The Pharma Innovation Journal 2022; 11(11): 1201-1204

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(11): 1201-1204

www.thepharmajournal.com
Received: 02-08-2022
Accepted: 03-09-2022

Sunil Indrajit Warwate
Division of Biochemistry, ICAR-Indian Agricultural Research Institute, New Delhi, India

Haritha Bollinedi
Division of Genetics, ICAR-Indian Agricultural Research Institute, New Delhi, India

Veda Krishnan
Division of Biochemistry, ICAR-Indian Agricultural Research Institute, New Delhi, India

Archana Singh
Division of Biochemistry, ICAR-Indian Agricultural Research Institute, New Delhi, India

Corresponding Author:
Archana Singh
Division of Biochemistry, ICAR-Indian Agricultural Research Institute, New Delhi, India

Diversity in starch and its components among the basmati rice (*Oryza sativa* L.) genotypes

Sunil Indrajit Warwate, Haritha Bollinedi, Veda Krishnan and Archana Singh

Abstract
The production and consumption of basmati rice have increased tremendously in the present time. Starch is the principal component we are getting from rice grain. The quality of starch depends on the amount of amylose and amylopectin. There are increased health risks from consuming rice which has come out due to its high glycemic index. Therefore, starch and its components have been estimated in 10 basmati rice genotypes. In the current study, the starch content among the studied basmati rice genotypes ranged from 77.05 to 81.39 percent. The amylose and amylopectin contents were found to be 17.04 to 27.82% and 49.88 to 63.03% respectively. In addition to this, the ratio of amylose to amylopectin was 0.27 to 0.56. Therefore, it is concluded that these basmati rice genotypes have moderate amylose to amylopectin contents and thus consuming such genotypes may slow down the rise in blood sugar levels, and hence consumers may avoid the possibility of diseases like diabetes, obesity, fatigue, etc. This information may be utilized with some additional research to manipulate the starch quality of basmati rice.

Keywords: Basmati rice, starch, amylose, glycemic index

1. Introduction
Rice (*Oryza sativa* L.) is one of the world's oldest cereals, forming a staple diet for more than half of the world's population. Asia produces about 90% of the world's rice. A majority of grain dry weight is composed of carbohydrates. The starch molecule is an abundant storage polysaccharide in plants that is the most common form of carbohydrate in foods. Approximately 25% of the calories in rice come from starch, which is decomposed into glucose by enzymes such as amylase and amyloglucosidase. Starch is frequently used in the food, biomedical, pharmaceutical, and other industries due to its affordability, biodegradability, and safety (Chen *et al*., 2018; Bashir and Aggarwal, 2019) [1, 2]. The two main components of starch are amylose and amylopectin. Amylopectin is a highly branched polymer linked by α-1, 6-glycosidic linkages at branch points, whereas amylose is largely a linear polymer linked by α-1, 4-glycosidic bonds (Nakamura and Kainuma, 2022) [3]. Rice varieties have a differential amount of these compounds, which affect the texture and starch quality of rice. Basmati rice is known as the queen of fragrance and is traditionally grown in India, Pakistan, and Nepal. As of now, the 1966 Seeds Act has been approved for 34 different types of basmati rice. According to 'The Economic Times' dated 30 August 2022, 3.94 million tonnes of basmati rice worth $3.54 billion were exported from India in 2021-2022. Basmati rice has milled grains that are extra-long and thin with a pleasant aroma (Singh *et al*., 2018) [4]. Cooking leads to a soft and fluffy structure, in addition to the elongation of grains at least twice as much as their original size. Since basmati rice has a considerable amylose level, post-cooking causes it less sticky. In contrast, sticky rice also known as glutinous rice becomes sticky after cooking because of having high amylopectin content. Because of this, basmati rice has a high demand in both the domestic and global markets, despite being the priciest. Agroclimatic conditions, harvesting methods, processing, aging, etc. impart characteristic features to the basmati rice. In addition, basmati rice typically has less arsenic, which may make it a good choice if rice is a staple food in our diet. The glycemic index (GI) is a measure of how well a food containing carbohydrates raises blood glucose levels. Based on their GI scores, foods fall into three categories: low, moderate, and high GI foods, with GI scores of less than 55, 55-70, and more than 70, respectively (Sievenpiper *et al*., 2018; Dona *et al*., 2010) [5, 6]. Basmati rice has lower glycemic index (50-58) compared to white rice (about 72). Diet with more basmati rice may overcome problems like type 2 diabetes, obesity, etc. Since starch components play vital role in the determination of glycemic index.

