Cooking and eating characteristics of Rice (*Oryza sativa* L.)—A review

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Abstract

Rice is staple food of Pakistani inhabitants and is a source of foreign exchange earnings. It is an immense source of starch. Rice starch is digested so quickly than any other high starchy food and this aspect make it distinctive among other cereals. The cooking and eating value is determined by the amylose content and gelatinization temperature. The cooking and eating characteristics of rice is the base of choice for the consumers. The amylose content is great determinant of rice cooking and eating characteristics. The introduction of newly evolved rice cultivars and high yielding rice varieties have enhanced the rice yield to a great extent, but no or little emphasis has been given to evaluate the cooking and eating characteristics of Pakistani rice varieties. The present literature was reviewed to analyze the physicochemical properties, cooking and eating characteristics and amylose content of different rice cultivars.

Keywords: Rice, starch, amylose, gelatinization, basmati

Physical and chemical changes occur during the rice storage. The eating and cooking properties are affected by the starch, protein and protein interaction, only structural changes occur rather than the change in the starch and protein interactions. These structural changes affect the flavor, texture, gelling and pasting characteristics. The range for milling of rice varieties was 64-70% and head rice out-turns range was 82%. The rice variety Superfast showed the highest milling out-turns that was nearly 70% while the lowest was observed for Khazar (Zhou et al., 2002)

Rice is an enormous source of starch and it is the component which affects the cooking and eating properties of rice. Rice starch is digested so quickly than any other high starchy food and this aspect make it distinctive among other cereals. The cooking and eating value is determined by the amylose content and gelatinization temperature. The cooking and eating characteristics of rice is the base of choice for the consumers. The amylose content is great determinant of rice cooking and eating characteristics. Amylose content is significantly affected by the various storage intervals and treatments. The amylose content of Basmati Super (222.91) and Basmati-385 (21.97) indicated a significant difference between the amylose content of Basmati Super (222.91) and Basmati-385 (21.97). An increase in gelatinization temperature has been observed with the decrease in alkali spreading value of rice starch. Basmati-385 had 3.75 for alkali spreading value while Basmati Super has mean value 4.27. The cooked rice texture perceived by the consumer governs the rice receiving. It is a multidimensional characteristic and palatability of rice is governed by these textural characteristics. The rice variety, amylose content, gelatinization temperature and cooking methods are the factors affecting the rice texture. Rice texture is soft and sticky for varieties having low amylose content while rice varieties become stiff and fluffy on cooking having high amylose content (Shabbir, 2008).

The grain size and shape were explained by the scale for size category. Cooking and eating characteristics included the grain elongation, amylose content, gel consistency, gelatinization temperature and aroma (Khush et al., 1979).

Rice varieties according to round, medium or long shape as well as by the ratio of length to width ratio. The shape of Indica rice varieties is wider and dense while grains of Japonica are more in length wise arrangement and slender in configuration. The classification has been suggested on the basis of cooking properties and final gelatinization temperature. The grains of japonica type cook non-sticky and well—separated while the grains of indica type become
soften on cooking and become mashy (Kent, 1982).

The six rice varieties showed the similar morphological appearance, but differ in amylose content and pasting characteristics. The structure of wild rice amylopectin was near to the waxy rice amylopectin possessing more branching and a large proportion of short branch chains. The difference in physicochemical characteristics of six wild rice varieties was due to the difference in branch chain length distribution of amylose and amylpectin (Wang and Porter, 2002).

Starch is the most important factor in rice, therefore, rice texture is significantly affected by the gelatinization and retrogradation of starch. Quite minor and medium gelatinization temperature has been observed in short and medium grain cultivars (Fan et al., 1999).

The tenderness and stickiness of the rice kernel is determined by the cooking time. The rice imbibition ratio is inversely related with the weight of cooked rice. The consumers of urban areas prefer rice which expands more in length wise than breadth wise on cooking while the working class consumers are not so much conscious about the rice whether it expands more in length wise arrangement or breadth wise (Denials et al., 1998).

The cooking quality of rice is influenced by the gelatinization and retrogradation characteristics of its starch. The range for high amylose containing rice was generally from 15-35%. The rice grains become dry and become firm upon cooling. The rice varieties having low amylose content cook wet and sticky. In major rice producing areas of the world intermediate amylose contents of rice is like most. There are many factors affecting the physicochemical properties of rice starch. The physicochemical properties are manipulated broadly by the varieties, composition and structure, processing method and storage conditions of rice starch. On other hand, many factors like rice cultivars, moisture content, proteins content, lipid, amylose content, processing methods, prolamin, pH affect the amylose content of rice (Zhou et al., 2001; Zhou et al., 2003).

