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Detection and Analysis of Quality Traits of Different Black Rice Varieties in the Southern Henan Rice Region

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Abstract

Using 14 black rice varieties imported from Southern Henan as experimental materials, the appearance quality, grinding quality, nutritional quality, cooking and eating quality of grain in Southern Henan were tested and analyzed by means of rice huller, rice mopping machine and near-infrared grain analyzer, combined with biochemical and physical analysis techniques. The results showed that there were abundant variation types in grain length, grain width, length-to-width ratio, brown rice rate, milled rice rate, head rice rate, soluble protein content, starch content, gelatinization temperature, gel consistency and viscosity of black rice. Particularly, grain type, starch content, gelatinization temperature, viscosity and other important quality traits in black rice materials have a large variation range. Therefore, our results provide important clues for developing new high-quality varieties of black rice.

Keywords: Black rice; Quality character; Detection; Germplasm resources.

1. Introduction

Rice (*Oryza sativa* L.) is one of the most important food crops in the world, with over half of the world's population and two-thirds of China's population relying on rice as their staple food [1, 2]. Meanwhile, rice is also a model organism for functional genomics research and crop genetic improvement [3]. Henan Province is an important grain production base in China, and the southern region of Henan Province is the main rice producing area. The rice planting area accounts for 83% of the province, with a perennial rice planting area of nearly 500000 hectares [4]. The southern Henan region spans the Huai River and is located in the transitional zone from subtropical to warm temperate zones, including Xinyang City, the southeast of Nanyang City, and the southern part of Zhumadian City. It is a transitional zone for the cross cultivation of indica and japonica rice, and its unique climate conditions and geographical advantages make it rich in special rice germplasm resources [5]. With the improvement of living standards for urban and rural residents, people's demand for rice is no longer just a single satiety function, but more emphasis is placed on a composite function that integrates satiety, deliciousness, nutrition, and health care [6]. Therefore, special rice is gradually being favored by people. Compared with ordinary rice, black rice has higher protein, fat, and mineral elements such as iron, calcium, and zinc; In addition, the content of vitamin B1 and vitamin B2 in black rice is 1.5-6.8 times that of regular rice. The melanin in black rice belongs to flavonoid anthocyanin compounds. It is a natural pigment that can not only be used as a food coloring agent, but also has various health functions [7]. Therefore, testing and analyzing the quality traits of black rice varieties introduced in the southern Henan rice region is of great significance for the promotion and application of high-quality black rice varieties in the southern Henan rice region.

Generally speaking, rice quality is mainly divided into four categories at home and abroad, namely nutritional quality, appearance quality, cooking and taste quality, and milling and processing quality [8-10]. The nutritional quality of rice depends on the protein content, amino acid content, and the content of trace nutrients such as vitamins in the rice [11]. For people in many developing countries around the world, rice is the main source of nutrients, with the human body consuming about 76% of the energy from rice. Therefore, the nutritional quality of rice is closely related to human nutrition and health [12, 13]. The appearance quality of rice is mainly determined by chalkiness, transparency, and grain type, and chalkiness is the most important appearance quality trait, generally measured by chalkiness rate, chalkiness area, and chalkiness degree [14, 15]. The grinding and processing quality of rice mainly consists of brown rice percentage, milled rice percentage, and whole milled rice percentage. Brown rice percentage, also known as roughening rate, refers to the percentage of brown rice in the sample mass after dehulling of clean rice. The milled rice rate refers to the percentage of rice processed and ground into a certain precision from brown rice to the quality of the tested rice, while the whole milled rice rate refers to the percentage of milled rice with a length of 2/3 of the average length of intact rice grains to the quality of the tested rice. The cooking and eating quality of rice is mainly measured by gelatinization temperature, gel consistency and amylose content. Meanwhile, the viscosity of rice powder is also an important indicator reflecting its cooking and eating quality [16, 17]. Among them, the amylose content (AC) of rice is generally 0-30%. The gelatinization temperature refers to the temperature required for starch in rice to gelatinize into a semi-transparent gel when it comes into contacting with water, or the temperature at which starch crystals lose their birefringence. Gel consistency (GC) refers to the length of gel extended in a horizontal test tube after rice gelatinization and cooling [18]. Among them, the appearance quality and cooking taste quality of rice are the most important quality traits and evaluation indicators [19], and they are also the two most concerned rice quality traits for consumers.

The overall quality of black rice in the southern region of Henan is poor. In the past decade, high-quality black rice varieties have been continuously introduced from other regions, and some black rice varieties have been demonstrated and promoted for planting, making important progress. However, the quality traits of rice are complex quantitative traits that are easily influenced by different environmental conditions. The quality traits of 14 types of black rice introduced in the southern region of Henan were tested, and the test results were comprehensively compared and analyzed. This will provide important basis for the introduction and large-scale promotion of high-quality black rice in southern Henan.

2. Materials and Methods

2.1. Materials

2.1.1. Test Materials

There are a total of 14 black rice varieties introduced from the southern Henan region as the test materials (Table-1). Among them, 2022WHH and 2023WHH are sourced from Huazhong Agricultural University, Black fragrant rice, Black fragrant glutinous rice, and Shanghai Black glutinous rice are sourced from Xinyang Agricultural and Forestry University, Early-maturing black rice and Pei-Hong-Pi-Hei are sourced from Yunnan Academy of Agricultural Sciences, and the remaining black rice varieties are sourced from the South Henan Special Rice Germplasm Resource Bank.

