

Original Research Article

Estimation of amylose content of rice varieties using NIR spectroscopy technique and its impact on cooking quality

Farah Shamim*, Mohsin Ali Raza, Misbah Riaz

Abstract

Rice Research Institute, Kala Shah Kaku.
Phone No. 04237951826
Fax No. 04237951827

*Correspondence Author E-mail:-
farah_tirmazi@yahoo.com

From the present study, the amylose content of the Basmati and non-basmati rice varieties of Punjab, Pakistan was assessed. The varieties of Basmati and Non-Basmati rice selected for this study were namely, Super Basmati, Basmati-515, Kissan Basmati, Chenab Basmati, Kissan Basmati, PK 1121 Aromatic, KSK 434, KSK 133, KS 282, IR-6, IR-9. The amylose content of Non-basmati varieties was found to be lowest. Whereas the amylose content in Basmati varieties was found to be lower than coarse (Non-Basmati). All the varieties were found to be significantly different between the groups but are found to be significantly similar within them.

Keywords: Amylose content, Basmati, Cooking, Non-Basmati, Rice varieties

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the supreme essential cereals in human nutrition, consumed by 2/3 of the global population. Rice is usually consumed as entire grain after cooking, and in traditional Asian diet it contributes for 40 to 80% of the total calorie consumption (Kennedy *et al.*, 2003; Paramita *et al.*, 2002; Hossain *et al.*, 2009)

Starch which is the chief component of rice, primarily determines the acceptability of the rice cultivar in terms of physico-chemical properties and cooking characteristics. Rice starch has unique benefits over other starches e.g. hypo-allergenicity, bland flavor, small granules, white colour and spreadability. Amylose and amylopectin are glucose polymers present in starch granules (Wani *et al.*, 2012; Lawa *et al.*, 2011). Amylose is fundamentally linear, consist of α -(1,4)-linked D-glucopyranosyl units while amylopectin is extremely branched and made up of α -(1,4)-linked Dglucopyranosyl units joined through α -(1,6) linkages. On the basis of amylose content, rice is classified as waxy (0-2% amylose), low (10-20% amylose), intermediate (20-25% amylose) and high (>25 amylose) (Yu *et al.*, 2009).

Starch is composed of essentially linear amylose and highly branched amylopectin polymers. Amylose has capability to form a firm gel during the gelatinization process and prone to retrogradation during storage,

whereas amylopectin illustrates low syneresis and high resistance to starch retrogradation. Amylose content (AC) is being considered to be one of the most important traits related to the cooking quality of rice (Bhattacharya *et al.*, 1982; Deepa *et al.*, 2008; Cai *et al.*, 2011). AC in endosperm is closely correlated with cooking and eating quality of rice and is mainly governed by genetic effects and environmental conditions (Amaka *et al.*, 2013; Yang *et al.*, 2014).

The amylose content of the rice starch directly affects the cooking and sensory properties of rice It varies among the different rice cultivars. A high-amylose rice grains increases their volume, become flaky and harder during cooling. Low-amylose rice grains are moist and sticky after cooking (Prasantha *et al.*, 2014; Chung *et al.*, 2011). It is a well-known fact that other physico-chemical and functional properties are also changed with the amylose content of rice (Sodhi and Singh, 2003; Hettiarachchi *et al.*, 2016). On the other hand, amylose/amylopectin ratio, greatly affects the physico-chemical and functional properties such as pasting, gelatinization and retrogradation. Calingacion *et al.*, 2015).

Rice varieties with higher amylose content are more prone to leach out solids into the cooking water during

cooking. It relates negatively with taste panel scores for color, cohesiveness, tenderness and gloss of rice. It is almost absent from the waxy (glutinous) rice. Such rice does expand in length not volume, glossy, non-sticky, flaky and remain firm when cooked (Juliano, 1971; Rebeira *et al.*, 2014).

All of the Japonica varieties of temperate regions have low amylose content. Varieties grown in the Philippines, Malaysia and Indonesia have intermediate amylose content. Both intermediate and high amylose types are generally grown in Indian sub-continent and the preference is for the earlier type. Intermediate amylose rice cook tender and moist and do not become stiff upon cooling. Sensory and functional end-use quality characteristics of varying rice cultivars are directly affected by amylose content such as rice flavor and texture. The sensory quality of retrogradation in rice is affected by the amount of amylose that is not complex with lipids affecting cooked rice storage time. Characterization of amylose kernel distributions is relevant to sensory and functionality as more uniform rice tends towards more uniform performance in various food processing. Champagne *et al.* (2004).

