Effect of Parboiling on Physico-chemical Qualities of Two Local Rice Varieties in Nigeria

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Summary

Two varieties of local rice in paddy form were used for this study. The rice were collected from local farmers at Okemesi Ekiti in Ekiti State of Nigeria (western Nigeria). The rice were divided into halves, one half was processed by Parboiling, Drying and Milling, the other half was processed by Drying and Milling only.

The result from the study showed that parboiling affected the physico-chemical qualities of the rice varieties. There were differences in the physical dimension, appearance, colour, water absorption, cooking time, amylose, protein, fat and carbohydrate contents of the parboiled and non-parboiled rice samples. Varietal differences also exist between the rice samples.

Parboiling reduced the breakage, fat, protein and amylose content of the rice while the cooking time, water uptake and thiamine contents were increased. It can therefore be inferred that parboiling which has been the means of processing rice in Nigeria can be a way of improving vitamin content and milling properties of rice and should attract the interest of food technologists and food processors to develop the rice industry.

Introduction

Rice is one of the leading food crops in the world and a favoured cereal in the diet, appearing often in different forms. It plays a very important role in the diet of many Nigerians because it is a good source of carbohydrate. The protein content of rice is low but studies have shown that it is comparable to that of wheat, while its digestibility is high compared to other cereals (Ngoddy and Ihekoronye, *1985).* Rice as an economic crop is also important in household food security, nutritional diversification, income generation and employment, hence it helps in poverty alleviation.

In Nigeria, the variety commonly cultivated is *Oryza glaberrima steud*, it is utilised mostly at household level where it is consumed as boiled rice, fried rice, ground rice and tuwọ shinkafa. At the industrial level it is used as brewers rice in brewery, where it is used as an adjunct and as component of weaning diet. It is mainly processed by parboiling, parboiling is the hydrothermal treatment of paddy or pre-cooking of the rice within the hull. It has been reported by many authors (Juliano, 1970, Bhattarcharya and Ali, *1985* and Adeyemi *et al* 1986 respectively) that parboiling affects the physico-chemical and cooking qualities of rice. Since many varieties of rice exist and there are variations in its utilization and preference depending on the consumer, there will be differences in the effects of parboiling on the different varieties.

The objectives of this study therefore are to study the effect of parboiling on the physico-chemical composition and cooking quality of two local rice varieties in Nigeria and determine the nutritional changes that may occur due to processing.

Materials and Methods

25 kg each of two local rice varieties in paddy form with local names *Offada* (white variety) and *Alaso-osun* (Brown variety) were collected from local farmers at Okemesi-Ekiti, Nigeria. The rice varieties had been stored for 180 days after harvesting. Half of each variety was parboiled while the other half was not parboiled. Cleaned paddy were soaked in water at room temperature (below the gelatinisation temperature of the rice to minimise the splitting of the grains), to hydrate the grains in a steeping tank for 5-8. Parboiling was done in the laboratory by the pressure parboiling method of Inenga *et al* (1980). In this method the paddy rice was not saturated with water but briefly exposed to steam under high pressure using an autoclave. The paddy rice was then exposed to steam to gelatinise the starch for 15 minutes at 15 p.s.i g.pressure (121°c). The parboiled paddy rice was then tempered for 30min to cool and air-dried in a cabinet dryer at *45°c* for 8 hours. Both the raw and the parboiled rice samples were milled in a grantex mill. Samples for physicochemical analysis were subsequently ground in a hammer mill and sieved in a sinon laboratory shaker, using 10 Nylon (171m aperture) sieve. Flour fractions (<17lum) were used for chemical analysis.

Physical dimension (length, breadth and shape) was determined by randomly picking twenty whole grains and measured by means of verner callipers, the mean was then calculated. Percentage breakage was determined by the method of Dimopolus and Mulier (1972) in which percentage breakage is defined as the amount of grains with less than 3/4 size per 100g of milled rice. Degree of parboiling was determined by the method of Luh and Shun Lu (1991). Cooking time and water absorption were determined by the method of Bhattarcharya (1979). Moisture content, Crude protein *(%Nx5.95),* Fat, Crude fibre and Ash were determined on triplicate samples by AOAC (1997) methods. Amylose was determined by the method of Williams, (1970). Thiamine was determined by the gravimetric method of Bessot, (1940) which is based on precipitation of thiamine as thiamine hydrochloride with tungtosilicic acid.

Results and Discussion

The parboiled rice kernel became translucent and glassy unlike the non-parboiled kernel that is white and opaque.

Table 1: Physical dimensions of parboiled and non-parboiled rice grains

Rice variety and treatment	Length (mm)	Breadth (mm)	Length: breadth	Classification	Shape
White parboiled	7.04	2.91	2.12	Extra long	Medium
White non parboiled	6.78	2.53	2.62	Long	Medium
Brown parboiled	6.66	2.60	2.56	Long	Medium
Brown non-parboiled	6.66	3.0	2.22	Long	bold

Table 2: Degree of parboiling, percentage breakage, water uptake and cooking time of parboiled and non-parboiled rice

Rice variety and treatment	Degree of parboiling	% Breakage	Water absorption (ml/g)	Cooking time (min)
White parboiled	75	65	13.56	56
White non parboiled	25	78	10.31	49
Brown parboiled	68.57	55	10.62	52
Brown non-parboiled	11.45	90	10.21	45

This occurrence is likely due to the to gelatinisation of starch and disruption of protein bodies which expanded and occupied all the air spaces in the endosperm during parboiling as reported by Rhagavendra, Rao and Juliano (1970). The opaque and white belly caused by loose arrangement of starch granules therefore disappeared making the kernel translucent.