Table-1. Test materials and sources

NO.	Black rice varieties	Source of black rice
1	2022WHH	Huazhong Agricultural University
2	2023WHH	Huazhong Agricultural University
3	Black fragrant rice	Xinyang Agriculture and Forestry University
4	Black fragrant glutinous rice	Xinyang Agriculture and Forestry University
5	Black fragrant glutinous rice 309	South Henan Special Rice Germplasm Resource Bank
6	Black fragrant glutinous rice 334	South Henan Special Rice Germplasm Resource Bank
7	Black fragrant glutinous rice 1926	South Henan Special Rice Germplasm Resource Bank
8	Black fragrant rice 193	South Henan Special Rice Germplasm Resource Bank
9	Zheng Hei Zhan	South Henan Special Rice Germplasm Resource Bank
10	Early-maturing black rice	Yunnan Academy of Agricultural Sciences
11	Quan Hei Xian Zhan	South Henan Special Rice Germplasm Resource Bank
12	Pei-Hong-Pi-Hei	Yunnan Academy of Agricultural Sciences
13	Full black long-grain glutinous rice	South Henan Special Rice Germplasm Resource Bank
14	Shanghai black glutinous rice	Xinyang Agriculture and Forestry University

2.1.2. Field Planting and Management

Fourteen black rice varieties were sown in the same field in the rice experimental base of Xinyang Normal University. Each variety was planted in 2 rows with 12 plants in each row, and the plant row spacing was 16.5 cm × 26.4 cm. From sowing to the final maturity of the seeds, the experimental materials were cultivated and managed in the ordinary field. The shallow water layer was maintained in the field during the whole growth period, and the disease, insect and grass damage were strictly controlled until the seeds were mature.

2.1.3. Preliminary Treatment of Test Materials

After the mature harvest of black rice seeds, they were naturally dried and threshed per plant. After being placed at room temperature for 3 months, the quality traits were detected by means of rice huller, rice mopping machine, visible spectrophotometer and other instruments.

2.2. Determination of Black Grain Quality

2.2.1. Determination of Appearance Quality Traits

Randomly selected 10 full black rice seeds, head and tail connected (or head and tail side by side), using electronic vernier caliper to measure the total length. Repeated three times, the average is the grain length (or grain width). Because the external aleurone layer of black rice seeds were black, the chalkiness traits of grains could not be effectively detected, so only the grain shape traits were investigated.

2.2.2. Determination of Grinding Quality

The milling quality is mainly composed of brown rice rate, milled rice rate and head milled rice rate. The milling quality of the tested black rice is carried out according to the standard NY 147-1988 issued by the Ministry of Agriculture [20]. The brown rice rate, milled rice rate and whole milled rice rate were determined by rice huller and milled rice machine in turn [21, 22].

2.2.3. Determination of Main Nutritional Quality

The soluble protein content of 14 black rice germplasm resources was determined by Coomassie brilliant blue G-250 method [23], and the total starch content was determined by DNS method (Dinitrosalicylic acid method) [24].

2.2.4. Cooking and Eating Quality

Cooking and eating quality is mainly measured by pasting temperature, gel consistency, viscosity and other traits [25]. The gelatinization temperature of rice is generally 55 ~ 79 °C, which is one of the important indexes to determine the quality of rice [26]. The alkali spreading value was used to indirectly detect the gelatinization temperature of black rice. Among them, the alkali spreading value of grade 1-3 (gelatinization temperature > 74 °C) was high gelatinization temperature, grade 4-5 (gelatinization temperature 70-74 °C) was medium gelatinization

temperature, and grade 6-7 (gelatinization temperature < 70 °C) was low gelatinization temperature. The gelatinization temperature and gel consistency of the tested black rice were tested according to the standard NY 147-1988 of the Ministry of Agriculture [20]. The viscosity of rice was measured by the American Bolefei viscometer (KU-3 model), and the average value was the corresponding viscosity value [8].

3. Results and Analysis

3.1. Detection and Analysis of Appearance Quality

Appearance quality is the primary trait that consumers pay attention to, and it is also an important indicator to evaluate the value of rice commodities. The appearance quality traits of rice include three important factors: grain shape (grain length, grain width and length-width ratio), chalkiness (chalkiness rate, chalkiness area and chalkiness degree) and transparency. Due to the color of the outer aleurone layer of black rice seeds, the chalkiness of the grain cannot be effectively detected, so only the grain shape traits were investigated. In this experiment, the grain length, grain width and length-width ratio of 14 kinds of black rice were measured by vernier caliper. The results showed that the average grain length of the tested black rice was 8.80 mm, the average grain width was 2.96 mm, and the average length-width ratio was 3.05 mm. It is obvious from Figure 1, 2, 3 that the grain length of early-maturing black rice is the longest (10.12 mm); Zheng Hei Zhan had the shortest grain length (7.46 mm). The grain width of Black fragrant rice 193 was the widest (3.55 mm). The grain width of Black fragrant glutinous rice 1926 was the narrowest (2.51 mm). The length-width ratio of Early-maturing black rice was the largest (3.77 mm). The length-width ratio of Black fragrant rice 193 was the smallest (2.16 mm).

In addition, more than 50% of the tested black rice varieties were slender (> 3.0 mm). Therefore, there are abundant variations in the grain shape of the tested black rice germplasm resources, which provides important germplasm materials for the breeding of new varieties of slender high-quality black rice in the later stage.