Traditionally, iodine calorimetry has been the technique employed by Scientists to determine the amylose content in cereal grains. However, it is extensively identified that this technique has concerns in Rice grains samples, such as the indefinite amount of amylose complexing with the residual lipid (left behind in milled rice), as well as the amount of iodine complexing with the amylopectin. These problems may lead to complications of properly detecting amylose content and cause an unpredictability in scientific papers (Fitzgerald *et al.*, 2009).

More quick determination of amylose content by utilizing NIR techniques on bulk or single kernel in varying rice cultivars may contribute positive economic impact and may stimulate less variability in amylose contents of same variety (Villarea *et al.*, 1994; Liu *et al.*, 2009).

Use of NIR analysis could lead to more rapid calculation of rice starch obtained from large sample numbers to aid in earlier selection or rejection in rice breeding programs (Bao *et al.*, 2001). Rapid assessment of amylose may also enable breeders to select for target micro-minerals for human or animal nutrition. Furthermore, quick amylose content analysis may develop the awareness of the sensory traits of rice flavor and texture that amylose affects marketing of the final product. The promptness that NIR analysis provide for amylose assessment help breeders to develop the appropriate cultivars in a much shorter time period (Bett-Garber *et al.*, 2001).

Being the major source of Agriculture, rice plays an important role in the state economy. Pakistan has its climatic and physiography favorable for rice cultivation and the crop is grown in a wide range of agro-ecological

sites. It is grown from hill slopes to very deep-water areas during very wet humid months to drier period of the year. Studies on rice quality have been carried out by various institutions/ researchers. However, investigation on the amylose content of rice varieties is limited in two races (Basmati and non-basmati) of Pakistan (Asghar *et al.*, 2012). Based on these facts, the key objective of the current study was to relate and provide details for amylose composition of different indigenous rice varieties of Pakistan and its influence on end product quality.

MATERIAL AND METHODS

Procurement of raw material

For the present study, 11 approved varieties of rice were harvested from the Farm Area, Rice Research Institute, Kala Shah Kaku, Lahore, Punjab, Pakistan. Each rice variety weighing 500gm after manual cleaning, was dehusked separately by passing through a Dehusker (Satake, Japan) to yield brown rice. After dehussing samples were polished by Polisher (Satake, Japan) for 35 seconds to get white rice. Samples were stored at room temperature in plastic bags for further analysis after proper labeling.

Chemical Analysis

Determination of amylose content

Amylose content (AC) of milled rice samples was measured by using Auto grain analyzer (AN-900 KETT Japan) using the principle of NIRT. 20g sample of each variety was placed in sample Cassette. Sample case was placed at Auto analyzer opening and noted the amylose reading on display screen. Reference sample of known value in Auto grain analyzer was run as sample run for calibration purpose.

Statistical analysis

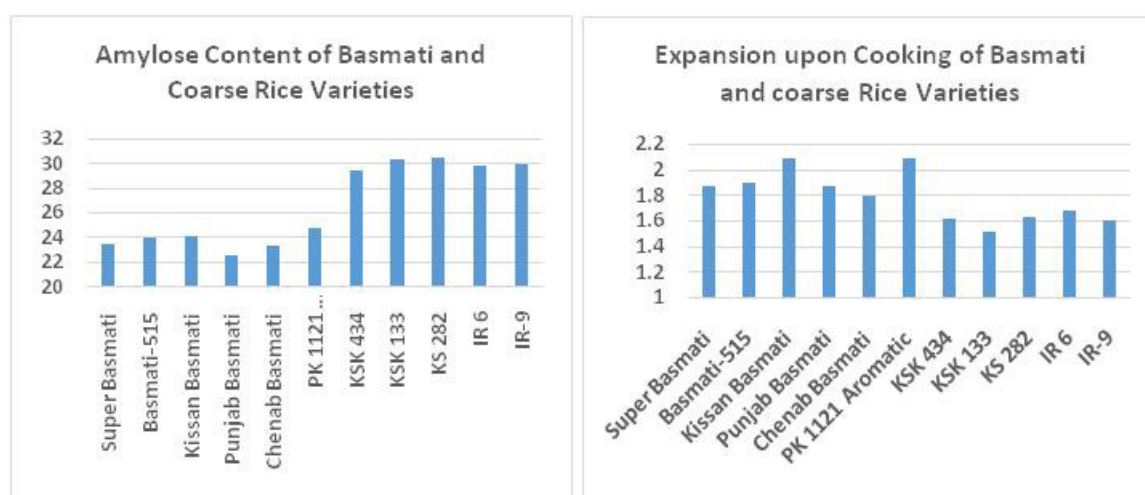
All the analysis was performed in triplicates and presented as mean. Statistical significance of the data obtained was analyzed by One-way analysis of variance (ANOVA) by using Statistix software 8.1. The significance difference was tested by LSD of mean at 95 % Confidence interval.