The physicochemical properties such as pasting properties and gel vigor are the most significant characteristics. Starch is the principal component in rice due to which gelatinization of starch significantly affects the properties of cooked rice. The milled rice contain starch as the major constituent and its features differ broadly among different rice cultivars as depicted by the amylose: amylpectin ratio and final gelatinization temperature. Amylose is considered as major factor responsible for the functional changes. The pasting properties rice starch granules are governed by the rigor of starch granules, which in turn affects the swelling potential of rice starch granules (Juliano, 1990).

The cooking and eating characteristics of rice starch are controlled by the rice starch source, genotype and amylose: amylpectin ratio. Short term as well as long term storage has effect on rice pasting as well as cooking and eating characteristics but the long term storage has significant effect (Perdon et al., 1997).

The rice starches with high amylose: amylpectin ratio take up more water during boiling and are considered more desirable for cooking purpose. Amylose content affect the cooking and eating properties and difference in rice varieties such as grain whiteness, grain shape. The rice cooking and eating properties are greatly subjective to Gelatinization temperature and amylose content. Gelatinization temperature which is very important test to determine the cooking quality of rice. Its range varies from 55°C to 79°C (Chrastil et al., 1992).

The high amylose content is correlated to the high volume expansion ratio and flakiness of rice. High AC in rice grains causes rice to become dried, decrease in softness and hard upon cooling in contrast to low amylose content. Higher peak viscosity has been observed for the stored rice than fresh rice. Ageing reduces the ability of starch granules to crack and split open after cooking to a large extent but the final viscosity and set back increases with the increase in storage time. Storage increases the rice hardens but stickiness decreases. The cooking and eating characteristics are greatly determined by its gelatinization characteristics. Rice viscosity increases with the increase in storage. The peak viscosities of rice decreases after storage as measured by amylograph, it was lower as compared to fresh rice and the same trend was observed for the final viscosities. The decrease in the peak viscosities of rice starch granules showed that the stored rice showed more resistance than the freshly harvested rice. The increase in peak viscosity was observed up to 6 %, setback value was 33 % and final viscosity was 19%. Zhout et al., (2001), described that the
cooking quality of rice is influenced by the gelatinization and retrogradation characteristics of its starch (Zhou et al., 2003).

The range for high amylose containing rice was generally from 15-35%. The rice grains become dry and become firm upon cooking. The rice varieties having low amylose content cook wet and sticky. In major rice producing areas of the world intermediate amylose contents of rice is like most. There are many factors affecting the physicochemical properties of rice starch. The physicochemical properties are manipulated broadly by the varieties, composition and structure, processing method and storage conditions of rice starch. On other hand, many factors like rice cultivars, moisture content, proteins content, lipid, amylose content, processing methods, prolamin, pH affect the amylose content of rice (Lai, 2001), stated that the milling methods, storage conditions freezing and melting conditions direct the physicochemical properties of rice starch.

The variation has been observed in the aroma of recently reaped and warehoused rice grain as well as its volume expansion and elongation ratio also showed variation. The amylose: amylopectin ratio of rice is the central property of rice starch and it is important parameter to determine the eating and cooking characteristic. Rice starches with high amylose: amylopectin ratio take up more water during boiling and are acknowledged extra pleasant for eating and cooking purpose. The rice varieties showed distinction in amylose content. The composition of the volatile compounds of rice and rice aroma was not contributed by any single volatile compound, however, 2-acetyl-1-pyrroline it is the most donating compounds for its contribution towards aroma in rice varieties (Singh et al., 2006).

The cooking and pasting characteristics of rice starch in Asian rice varieties. The milled rice samples of five cultivars were studied for their protein and amylose content and its range was 5.74 to 10.98% and 5.74 to 10.98% respectively. The range for peak viscosities was 510 to 1085 Brabender Units (BU), Final viscosities at 95°C were 40 to 635 BU and set back values were -405 to -620 BU. (Juliano et al., 1992),

Rice eating and cooking quality is predicted by the amylose content which is the single main vital factor. The amylose operate as diluent as well as at the same time as an inhibitor of swelling of rice starch granules. The amylose content method is more precise to point out the difference in cooking quality of different rice varieties. The variation among rice varieties and their pasting properties is greatly affected by starch and water concentration, protein and operating conditions of the experimental instrument (Batey et al., 2000).