Fig-1. Appearance quality of 14 black rice varieties (Grain length)

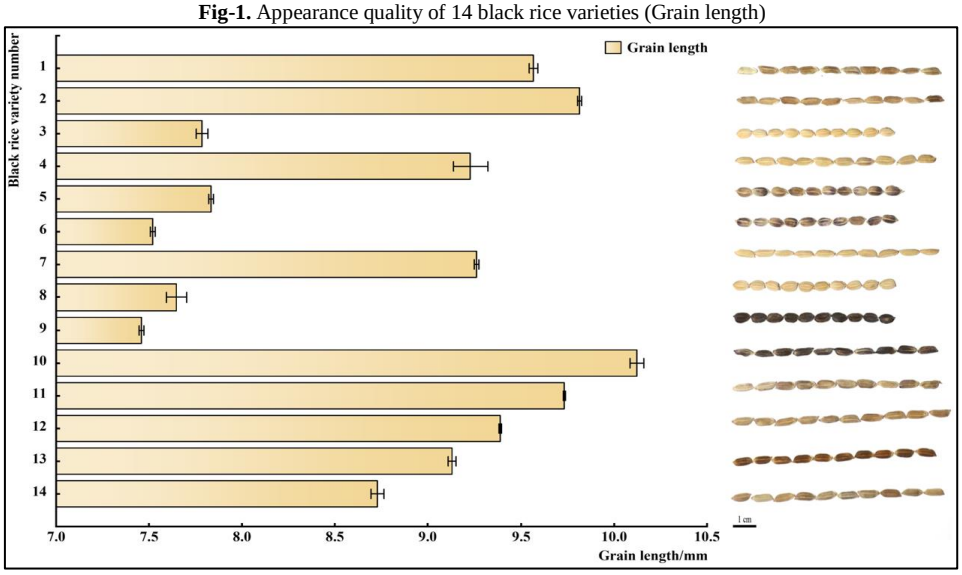


Fig-2. Appearance quality of 14 black rice varieties (Grain width)

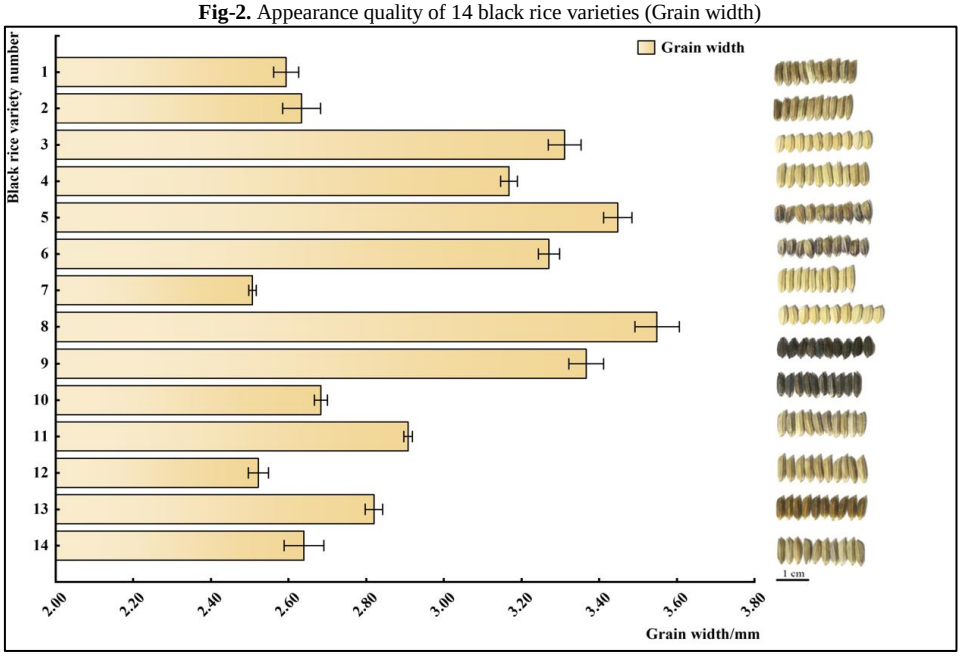
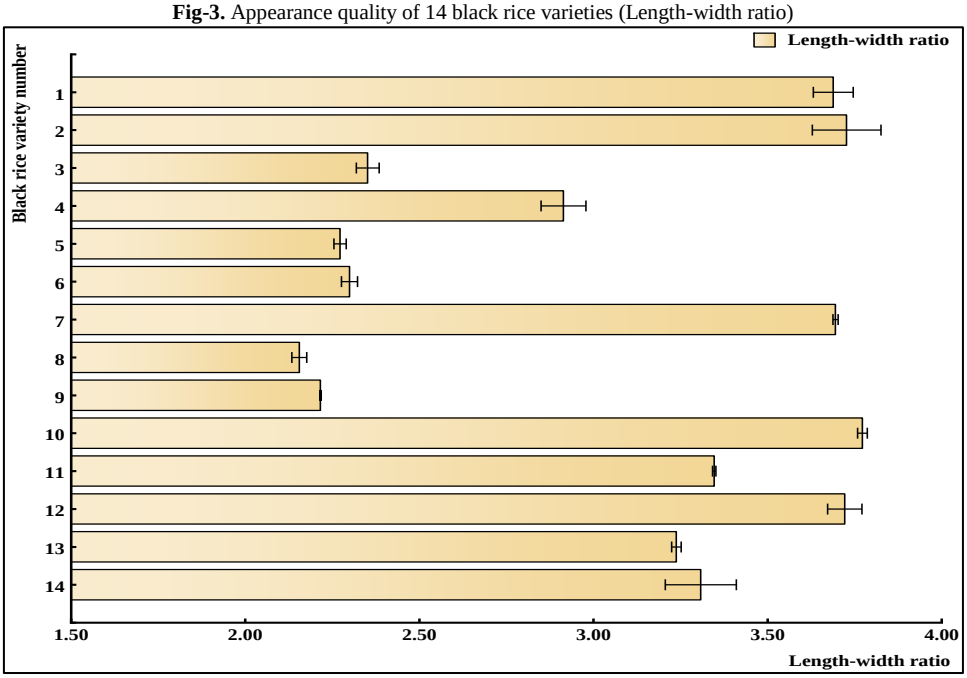