RESULTS AND DISCUSSION

Amylose content exerted significant role in determining the overall cooking, eating and pasting properties of a rice varieties. Starch is the major constituent of rice and

Table 1. Provide table legend

Variety	Amylose Content	Length wise Expansion upon Cooking
Super Basmati	23.5	1.87
Basmati-515	24.0	1.89
Kissan Basmati	24.1	2.09
Punjab Basmati	22.6	1.87
Chenab Basmati	23.3	1.79
PK 1121 Aromatic	24.8	2.09
KSK 434	29.4	1.61
KSK 133	30.3	1.52
KS 282	30.5	1.63
IR 6	29.8	1.68
IR-9	30.0	1.6

**Figure 1.** Provide figure legend

the amylose content of rice differ among the varieties. The results of the amylose content presented in table 1 revealed a wide range of variation of both Basmati and Non-Basmati samples. The amylose content of the Basmati and non-basmati samples ranged from 21±29g/100g. The present results are slightly similar with the study of Asghar *et al.* (2012) who found the amylose content of brown rice varieties to be 22.90 to 26.19g/100g. Form the statistical analysis; it was found that the polished samples of Basmati lines were found to be statistically at par ($p > 0.05$) within them. However, PK 1121 Aromatic, Basmat-515 and Kissan Basmati contained amylose levels statistically similar within them. All the varieties were found to be significantly different between the Basmati and Non-basmati but are found to be significantly similar within them. In a study by Thomas *et al.* 2013 among different rice varieties, brown rice had the lowest amylose content of 3.36±0.60 % and the amylose content was found to be highest in the white rice i.e. 27.71±1.20%.

According to food classification based on amylose content, non-basmati varieties had relatively higher

amylose content. Basmati varieties had intermediate amylose as observed from this study. The observed levels of amylose are consistent with data in previous studies on milled rice varieties. The samples studied by Odenigbo *et al.* (2013) had amylose content in the range of 8.59% to 18.57%. (Table 1.), Figure 1

Processing and cooking can be judged only by Amylose Content (AC) and considered the most important character. Juliano (1979); Webb, (1985). The difference in the amylose content within the varieties may be due to differences in the variety, environmental factors such as temperature and processing. The difference may also be due to presence of bran layer in the brown rice which contains less amount of starch. The amylose content of polished varieties increased which may be due to the fact that starch is mostly concentrated in the endosperm and less in the bran. AC content show dominance over intermediate and low AC contents Kumar and Khush(1986).

Basmati varieties generally have an intermediate AC of 20–25% and their grains remain firm and separated after cooking. Basmati 370 showed an intermediate AC of

19.6%, whereas the non-basmati parent MR 84 had a high AC of 28%. The AC range for the developed mapping population was 14-26%, and only 15 individuals were found to have an AC lower than 19%. A long slender grain with a delicate curvature is another unique characteristic of Basmati rice. Basmati 370 was characterized by extra-long grains of 2.0cm, whereas MR 84 had comparatively shorter grains of 1.5cm. Amylose content is directly related to water absorption, volume expansion, fluffiness of cooked rice. It is inversely related to cohesiveness, tenderness, and glossiness. Zhoust, (2001). Amylose content is positively correlated with hardness and negatively correlated with stickiness. Suwannaporn,(2007).

CONCLUSION

Varietal differences were evident in Amylose content and cooking characteristics of rice. Basmati varieties were found to be lower in Amylose comparison to the Coarse varieties but insignificant among varieties. Volume expansion and amylose content are inversely proportional to each other as evident by this study. This information can be utilized for devising the breeding plant to their improvements for cooking quality.

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