Due to the increasing preferences as well as demand of basmati varieties, we have studied the starch and its composition of 10 diverse basmati rice genotypes based on their consumption.

2. Material and methods

Matured seed kernels of a total of 10 basmati rice genotypes were procured from the Genetics Division of the Indian Agricultural Research Institute (IARI), New Delhi-110012. Rice kernels were hulled in a Satake huller (1900, No. 554023) and then milled in a Satake Grain Testing Miller (Tm-05, No.554023, Japan). These samples were stored in airtight vials for further investigation.

Table 1: List of 10 diverse basmati rice genotypes used in the present study

S. No.	Name of genotype	S. No.	Name of genotype
1	Basmati-397	6	Chimbalate Basmati
2	Basmati Surkh-161	7	Pusa Bsmati-1121
3	Basmati-802	8	Super Basmati
4	Basmati-6141	9	Rajendra Basmati
5	Seond Basmati	10	Pusa Basmati-1509

2.1 Estimation of Metabolites

2.1.1 Total starch

Total starch content (TSC) was estimated as per Krishnan *et al*., 2020 [7]. 100 mg of samples were finely grounded using mortar and pestle. The starch was extracted twice with hot 80% ethanol. The residue was then treated with 6.5 mL of 52% perchloric acid and 5 mL of distilled water. Centrifugation was performed for 10 min at 25 °C. The supernatant was collected and a 100 mL of the final volume was made using distilled water. A suitable aliquot was treated with 5 mL anthrone (0.2%) reagent and absorbance were recorded at 620 nm. TSC was calculated using a glucose standard curve.

2.1.2 Amylose content

The colorimetric technique was used to assess the amylose content (AC) (Juliano, 1971) [8]. 100 mg of samples were finely grounded using mortar and pestle, then 1 mL of ethanol (95%) and 9 mL of sodium hydroxide (1 N) were added. The tubes were incubated for 15 min in a boiling water bath then 100 mL of volume was made using distilled water. Another 100 mL volumetric flask was filled with a 5 mL aliquot, 1 mL of 1 N acetic acid, and 2 mL of 0.2% iodine solution before being placed in the dark for 20 min. At 620 nm, the absorbance was measured and AC was calculated using a standard curve prepared from potato amylose (Sigma).

2.1.3 Amylopectin content

Amylose/Amylopectin Megazyme assay kit (International Ireland, Ltd., Bray, Ireland) was used to quantify the amylopectin content (APC). In order to lose lipids 20 mg of powdered sample with 1 mL of dimethylsulphoxide (DMSO) was heated, and 6 mL of 95% ethanol was used to precipitate starch. It was also added a 100 mM acetate-salt solution (pH 4.5). Centrifugation was used to precipitate amylopectin using a 4 mL concanavalin A lectin solution. Then α-amylase and amyloglucosidase were used to hydrolyze APC into D-glucose and it is measured using glucose oxidase-peroxidase (GOPOD) at 510 nm.

2.2 Statistical analysis

Two biological and three technical replicates were used to produce the results. When comparing a dataset's dispersion to its mean, the standard deviation (±) is employed as a measure.

3. Results and Discussions

3.1 Total starch contents

Almost half the world's population consumes rice for calories and the increased demand and preference for basmati rice led us to determine the starch level in different basmati genotypes. In the present study, 10 basmati rice genotypes had total starch content ranging from 77.05 to 81.39 percent (Fig. 1), with Basmati-6141 having the highest total starch content and Pusa Basmati-1509 having the lowest. Total starch content is 77.53, 77.71, 78.04, 78.88, 79.43, 79.9, 80.08, and 80.99 percent in Rajendra Basmati, Basmati-802, Pusa Basmati-1121, Basmati-397, Chimbalate Basmati, Basmati Surkh-161, Super Basmati, and Seond Basmati respectively. The findings of the current investigation were consistent with those of Kale *et al*., 2015 [9], for Pusa Basmati-1121. Deepa *et al*., 2010 [10], measured the total starch content of three rice cultivars and found it in between the 79 to 89% range. Based on our results, basmati rice genotypes have an average starch content of 79.13 percent. Although normal rice and basmati rice genotypes have a similar range of starch content, the glycemic index is determined by amylose-to-amylopectin ratios. Accordingly, we estimated the amylose and amylopectin content of basmati rice genotypes to correlate with starch digestibility in the human diet.