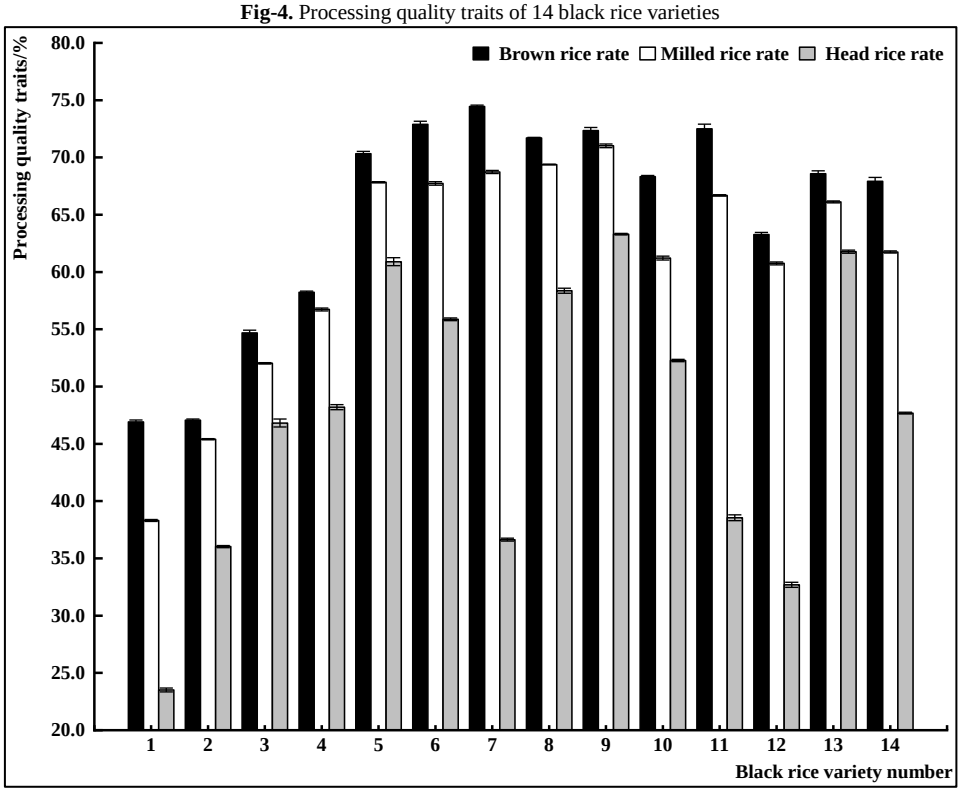
Fig-3. Appearance quality of 14 black rice varieties (Length-width ratio)



3.2. Detection and Analysis of Grinding Quality

The milling quality of rice mainly reflects the state of rice after milling. It is not only the most important quality in rice production, but also an important trait for the evaluation of high-quality rice. It generally includes three indicators: brown rice rate, milled rice rate and head rice rate. The milling quality is closely related to the final yield of rice, especially the head milled rice rate is the most important trait index to evaluate the milling quality of rice. The brown rice rate, milled rice rate and head milled rice rate of 14 kinds of black rice were tested. The results showed that the brown rice rate, milled rice rate and head milled rice rate of 2022WHH were the lowest, which were 46.92%, 38.32% and 23.52%, respectively. The highest brown rice rate was Black fragrant glutinous rice 1926, which was 74.45%, but its head rice rate was only 36.63%. The milled rice rate and head rice rate of Zheng Hei Zhan were the highest, which were 71.02% and 63.30%, respectively. Therefore, Zheng Hei Zhan is of great significance for the breeding and promotion of high-quality black rice. In addition, the head rice rate of six tested varieties reached the first-class standard of high-quality rice, namely Black fragrant glutinous rice 309, Black fragrant glutinous rice 334, Black fragrant rice 193, Zheng Hei Zhan, Early-maturing black rice and Quan Hei Xian Zhan, which provided important information for the breeding of new black rice varieties with excellent grinding quality in the later stage.

