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Effect of Processing Condition and Polishing Rate on Apparent Amylose Content of Some Sri Lankan Rice Varieties

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ABSTRACT *Rice (Oryza sativa) is the staple food in Sri Lanka. Amylose content is the key determinant of cooking and eating qualities of rice. Therefore it is commonly used as an objective index for cooked rice texture. High amylose varieties tend to have low glycemic indices. This study investigated the apparent amylose content of raw and parboiled rice which were polished at 10% and 5% on weight basis in six Sri Lankan rice varieties. Determination of apparent amylose content was done according to AACC method 61-03. Five Bg varieties; 2 short grain (Bg 358, Bg 360), two medium grain (Bg 300, Bg 352) and one long grain (Bg 305) were used for the study together with the long grain rice variety At 405. The apparent amylose content of rice varieties Bg 300, Bg 305, Bg 352, Bg 358, Bg 360 and At 405 under 10% polished raw were 29.3±0.4%, 32.5±1.3%, 32.8±0.75%, 26.1±0.8%, 31.9±0.8% and 14.9±1.3%, respectively. A significant difference (p<0.05) was observed for apparent amylose content among the selected rice varieties. Bg 305, Bg 360 and Bg 352 had a significantly higher apparent amylose content than Bg 358, Bg 300 and At 405 under 10% polished raw form. All the five Bg varieties tested in the study belong to high amylose rice while the variety At 405 is a low amylose type. Although there was a significant varietal difference in apparent amylose content of rice no clear difference was observed in apparent amylose content due to parboiling or polishing.*

Key words: *Apparent amylose content, parboilng, polishing rate, rice*

INTRODUCTION

Rice (*Oryza sativa*) is the staple food in Sri Lanka. It contributes to nearly 50% of the energy and 40% of protein in the daily diet of its people (Sartaj and Suraweera, 2005). Rice sector contributes to 30% of the agricultural Gross Domestic Product (GDP) of Sri Lanka. Rice is grown under both irrigated and non-irrigated conditions (Mendis, 2009). The annual per capita consumption of rice in Sri Lanka has increased from 100 kg in 2000 to 108 kg in 2008, mainly due to increasing prices of wheat flour. In addition, a demand for physical purity as well as for better intrinsic quality in rice has also been increased (Kotagama and Kumara, 1996). Rice is mainly consumed as cooked grain kernels. Physicochemical properties of cooked rice are important for its edible quality. Rice grain quality has four constituents as milling quality, appearance quality, cooking quality and eating quality. Physicochemical properties such as the amylose content, gelatinization temperature and gel consistency have an effect on cooking and eating qualities (Zefu *et al.*, 2003).

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Amylose content is the key determinant of the cooking and eating qualities of rice (Wickramasinghe and Noda, 2008). It is commonly used as an objective index for cooked rice texture (Delwiche *et al*., 1995). Low amylose levels are associated with cohesive, tender and glossy cooked rice while high amylose levels tend to absorb more water and expand more during cooking. Grains with high amylose contents tend to cook dry, fluffy and separate (Juliano, 1971). High amylose varieties tend to have low glycemic index values which are suitable for diabetic patients (Miller *et al*., 1992). This is mainly due to the less susceptibility of high amylose starches to hydrolysis by α-amylase as it is a larger linear molecule and not branched as amylopectin (Pathiraje *et al*., 2010). In general high quality rice is considered to be soft and slightly moist when cooked. These qualities are provided by starches with intermediate amylose and moderate gelatinization temperatures (Wickramasinghe and Noda, 2008). The environmental conditions such as changes in the temperature and day length and also genotype-environment interactions affect the cooking and eating qualities of rice (Jianrong *et al.*, 2005).

Amylose content of rice can be categorized as waxy (0-5%), very low (5-12%), low (12-20%), intermediate (20-25%) and high (25-33%) (Juliano, 1971). Commercially rice is classified on the basis of its amylose content as either low (<20% amylose), medium (21-25% amylose) and high (26-33% amylose) (Suwannaporn *et al*., 2007). It has been reported that parboiling would reduce the amylose content of rice (Ostegbayo *et al*., 2001) but the effect of polishing on its amylose content is not known. The objective of this study was to determine the amylose content in six popularly consumed Sri Lankan rice varieties under different processing conditions: raw and parboiled and different polishing rates: 10% (fully) and 5% (half) on weight basis.

MATERIALS AND METHODS

Raw materials

The short grain (Bg358, Bg360), medium grain (Bg 300, Bg 352) and long grain (Bg 305, At 405) rice varieties were obtained from Bathalagoda Rice Research Institute, Sri Lanka. Parboiling and polishing operations were done in the laboratories of the Faculty of Agriculture, University of Peradeniya, Sri Lanka. Parboiling was done by soaking paddy in water: short grains were soaked for 24 hours and long grains were soaked for 48 hours, followed by steaming and sun drying as described by Juliano (1971). The variety At 405 is a *Basmati* type rice, which is not commercially parboiled and hence it was not subjected to parboiling in this study.