Cooked rice texture which governs the rice reception is perceived by the consumers. Rice texture is a multidimensional characteristic and firmness and gumminess of rice is significant and palatability of rice is governed by these textural characteristics. There are number of factors affecting the rice texture including the variety, amylose content, and cooking methods. The rice characteristics are significantly influenced by the gelatinization and retrogradation of starch as starch is the leading factor which has significant influence on these properties. Relatively low gelatinization temperature has been observed for short and medium grain cultivars. The gelatinization and retrogradation properties of rice are significantly subjected by the temperature, time interval and moisture content during storage. The variation in amylose content was 7.83 to 18.86% showed by different rice cultivars. The amylose content in five cultivars has been separated and it was lowest in PR-103 which is 7.83%, the highest amylose content was shown by the PR-113, PR-114 possess intermediate amylose content, PR-114 contain 16.13% and IR-8 has 15.83%. The starch granules swell upon heating and the amylose content within the granules leaches out concurrently. A three dimensional network develops from the leached amylose. The paste is formed by the gelatinizing the aqueous suspension of starch. The high starch concentration causes the paste to be settled into gel rapidly (Bergman et al., 2000),

The amylose content of rice varieties and milling fractions of brown rice was 22.90% to 26.19% and for white rice varieties 24.14% to 25.31%. IIRI-6 contains higher content of amylose and followed by the KS-282 and Super Basmati. The milling fraction of the IRRI-W (26.81%) contains the highest amylose followed by KS-R (26.69%) and IRRI-B contains 25.46%, KS-B contain 25.34%, 23.41% for B2-W, 23.37% for SB-B and the B2-B hold the lowest amylose contents. The amylose content in the range of 18.60-28.0% for different rice varieties (Shabbir et al., 2006).
Amylose content varied from 18.6 to 26% for Basmati varieties showed lower amylose content. The most varieties showed 3.1 to 7.0% alkali spreading value. Water uptake is positively correlated to the alkali spreading value and it ranged from 172-450%. Protein content showed positive correlation with the elongation ratio of rice and it ranged from 6.01 to 10.26% (Chordhury and Ghosh, 1979).

The varietal properties of rice such as grain size, shape and percentage hull, dormancy and bulk density to a great extent influence the grain quality. The increase in paste viscosity is governed by the starch when it is cooled, this results in the swallowing of starch granules to be ruptured when held at high temperature and subjected to permanent shearing action and it is measured by Breakdown viscosity, degree of retrogradation is measured by setback viscosity. The starch content of milled rice become swollen on cooking by absorbing moisture and some solid content is also dissolved on cooking due to the gelatinization of the starch granules. Rice elongation ratio has a significant relationship with other cooking characteristics. There exist a strong positive correlation with kernel length and with length to breadth ratio and alkali spreading value, water uptake ratio and negative relationship exist with kernel breadth after cooking, gel consistency, optimum cooking time and gelatinization temperature. Positive correlation exist among optimum cooking time with water uptake ratio and kernel breadth after cooking kernel length and breadth after cooking and negative correlation with elongation ratio and cooking time (Juliano, 1990).

High amylose content has been experienced with the coarse rice varieties which are closely interconnected to the property of dry on cooking and less gentleness IIRI-6 has highest FV95°C, 527.0 BU and Basmati 2000 has 453.0 FV95°C, which is lower FV95°C of KS-282 showed 517.0 BU and Super Basmati (SB) varieties showed 472.0 BU, respectively. The highest FV95°C was observed in milling fraction of IRRI-W 545.0 BU and in B2-B. The CV50°C for brown rice of milling fraction is 826.75 and 900.75 BU for white rice. IRRI –W contains highest CV50°C for 992.0 BU and KS (973.0 BU), IRRI-B (879.0 BU), KS-B 859.0 BU, SB-W (833.0 BU), B2-W (805.0 BU), B2-B (774.0 BU) and lowest was found in B2-B (774.0 BU). Storage temperature and treatments greatly affect the volume expansion ratio. The water absorption ratio is determinant of rice eating and cooking quality. Two rice varieties were observed for the affect of treatment and storage intervals. The elongation ratio is greatly determined by the storage interval and treatment (Shabbir et al., 2006).

Conclusion

The cooking and pasting characteristics of different rice varieties varied among the rice varieties. This variation also exists among the physical, chemical and sensory characteristics between rice cultivars. The difference in these parameters can be exploited by the rice breeders in their hybridization programme. The better quality rice is also delighted by the consumers.

References