Fig-4. Processing quality traits of 14 black rice varieties

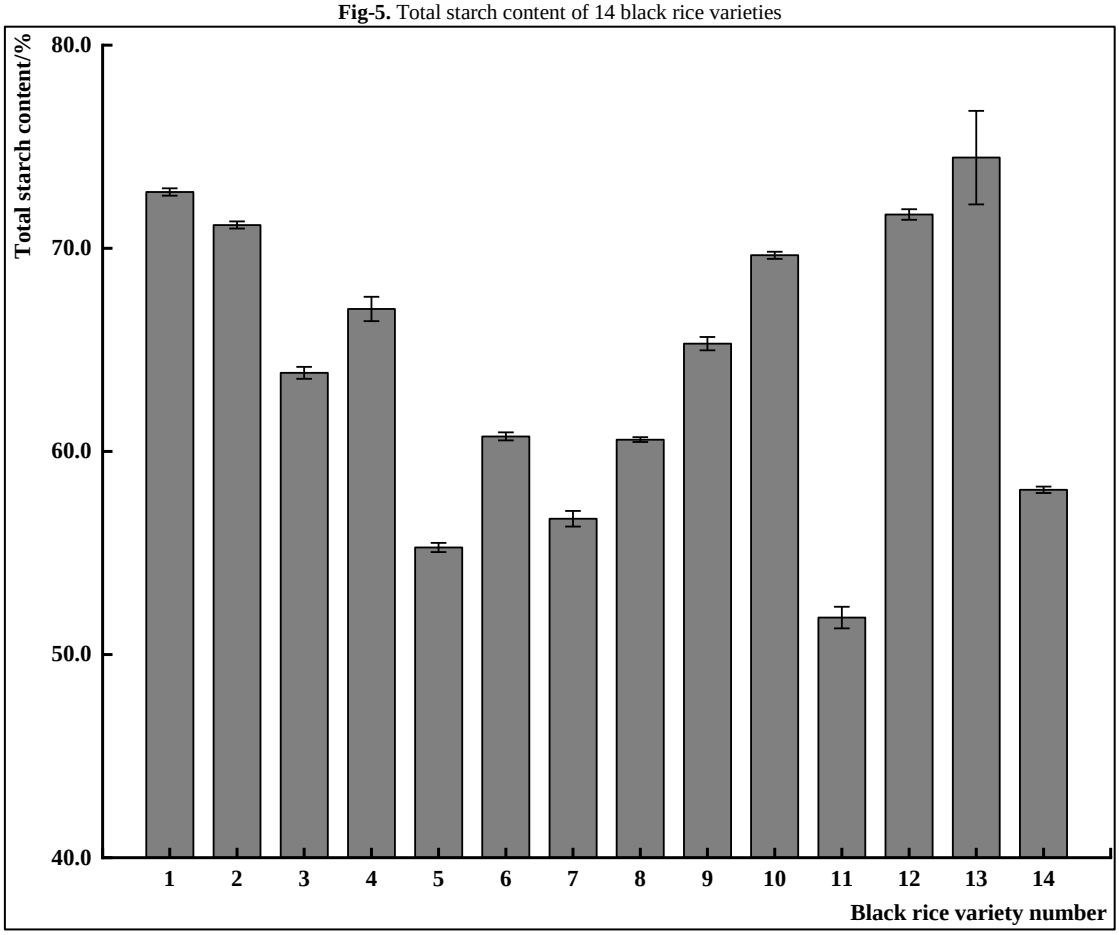


3.3. Detection and Analysis of Nutritional Quality

3.3.1. Detection and Analysis of Total Starch Content

Starch in rice is divided into amylose and amylopectin. Among the many factors affecting the cooking and eating quality of rice, the influence of amylose content is greater, followed by the content and structure of amylopectin (short chain / long chain ratio and long chain ratio). Rice with higher amylose content has higher elasticity and hardness, and the corresponding eating quality is poor. The total starch content of 14 kinds of black rice was determined. The results showed that the average total starch content of the tested black rice was 64.18%. Among them, the total starch content of Full black long-grain glutinous rice was the highest, which was 71.67%. Followed by 2022WHH, Pei Hong Pi Hei, 2023WHH, the total starch contents were 72.71%, 71.67%, 71.15%; the total starch content of Quan Hei Xian Zhan was the lowest, which was 52.06%. Therefore, there was a significant difference in the total starch content of the tested black rice varieties.

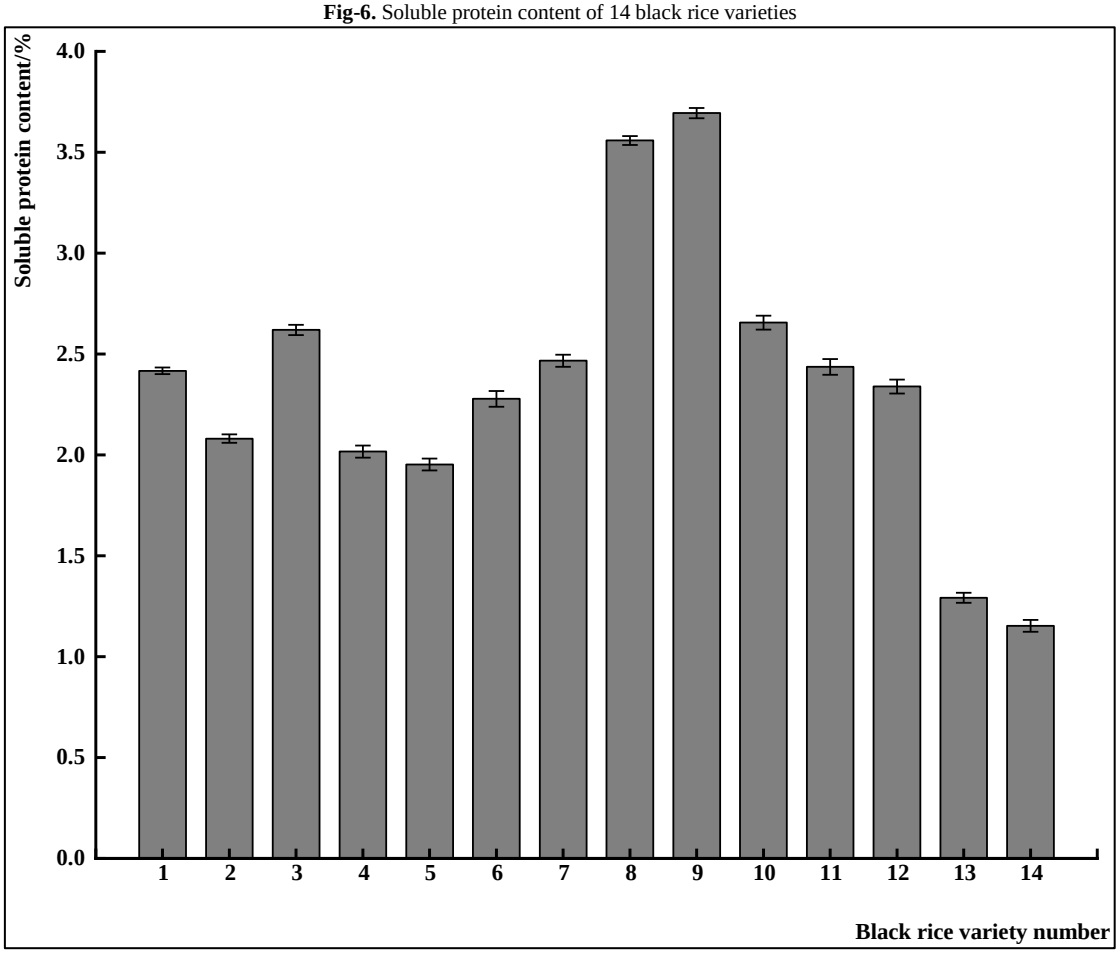
Fig-5. Total starch content of 14 black rice varieties