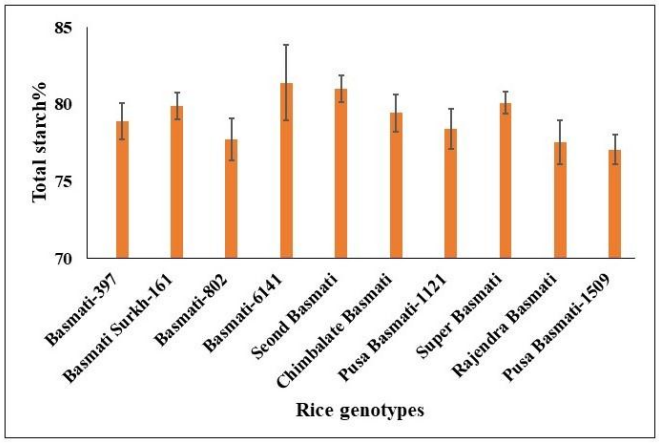

Fig 1: The amount of total starch contents in 10 diverse basmati rice genotypes. Results are shown of two biological and three technical replicates with ± standard deviation

3.2 Amylose content

Amylose works well as a thickening, a water binder, an emulsion stabilizer, and a gelling agent in industrial and nutritional settings. In the current investigation, we theorized a relationship between blood sugar levels and the proportion of amylose content from various types of basmati rice. The relative amylose content of 10 basmati rice genotypes ranges from 17.04 to 27.82% (Fig. 2), where Basmati-802 with maximum AC and Super Basmati with least. Amylose contents were found 25.83, 24.38, 24.36, 22.14, 21.97, 20.44, 18.93, and 17.77 percent in Chimbalate Basmati, Pusa Basmati-1509, Basmati-6141, Basmati Surkh-161, Basmati-397, Rajendra Basmati, Seond Basmati, and Pusa Basmati-1121 respectively. In agreement with our findings Naseer *et*

al., 2021 [11], reported that among the various rice genotypes, the apparent amylose content (AAC) varied significantly from 15.40 to 28.31%. In addition, Govindaraju *et al*., 2022 [12], studied ten rice genotypes and reported that amylose content ranged between 7.50 and 28.58%. Bhardwaj *et al*., 2019 [13] crossed Basmati 370 with Pusa Basmati 1 and created a total of 140 recombinant inbred lines to evaluate rice grain quality based on amylose concentration variation. According to their findings, the amylose content varied between low (18.1%) and moderate (24.5%). The genotypes of basmati rice, therefore, have an average of intermediate amylose contents, according to the current findings and the literature that is currently in use. Therefore, using basmati rice in our diet, won't cause a sharp increase in blood sugar levels, which may reduce the health issues associated with rice.

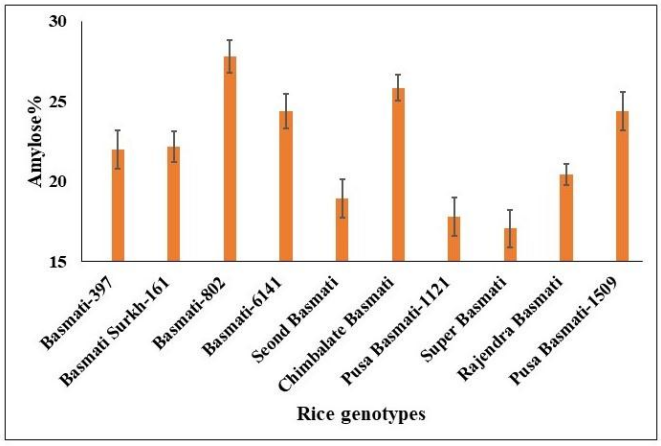

Fig 2: The amount of amylose contents in 10 diverse basmati rice genotypes. Results are shown of two biological and three technical replicates with ± standard deviation

3.3 Amylopectin content

Amylopectin, a highly branched starch molecule, is what gives the rice its gelatinous and sticky texture. The amylopectin content from 10 basmati rice genotypes was found in the range of 49.88 to 63.03% (Fig. 3) where Super Basmati with maximum amylopectin and Basmati-802 with least. Amylopectin content was measured 62.06, 60.62, 57.76, 57.09, 57.03, 56.91, 53.60, and 52.68 percent in Seond Basmati, Pusa Basmati-1121, Basmati Surkh-161, Rajendra Basmati, Basmati-6141, Basmati-397, Chimbalate Basmati, and Pusa Basmati-1509 respectively. Ansari *et al*., 2021 [14], observed that the amylopectin content of a total of 8 basmati rice varieties ranged from 75.6 to 79.8% while Chakraborty *et al*., 2009 [15], found that amylopectin of rice genotypes varies from 74.44 to 84.75%. They got a higher percentage because they calculated amylopectin indirectly by deducting amylose content from total starch content while we calculated directly with the Megazyme kit. As a result, the current study concluded that Super Basmati (high amylopectin) rice genotypes may create sticky rice after cooking and get digested more quickly than those with low amylopectin. Linking the digestibility and subsequent rise in blood sugar to the specific contents of amylopectin or amylose is rather challenging. We further evaluated the ratio of starch components to produce a more precise result.