Sample preparation

Both raw and parboiled rice from the five Bg varieties were polished at 10% (degree of polishing 100%) and 5% (degree of polishing 50%) on the basis of weight with the rice husker and polisher (PM 500, Japan) which has the capacity of adjusting the rate of polishing. After polishing methylene blue was used to stain the surface of rice to ascertain the effectiveness of polishing. In the case of variety At 405, only the.raw form of the rice was used for the study, following the commercial preparation method, and it was polished only at 10% rate.

Rice was ground (M-2, Kansas) and passed through a 0.5 mm sieve. The samples were then de-fatted by refluxing 95% ethanol for 16 h in a Soxhlet extractor. Triplicates of 100 mg samples were weighed and transferred quantitatively to 100 ml volumetric flasks, 1ml of 95% ethanol was added carefully washing down any sample adhering to sides of tube. Then the tubes were vortexed thoroughly. Sodium hydroxide (9 ml of 1N solution) was added to each sample and kept at room temperature for 24 h without shaking. After dispersion, starch solutions were made into 100 ml volume with distilled water and vortexed vigorously. One in to ten dilutions was then prepared for each solution. Three replicates were prepared for each variety under raw and parboiled conditions and the two polishing rates.

Determination of amylose content

Apparent amylose content was determined according to AACC (2000) method 61-03. Solutions (1g/liter) of potato amylose (Sigma-Aldrich, UK) and amylopectin (Himedia Laboratories, India) were prepared using 1 ml of 95% ethanol following the procedure described above for the preparation of samples. They were used as stock solutions for preparing working solutions. Amylose/amylopectin mixtures for the standard curve were prepared as shown in table 1.

Standard curve was prepared using Amylose or amylopectin solutions. Amylose or amylopectin solutions were pipetted (5 ml) into 100 ml volumetric flasks, each containing about 50 ml distilled water. Blank was prepared using 5.0 ml, 0.09N sodium hydroxide. Then 1.0 ml 1N acetic acid was added and mixed. Thereafter 2 ml iodine solution was added and made up to 100 ml with distilled water and mixed. Then they were allowed to stand for 20 minutes and color absorbance was red at 620 nm using the blank to zero the spectrophotometer (UV-1601, Japan). The absorbance was plotted at 620 nm against amylose concentration of working solutions for a standard curve. Aliquots (5 ml) of alkaline dispersions of samples were pipetted into 100 ml volumetric flasks, each containing about 50 ml of distilled water. Sodium hydroxide (0.09N, 50 ml) was used for the blank. Then the absorbances were measured three times per replicates at 620 nm as described above and plotted against the assigned amylose content and the mean amylase content was obtained for each replicate.

Table 1. Amylose and amylopectin ratios for the working solutions

Amylose in milled rice (% dry basis)	Volume ratio of stock solution (ml/100 ml)		
	Amylose (ml)	Amylopectin (ml)	0.09 N NaOH
0	0	7.0	3
10	1.0	6.0	3
20	2.0	5.0	3
25	2.5	4.5	3
30	3.0	4.0	3

Statistical analysis

Data obtained from each variety under different processing conditions and polishing rates were fitted into a factorial (5x2x2) completely randomized design (CRD) and subjected to analysis of variance (ANOVA). Mean separation was done using the Duncan's Multiple Range Test to determine the statistical differences among varieties at a significance level of 0.05. Statistical analysis was carried out using SAS (1990) software package.

RESULTS

As the highest order interaction was significant, man separations were done separately.

Effect of variety on apparent amylose content of rice

A significant difference ($p<0.05$) was observed for apparent amylose content among the selected rice varieties. Bg 305, Bg 360 and Bg 352 had a significantly higher apparent amylose content than Bg 358, Bg 300 and At 405 under 10% polished raw form (Table 2). According to the classification of rice based on amylose content, At 405 is a low amylose type and the other five varieties belong to high amylose type. When short, medium and long grain categories were compared a clear difference in the amyloase content was not observed among them.

Table 2. Apparent amylose content of rice varieties (raw) under 10% polishing rate

Variety	Apparent amylose content (%)
Bg 305	32.5±1.3[a*]
Bg 358	26.0±0.8[c]
Bg 360	31.9±0.8[a]
Bg 300	29.3±0.4[b]
Bg 352	32.8±0.7[a]
At 405	14.9±1.3[d]

* Mean ±SD (n=3). Means bearing the same simple letter are not significantly different at p=0.05

Effect of polishing rate on apparent amylose content of rice

As shown in table 3 there is no significant difference ($p>0.05$) in apparent amylose content in raw form of Bg 305, Bg 358, Bg 352 and Bg 360 varieties under 10% polished or 5% polished conditions. When consider the parboiled varieties, there is no significant difference on apparent amylose content between 10% polished and 5% polished form of five Bg varieties (Table 4).