3.3.2. Detection and Analysis of Soluble Protein Content

The proteins in rice are divided into soluble proteins and insoluble proteins. The soluble protein content of 14 kinds of black rice was determined by Coomassie brilliant blue method. The results showed that the soluble protein content of 14 kinds of black rice was 1.153% ~ 3.694%. The soluble protein content of Zheng Hei Zhan was the highest (3.694%). Followed by Black fragrant rice 193, the soluble protein content was 3.558%; the soluble protein contents of Full black long-grain glutinous rice and Shanghai black glutinous rice were 1.292% and 1.153%, respectively. Soluble protein is composed of the large number of amino acids, so the test results of soluble protein content of black rice varieties provide important guiding significance for screening black rice varieties with high nutritional quality.

Fig-6. Soluble protein content of 14 black rice varieties



3.4. Detection and Analysis of Cooking and Eating Quality

3.4.1. Detection and Analysis of Gelatinization Temperature

The pasting properties reflect the change of rice starch viscosity in the process of rice cooking. The gelatinization temperature of 14 kinds of black rice was detected. The results showed that the alkali spreading value of Black fragrant glutinous rice 309 and 2023WHH was the lowest, which was 1.0. The alkali spreading value of Early-maturing black rice was the highest, which was 6.7 (Table-2). The varieties with high gelatinization temperature account for 64.29%, including 2022WHH, 2023WHH, Black fragrant glutinous rice 309, Black fragrant glutinous rice 334, Black fragrant glutinous rice 1926, Black fragrant rice 193, Pei Hong Pi Hei , Full black long-grain glutinous rice, and Shanghai black glutinous rice The varieties with medium gelatinization temperature account for 28.57%, including Black fragrant rice, Black fragrant glutinous rice, Zheng Hei Zhan, and Full black long-grain glutinous rice; There is only one variety with low gelatinization temperature, which is Early-maturing black rice. Therefore, there is a large range of variation in the gelatinization temperature of different black rice varieties, which provides important genetic resources for the cultivation and promotion of high-quality new black rice varieties in the later stage.

Table-2. Gelatinization temperature and types of 14 black rice varieties

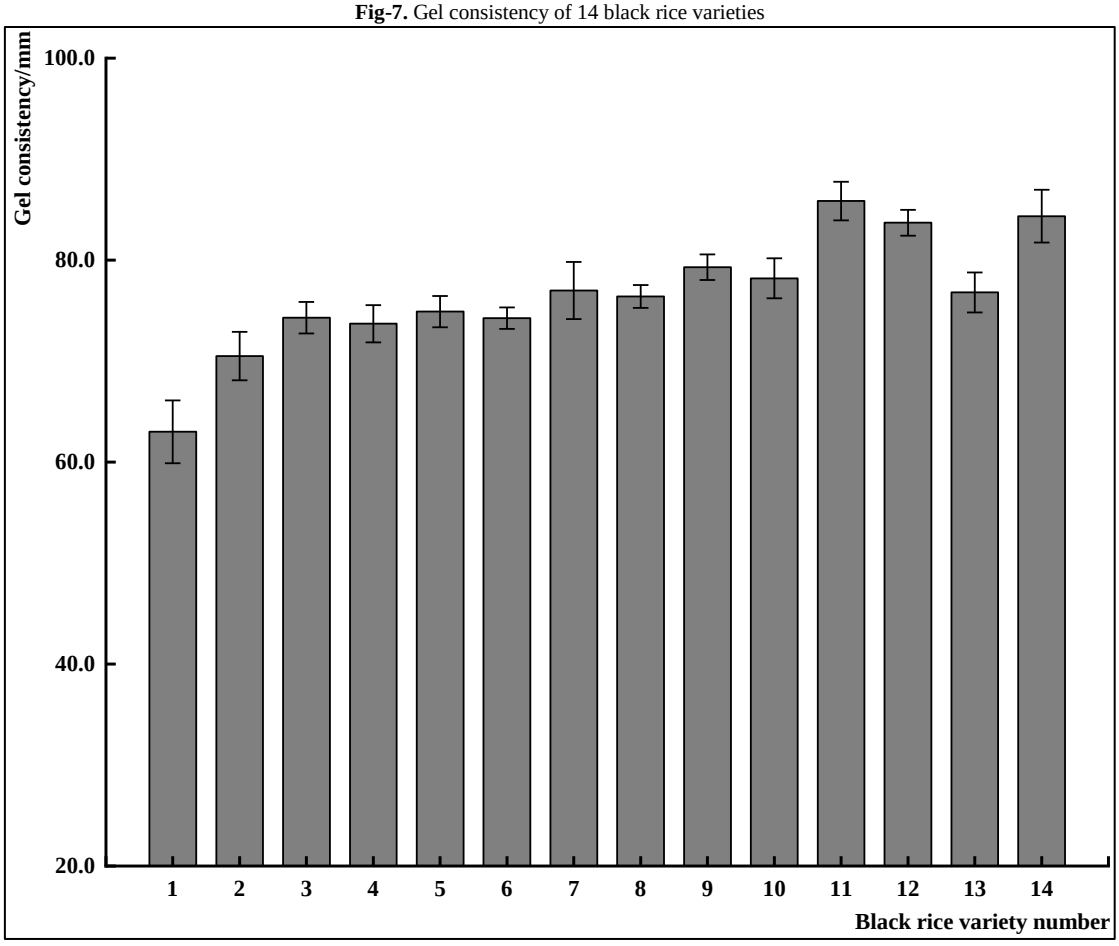
NO.	Variety	Alkali spreading value	Gelatinization temperature range (℃)	Type
1	2022WHH	2.5	> 74	High gelatinization temperature
2	2023WHH	1.0	> 74	High gelatinization temperature
3	Black fragrant rice	4.5	70~74	Middle gelatinization temperature
4	Black fragrant glutinous rice	3.8	70~74	Middle gelatinization temperature
5	Black fragrant glutinous rice 309	1.0	> 74	High gelatinization temperature
6	Black fragrant glutinous rice 334	2.6	> 74	High gelatinization temperature
7	Black fragrant glutinous rice 1926	2.8	> 74	High gelatinization temperature