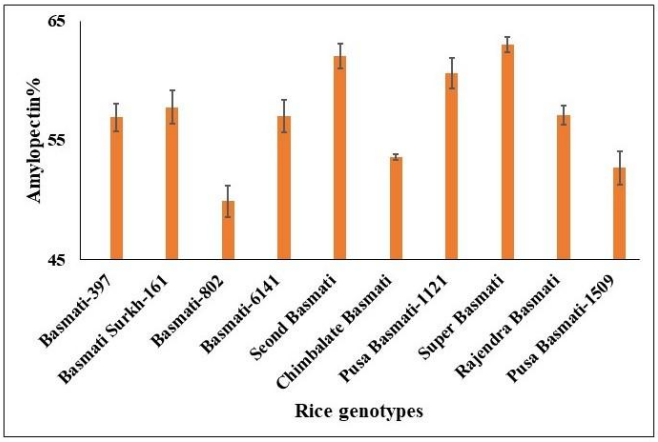

Fig 3: The amount of amylopectin contents in 10 diverse basmati rice genotypes. Results are shown of two biological and three technical replicates with ± standard deviation

3.4 Ratio of amylose to amylopectin

Various types of starches and varied cultivars of the same crop have different ratios of amylose to amylopectin. The amylose to amylopectin ratio in this study ranged from 0.27 to 0.56 (Fig. 4) where Basmati-802 with maximum amylose to amylopectin ratio and Super Basmati with least. Amylose to amylopectin ratio was found 0.29, 0.31, 0.36, 0.38, 0.39, 0.43, and 0.46 in Pusa Basmati-1121, Seond Basmati, Rajendra Basmati, Basmati Surkh-161, Basmati-397, Basmati-6141, Pusa Basmati-1509, and Chimbalate Basmati respectively. The amylose to amylopectin ratio of a total of 8 basmati rice varieties ranging from 0.25 to 0.32 (Ansari *et al*., 2021) [14] has been reported earlier also in this line. The ratio of amylose to amylopectin is important because rice genotypes with the almost same amount of amylose may have differences in their physiochemical properties and hence leads to variation in the digestibility and the rise of blood glucose. Therefore, the present study suggests that the ratio of amylose to amylopectin may determine the digestibility quality of basmati rice genotypes. As per our findings, the best starch genotype for eating and cooking is Basmati-802, followed by Chimbalate Basmati and Pusa Basmati-1509.

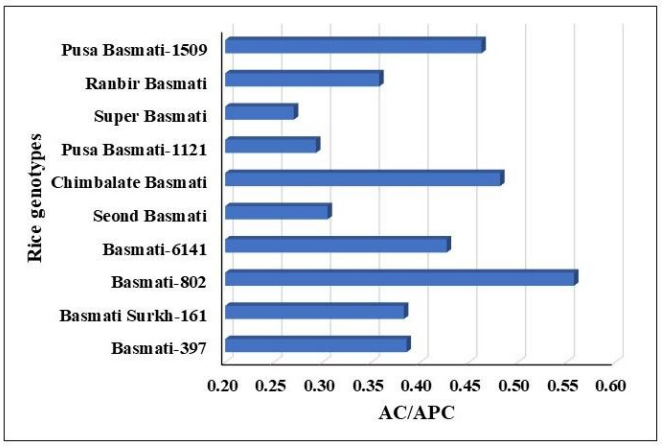

Fig 4: The amylose to amylopectin ratio in 10 diverse basmati rice genotypes has been indicted by stacked bars. Here, AC stands for amylose content and APC for amylopectin content.