Table 3. Apparent amylose content of rice varieties (raw) under different polishing rates

Rice variety	Apparent amylose content (%)	
	5% polished	10% polished
Bg 305	31.9±1.8[a*]	32.4±1.3[a]
Bg 358	26.2±1.3[a]	26.0±0.8[a]
Bg 360	32.1±0.4[a]	31.9±0.8[a]
Bg 300	30.3±0.5[a]	29.9±0.4[a]
Bg 352	31.4±1.6[a]	32.8±0.7[a]

* Mean ±SD (n=3). Means bearing the same simple letter in a raw are not significantly different at p=0.05

Table 4. Apparent amylose content of rice varieties (parboiled) under different polishing rates

Rice variety	Apparent amylose content (%)	
	5% polished	10% polished
Bg 305	32.0±1.7[a*]	31.7±1.0[a]
Bg 358	26.7±2.3[a]	26.6±0.8[a]
Bg 360	33.2±0.7[a]	30.9±1.6[a]
Bg 300	30.6±2.2[a]	29.2±1.7[a]
Bg 352	34.0±1.5[a]	33.8±0.7[a]

* Mean ±SD (n=3). Means bearing the same simple letter in a raw are not significantly different at p=0.05

Effect of parboiling on apparent amylose content of rice

Referring to the table 5, there is no significant difference (p>0.05) in apparent amylose content in rice varieties between 5% polished raw and 5% polishedd parboiled suggesting that parboiling has no effect on apparent amylase content when 5% polished. The same pattern is observed between 10% polished raw and 10% polished parboiled rice varieties (Table 6)

Table 5. Apparent amylose content of rice varieties (raw andparboiled) under 5% polishing rate

Rice variety	Apparent amylose content (%)	
	Raw	Parboiled
Bg 305	31.9±1.8[a*]	32.0±1.7[a]
Bg 358	26.2±1.3[a]	26.7±2.3[a]
Bg 360	32.1±0.4[a]	33.2±0.7[a]
Bg 300	30.3±0.5[a]	30.6±2.2[a]
Bg 352	31.4±1.6[a]	34.0±1.5[a]

* Mean ±SD (n=3). Means bearing the same simple letter in a raw are not significantly different at p=0.05

Table 6. Apparent amylose content of rice varieties (raw andparboiled) under 10% polishing rate

Rice variety	Apparent amylose content (%)	
	Raw	Parboiled
Bg 305	32.4±1.3[a*]	31.7±1.0[a]
Bg 358	26.0±0.8[a]	26.6±0.8[a]
Bg 360	31.9±0.8[a]	30.9±1.6[a]
Bg 300	29.9±0.4[a]	29.2±1.7[a]
Bg 352	32.8±0.7[a]	33.8±0.7[a]

* Mean ±SD (n=3). Means bearing the same simple letter in a raw are not significantly different at p=0.05

DISCUSSION

Amylose content is considered the single most important factor for predicting the behavior of rice cooking and processing (Zhou, 2002). Amylose content is directly related to water absorption, volume expansion, fluffiness, and separatability of cooked grains. The consumer's concern is to get rice of better qualities (cooking and eating), that is largely dependent on the physico-chemical properties of starch which make up 90% of milled rice (Bhattacharjee *et al*., 2002).

The apparent amylose content of a rice variety can be varied due to the differences in the methodology adopted. Wickramasinghe and Noda (2008) have reported similar values for the amylose content of some of the varieties reported in this study. Following the blue value method, they estimated the apparent amylose content of varieties Bg 358, Bg 352, Bg 300 and At 405 to be 27.3%, 32.6%, 33.7% and 16.0%, respectively. According to Fari *et al.* (2011) the amylose content of the varieties Bg 352, Bg 300 and At 405 were 28.9%, 26.8% and 18.7%, respectively. According to Juliano (1984) the amylose content based on blue value tends to be higher. Pillaiyar and Mohandoss (1981) reported that soluble amylose (in gruel) content was negatively correlated with the temperature of parboiling process. Similarly, Archana *et al.* (2007) have also reported that significant decrease in amylose content, hot water soluble amylose content and starch iodine blue value of high temperature (>50 ^{o}C) cured and steamed *Basmati* and non-*Basmati* rice varieties compared to control samples. Ostegbayo *et al*. (2001) reported that the parboiling tends to reduce the amylose content of rice. However this study did not show any significant difference of apparent amylose content between raw and parboiled varieties of rice.

It is reported that endosperm starch amylose content is influenced by ambient temperature and that high ambient temperatures decrease the amylose content while the cool temperatures during grain development increase the amylose content (Juliano, 2003). Other than the environment temperature, genetics play a major role in the amylose content of rice. The level of waxy gene protein increases in lower temperatures leading to high amylose content in mature seeds. Therefore amylose content can vary within the same year and site of cultivation, even for the same cultivar (Suzuki *et al*., 2003). Apart from that minor genes and the environment also have an influence on amylose content of rice (Chen *et al*., 2007).

CONCLUSIONS

The apparent amylose content of rice varieties Bg 300, Bg 305, Bg 352, Bg 358, Bg 360 and At 405 under 10% polished raw were 29.3%, 32.5%, 32.8%, 26.1%, 31.9% and 14.9%, respectively. All the five Bg varieties tested in the study belong to high amylose rice while the variety At 405 is a low amylose type. There is no significant difference in the apparent amylose content with the polishing rate or parboiling operation.

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