The rice samples are long grain type according to Webb and Stermer (1972) method of grain classification. However the parboiled rice kernel has a shorter length and broader breadth when compared with the non-parboiled rice sample. This is in agreement with the result of Rhaghavendra and Juliano (1970) that parboiled rice expanded less in length but more in breadth.

The degree of parboiling which is a measure of severity of the heat treatment the rice was subjected to can be said to be higher in the white parboiled samples than the brown parboiled samples. This is measured by the percentage of the rice grain that disintegrated in dilute alkali. The greater the disintegration the higher the degree of parboiling. This may also explain the reason why the percentage breakage in the brown rice variety (parboiled) is higher than that of the white variety. It may be due to incomplete parboiling which results in a "white belly" kernel, which causes increase breakage during milling. The percentage breakage in the parboiled rice samples is lower than that of the non-parboiled samples. This is as a result of hardening of the grains after parboiling which reduces the breakage and the milling quality.

The cooking time of the parboiled rice samples was between 52-56 mm while for the non-parboiled rice it was 45-49 mm. The two varieties of rice generally have a high cooking time when compared with 10-25 mm reported by Adeyemi *et al* (1986) and Rhagavendra and Juliano (1970). The longer cooking time of the parboiled rice samples compared to the non parboiled samples may be due to the strong cohesion between the endosperm cells which are tightly packed. This makes the starch grains to hydrate at a slower rate, which leads to a decrease in water penetration into the grains, hence a longer cooking time. Juliano and Perez, (1986) found that the higher the protein content of rice, the higher the gelatinisation temperature, hence cooking time. This is ostensibly due to the hydrophobic nature of proteins, which act as a barrier to inward diffiusion of water into the cooking grain, and hence raise the gelatinisation temperature. The water absorption of the parboiled samples were higher than that of the non-parboiled samples, while the water absorption of the white variety was higher than that of the brown variety. Mustapha (1979) in his study on physico- chemical qualities of rice stated that parboiled rice has higher water absorption, which may be as a result the steaming pressure during parboiling which in turn affects starch gelatinisation.

There is decrease in protein content of the parboiled rice samples compared to the non-parboiled samples, which may be due to leaching of protein substances during soaking and rupturing that occurs in the molecules due to steaming. The process of parboiling makes the protein bodies to sink into the compact mass of gelatinised starch grains, making it less extractable hence a decrease in the protein content. There is no soaking or steaming process for the non-parboiled samples though little loss in protein content may occur during milling, but this is incomparable to what happens during parboiling, hence it has a higher protein content than the parboiled samples. However the white variety has a higher

Table 3: Proximate composition, Amylose and Thiamine content of rice varieties.

Rice variety and treatment	Moisture (%)	Crude protein (%)	Crude Fibre (%)	Crude fat (%)	Carbohydrate (%)	Ash (%)	Amylose (%)	Thiamine (g) (as thiamine hydrochloride)
White parboiled	10.30	8.31	0.5	0.36	79.93	0.6	25.45	0.027
White non-parboiled	9.70	8.75	0.3	0.66	78.97	0.8	28.58	0.003
Brown parboiled	9.50	6.56	0.5	1.28	88.08	0.9	26.57	0.021
Brown non-parboiled	9.60	6.85	0.4	1.29	80.86	1.0	22.39	0.0022

protein content than the brown variety. The parboiled rice samples also have lower fat content than the non-parboiled samples. This may be explained in terms of leaching and rupturing of the oil globules that occur due to increase in temperature and steaming pressure that occurs during the parboiling process. The carbohydrate content of the parboiled rice samples was higher than that of the non-parboiled samples. This may be as a result of starch gelatinisation, which makes the grain to expand, thus filling up the surrounding air spaces. Starch re-association, increase in some carbohydrate components like reducing sugars, change in molecular size and partial dextrinisation of starch which have been known to occur during parboiling. (Rhaghavendra and Juliano, (1970).

There was slight increase in the thiamine content of the parboiled rice samples. This agreed with the findings of Gariboldi, (1974) that it may be due to the fact that during steaming, water soluble vitamins are spread throughout the grain, thus altering their distribution and concentration, with infusion of thiamine from the germ into the starchy endo sperm. There is also a decrease in Amylose content of the parboiled rice compared with the non-parboiled rice samples. This is because of starch solubilisation and leaching of the amylose molecules into the surrounding water during soaking and subsequent steaming during parboiling. The differences in chemical composition of the two rice varieties may be caused by variety and environmental factors such as location of field, planting season, time and rate of nitrogen fertiliser application, solar radiation during grain development, spacing, application of herbicides at subhebicidal levels, location and structure of oil globules.

Conclusion

Parboiling as a means of rice processing affects both the physical and chemical properties of the grain. It improves milling and cooking qualities of the rice grains in a positive manner which has been found to influence consumers demand and acceptability. The increase in thiamine content of the parboiled rice can also serve as an effective means of improving the thiamine intake in peoples diet thereby enhancing their nutritional status. The two rice varieties used have protein content between 6.86-*8.75%*, this therefore means that the rice could be a major source of protein in the diets of Nigerians if consumption is adequate.

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