4. Conclusion

The consumption of basmati rice has increased throughout the world. India is a major producer and exporter of basmati rice. People are getting calorific demand from rice starch. Starch is used in a wide range of food and non-food applications. Therefore, the author estimated the amount of starch in the different basmati rice genotypes. The quality of starch might be affected by the ratio of amylose to amylopectin. The level of amylose and specifically the ratio of starch components may affect the glycemic index and hence the blood sugar level. Among the studied 10 basmati rice genotypes, Bsamti-6141 had the maximum starch content. Whereas Basmati-802 and Super Basmati had maximum amylose and amylopectin contents respectively. The ratio of amylose to amylopectin was found maximum in Basmati-802. Therefore, it indicates that genotypes with high amylose content might form complexes with the other components like fatty acids and hence get digested incompletely in the small intestine. In addition, high amylose may form structural changes in the starch granule. Therefore, eating such rice may reduce the risk of diabetes, obesity, fatigue, etc. Breeders may directly use these genotypes to improve the starch quality of basmati rice through hybridization approaches.

5. Conflict of interest

We confirm that there are no known conflicts of interest associated with this work.

6. Acknowledgements

The authors thankfully acknowledge the financial support received from ICAR- Indian Agricultural Research Institute (IARI), Ministry of Agriculture, Government of India.

7. References

1. Chen B, Zhang B, Li MN, Xie Y, Chen HQ. Effects of glutenin and gliadin modified by protein-glutaminase on pasting, rheological properties and microstructure of potato starch. Food Chemistry. 2018;253:148-155.
2. Bashir K, Aggarwal M. Physicochemical, structural and functional properties of native and irradiated starch: a review. Journal of Food Science and Technology. 2019;56(2):513-523.
3. Nakamura Y, Kainuma K. On the cluster structure of amylopectin. Plant Molecular Biology. 2022;108:291-306.
4. Singh V, Singh AK, Mohapatra T, Ellur RK. Pusa Basmati 1121 a rice variety with exceptional kernel elongation and volume expansion after cooking. Rice. 2018;11(1):1-10.
5. Sievenpiper JL, Chan CB, Dworatzek PD, Freeze C, Williams SL. Nutrition therapy. Canadian Journal of Diabetes. 2018;42:64-79.
6. Dona AC, Pages G, Gilbert RG, Kuchel PW. Digestion of starch: *In vivo* and *in vitro* kinetic models used to characterise oligosaccharide or glucose release. Carbohydrate Polymers. 2010;80(3):599-617.
7. Krishnan V, Awana M, Samota MK, Warwate SI, Kulshreshtha A, Ray M, *et al*. Pullulanase activity: A novel indicator of inherent resistant starch in rice (*Oryza sativa* L.). International Journal of Biological Macromolecules. 2020;152:1213-1223.
8. Juliano BO. A simplified assay for milled rice amylose. Cereal Science Today. 1971;16:334-360.
9. Kale SJ, Jha SK, Jha GK, Sinha JP, Lal SB. Soaking induced changes in chemical composition, glycemic index and starch characteristics of basmati rice. Rice Science 2015; 22(5):227-236.
10. Deepa G, Singh V, Naidu KA. A comparative study on starch digestibility, glycemic index and resistant starch of pigmented ('Njavara'and 'Jyothi') and a non-pigmented ('IR 64') rice varieties. Journal of Food Science and Technology 2010; 47(6):644-649.
11. Naseer B, Naik HR, Hussain SZ, Shikari AB, Noor N. Variability in waxy (Wx) allele, in-vitro starch digestibility, glycemic response and textural behaviour of popular Northern Himalayan rice varieties. Scientific Reports 2021; 11(1):1-10.
12. Govindaraju I, Zhuo GY, Chakraborty I, Melanthota SK, Mal SS, Sarmah B *et al*. Investigation of structural and physico-chemical properties of rice starch with varied amylose content: A combined microscopy, spectroscopy, and thermal study. Food Hydrocolloids 2022; 122:107093.
13. Bhardwaj R, Salgotra RK, Sharma M. Studies on correlation of amylose content and grain dimensions in Basmati rice (*Oryza sativa* L.). Electronic Journal of Plant Breeding 2019; 10(2):364-369.
14. Ansari IT, Sahito MA, Narejo NT, Suheryani I, Umrani JH, Ansari ZA *et al*. Differential Protein constituents and physicochemical characteristics of some rice varieties in Sindh Pakistan. Sindh University Research Journal 2021; 53(2):127-134.
15. Chakraborty R, Chakraborty S, Dutta BK, Paul SB. Screening bold grained rice (*Oryza sativa* L.) genotypes based on the ranking of their performance for biochemical traits. Biosciences, Biotechnology Research Asia 2009;6(1):121-130.