8	Black fragrant rice 193	2.2	> 74	High gelatinization temperature
9	Zheng Hei Zhan	4.0	70~74	Middle gelatinization temperature
10	Early-maturing black rice	6.7	< 70	Low gelatinization temperature
11	Quan Hei Xian Zhan	4.7	70~74	Middle gelatinization temperature
12	Pei Hong Pi Hei	2.7	> 74	High gelatinization temperature
13	Full black long-grain glutinous rice	3.0	> 74	High gelatinization temperature
14	Shanghai black glutinous rice	2.7	> 74	High gelatinization temperature

3.4.2. Detection and Analysis of Gel Consistency

Gel consistency is one of the important indexes of cooking and eating quality of black rice. Due to the different varieties of black rice, the gel consistency may also be different, which affects the eating quality of black rice. The gel consistency of 14 black rice varieties was tested. The results showed that the average gel consistency was 76.59 mm among the 14 black rice varieties tested. The highest gel consistency was Quan Hei Xian Zhan, which was 85.85 mm. Followed by Shanghai black glutinous rice, gel consistency was 84.35 mm; next is Pei Hong Pi Hei, gel consistency is 83.70 mm: the minimum gel consistency was 2022WHH, which was 63.00 mm.

Fig-7. Gel consistency of 14 black rice varieties



3.4.3. Detection and Analysis of Viscosity

Viscosity is one of the important factors in rice cooking and eating quality. The viscosity of 14 kinds of black rice was tested. The results showed that the viscosity of rice flour of different black rice varieties was different when it was first heated to 50 °C during the whole process of simulated cooking. Among them, the viscosity value of Quan Hei Xian Zhan is the largest, which is 155.67 cp, while the viscosity value of Black fragrant glutinous rice 1926 is the smallest, only 42.67 cp (Table-3). When the temperature rose from 50 °C to 95 °C, the viscosity value of rice flour of each black rice variety increased, among which the viscosity value of Shanghai black glutinous rice and Black fragrant rice 193 reached more than 330 cp, and the increase was the most obvious. At this time, the lowest viscosity value is Black fragrant glutinous rice 334, which is 105 cp. When the temperature decreased from 95 °C to 50 °C, the viscosity value of black rice varieties still showed an increasing trend. At this time, the viscosity value of

black rice was the largest, which was 594.67 cp. It can be seen from Table-3 that when the temperature rose to 50 °C, the viscosity value of 14 parts of black rice flour was almost not significantly different ($P > 0.05$), and the viscosity value of Full black long-grain glutinous rice was significantly increased. When it rose to 95 °C, there was no obvious regularity and significant difference, and the viscosity value of Shanghai black glutinous rice increased significantly. When the temperature was reduced to 50 °C, the viscosity value was significantly different ($P \leq 0.05$), only there was no significant difference between Black fragrant glutinous rice 309 and Zheng Hei Zhan. During the whole heating and cooling process, the viscosity values of different black rice flour showed an increasing trend and the increasing speed was fast and slow. There were significant differences in the viscosity values of different black rice flours under different temperatures.

Table-3. Viscosity of 14 black rice varieties

NO.	Variety	Rise to 50 ℃	Rise to 95 ℃	Reduce to 50 ℃
1	2022WHH	64.33±7.64 fg	132.00±4.04 j	249.67±2.89 k
2	2023WHH	90.67±4.51 c	169.00±9.50 hc	293.67±2.89 i
3	Black fragrant rice	87.00±6.56 cd	159.00±8.08 i	594.67±6.43 a
4	Black fragrant glutinous rice	87.33±7.09 cd	184.00±5.00 g	276.33±6.03 j
5	Black fragrant glutinous rice 309	65.67±5.51 f	158.00±5.03 hi	223.33±4.51 l
6	Black fragrant glutinous rice 334	52.67±4.16 h	105.00±2.89 l	147.67±2.52 m
7	Black fragrant glutinous rice 1926	42.67±2.89 i	248.00±7.64 e	369.33±2.89 f
8	Black fragrant rice 193	79.00±3.00 de	338.00±3.06 b	504.00±5.00 c
9	Zheng Hei Zhan	72.67±2.89 ef	128.00±4.04 k	228.00±5.00 l
10	Early-maturing black rice	89.33±2.89 c	259.00±6.35 d	579.67±4.62 b
11	Quan Hei Xian Zhan	155.67±5.77 a	239.00±5.51 ef	335.33±3.06 h
12	Pei Hong Pi Hei	139.00±7.00 b	228.00±2.89 f	377.67±5.77 e
13	Full black long-grain glutinous rice	82.67±2.89 cd	279.00±4.04 c	361.00±5.00 g
14	Shanghai black glutinous rice	56.67±1.15 gh	361.00±2.65 a	487.33±2.89 d

