or less unchanged. This observation was supported by the postulation that as water soluble vitamins and minerals moved in to the grain during parboiling, fat moved out. Dutta and Borua (1978) [8] reported that the fat content in two milled waxy rice namely *Jengoni bora* and *Ghee bora* were 2.14 and 2.27% on dry basis respectively which is quite similar to the values obtained for *Kola bora* in this study.

3.3.3 Crude fibre content The results presented in Table 3 shows that crude fibre content was 0.3 and 0.2% (d.b.) in raw *Teli chowkua* and raw *Kola bora* respectively. In case of their *kumal chawl*, crude fibre content increased to 0.4% and 0.3% respectively. After parboiling the fibre content was more than that of raw rice. There was 33.33% increase in fibre content in case of *chowkua kumal chawl* and 50 percent in case of *bora kumal chawl.*

The substantial increase in fibre content in *kumal chawl* can be attributed to the slightly lower degree of milling of the parboiled rice as it is well established that fibre is highest in the outer layers of the grain and decreases towards the centre.

3.3.4 Total ash content the total ash in raw *chowkua* rice was 0.6% and raw *Kola bora* was 0.7% (Table 3). The ash content of both the parboiled rice were seen to be increased after parboiling found an increase of 1 percent of ash content in parboiled rice from 0.5% in raw rice. Damir (1985) [6] reported an increase from 0.39%in raw rice to 0.44% in parboiled rice in ash content. The increase of ash content percent is more in case of *Teli chowkua kumal chawl* where 16.67% increase was noticed than *Kola bora kumal chawl* with 14.49% increase (Table 3).

Bhattacharya (1985) [3] reported that the most of the elements migrated deep in to the grain during parboiling; resulting in a greater retention of these nutrients in milled parboiled rice which is in concurrence with present findings. The high ash content in *kumal chawl* can be because of two reasons, one being the inward migration of minerals during parboiling and the other reason being the reduced level of milling of *kumal chawl.* It has been well established that distribution of minerals within the rice grain generally follows that of fibre and lipids. Minerals content is higher in the outer layers of endosperm with concentration decreasing towards the centre (Luh and Mickus, 1991) [15].

3.3.5 Carbohydrate content: The carbohydrate content by difference in *chowkua* raw rice was 88.71% and in *bora* raw rice (Table 3). From the Table 3 it was revealed that the amount of carbohydrate decreased by about 0.56 percent in *Teli chowkua kumal chawl* and by about 0.89% in case of *Kola bora kumal chawl.* The amount of carbohydrate was lower in *chowkua* and *Bora kumal chawl* samples which is clearly due to the presence of higher sum total amount of other nutrients like protein, fibre and ash as compared to corresponding raw rice.

3.3.6 Energy content Energy value of both *chowkua* and *bora* raw rice were almost similar to its *kumal chawl* samples. *Bora kumal chawl* provided about 3Kcal more energy than *chowkua kumal chawl.* The percent decrease in energy content in both *Teli chowkua* and *Kola bora kumal chawl* were 0.32%.

When compared with Gopalan *et al.* (2000) [10] nutritive values given for raw rice and parboiled rice calculated on dry basis, slight differences were observed which can be explained as to be due to the low amylase and waxy type of rice evaluated in this study. The type of rice used in Gopalan *et al.* (2000) [10] data is not known.

4. Conclusion: Parboiling is a traditional hydrothermal method practiced in Assam for value addition of rice. It leads significant changes in the rice grain properties. This study was carried out to assess the changes in physical properties and nutritive value of *chowkua* and *bora kumal chawl* samples corresponding to its raw counterparts. An interesting observation in the present investigation was the increase in length of all *kumal chawl* samples and no particular trend in breadth and thickness, which is contrary to the reported findings that parboiled rice has increased in breadth only. The increased length is may be due to the boiling of paddy for 1-3 min prior to overnight soaking in water to allow for rapid and high hydration of the grains. The colour intensity of raw and parboiled rice revealed that lightness reduced on processing of both *chowkua* and *bora* paddy in to *kumal chawl* which can be explained as due to the gelatinization of starch leading to translucency of the grain. Colour intensity values can be taken as quality indicator of kumal *chawl.*

Parboiling of paddy rice is an important processing technique that has many advantages from the nutritional point of view. In *kumal chawl* samples of both *Teli chowkua* and *Kola bora,* protein, fibre and ash were found to increase whereas fat was decreased slightly with resultant decrease in carbohydrate. The slightly higher values of protein, ash and fibre can be attributed to the combined effects of the rice types used, the 1 min and 3 min boiling of paddy prior to overnight soaking and lesser degree of milling of *kumal chawl* Proper commercialization of this popular Assamese breakfast cereal is needed in present times to sustain its consumption in view of its good nutrient composition and ease of consumption.

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