4. Discussion

Rice quality refers to the various basic characteristics that rice possesses as a commodity throughout the entire process from production to processing, making it a direct consumer good. Therefore, rice quality is a comprehensive trait. For the convenience of research, rice quality is usually divided into appearance quality, milling and processing quality, nutritional quality, and cooking and taste quality [9]. Appearance quality is the primary characteristic that consumers pay attention to, and it is also an important indicator for evaluating the value of rice products. The appearance quality of black rice mainly includes grain length, grain width, and aspect ratio [27]. Among the 14 black rice varieties tested, early-maturing black rice had the highest aspect ratio of 3.77 mm; The length to width ratio of Black fragrant rice 193 is the smallest, at 2.16 mm. This provides important seed resources for the breeding of new varieties of slender and high-quality black rice in the future. The quality of milling processing mainly reflects the state of rice after milling processing, generally including brown rice rate, milled rice rate, and head rice rate. The higher the value of whole head rice percentage, the more whole head rice can be produced from rice of the same quality, resulting in higher economic value [28]. Among the 14 black rice varieties tested, Zheng Hei Zhan had higher milled rice rate and whole milled rice rate, which were 71.02% and 63.30%, respectively. This black rice variety is of great significance for the breeding and promotion of high-quality black rice.

The soluble protein content of the 14 black rice varieties tested in this experiment was 1.153%~3.694%, while Gu Chaojian et al. measured the soluble protein content of 16 black rice varieties collected and bred by the Rice Research Institute of Sichuan Agricultural University, with a content of 1.16%~2.16% [29]. The difference between the results of this experiment and those of Gu Chaojian et al. is not significant, which may be due to the different origins and varieties of black rice in the experiment. In this experiment, Zheng Hei Zhan had the highest soluble protein content, while Quan Hei Xian Zhan and Shanghai black glutinous rice had lower soluble protein content. The average total starch content is 64.18%, with Full black long-grain glutinous rice having the highest total starch content at 71.67%, and Quan Hei Xian Zhan having the lowest total starch content at 52.06%. The determination of the nutritional quality of the test materials provides important theoretical basis for cultivating high-quality black rice new varieties. Gelatinization temperature, gel consistency, and viscosity are important indicators for evaluating the taste quality of rice during cooking. The higher the gelatinization temperature, the longer the cooking time, which ultimately affects the taste and appearance quality of rice [30]. It is generally believed that middle gelatinization temperature has the least impact on the taste and appearance quality of rice, and is most suitable for cooking [31]. There are four varieties with middle gelatinization temperature, including Black fragrant rice, Black fragrant glutinous rice, Zheng Hei Zhan, and Quan Hei Xian Zhan, which provide important genetic resources for the cultivation and promotion of high-quality new black rice varieties in the later stage. The viscosity can evaluate the taste quality of rice during the cooking process. Rice with higher viscosity has a better taste when cooked [32]; However, rice with lower gel consistency tends to be harder when steamed, resulting in poor inter grain viscosity and therefore poorer taste quality [33]. Among the 14 black rice varieties tested, the average gel consistency was 76.59 mm; The highest viscosity is Quan Hei Xian Zhan, accounting for 85.85 mm; The adhesive with the lowest viscosity is 2022WHH, which is 63.00 mm. Liu Jiafu et al. classified rice varieties into four categories based on gel length: hard (27-35 mm), medium hard (36-40 mm), medium (41-60 mm), and soft (61-100 mm) [27]. After analysis and comparison, all 14 types of black rice tested in this experiment were soft rice. In the whole process of simulated

cooking, the viscosity of rice powder of different black rice varieties was different when it was heated to 50 ℃ for the first time, and the viscosity value of Quan Hei Xian Zhan was the largest; When the temperature was heated from 50 ℃ to 95 ℃, the viscosity of rice powder of all black rice varieties increased, and the viscosity of Shanghai black glutinous rice and Black fragrant rice 193 increased most significantly; When the temperature decreased from 95 ℃ to 50 ℃, the viscosity value of rice power of all black rice varieties still showed an increasing trend, and the viscosity value of black fragrant rice was the largest at this time. Peng Bo et al. tested the viscosity of five types of rice introduced from southern Henan, and found that they all showed a trend of increasing gradually, with different rates of increase [8]. The test results also showed that the viscosity value of different black rice. Rice powder showed an increasing trend during the whole heating and cooling process, which was consistent with the previous test results.

5. Conclusions

Through the detection and analysis of the black rice quality of 14 kinds of black rice, this experiment mainly investigated the grain type in the appearance quality, the brown rice rate, milled rice rate and head rice rate in the grinding quality, the soluble protein content and total starch content in the nutritional quality, and the rice powder viscosity, gel consistency and gelatinization temperature in the cooking and eating quality. The test results found significant variations in the appearance quality, grinding and processing quality, nutritional quality, and cooking taste quality of the 14 tested black rice varieties. This will provide important genetic breeding resources for the cultivation of new high-quality black rice varieties in the future, and provide important basis for the introduction and large-scale promotion and application of high-quality black rice in southern Henan.

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