

Analysis of Compositions and Physical Characteristics of Different Rice From Heilongjiang China

Fenglian Chen^a, Xinming Li^b, Mingshou Lv^c, Yanguo Shi^{d,*}

Department of Food Science & Engineering, Harbin University of Commerce, Harbin 150076, China

Corresponding author e-mail: ^{d}yanguosh@163.com

^afinexm@163.com, ^b931367406@qq.com, ^chrbcufood@126.com,

^dCampa@purdue.edu,

Abstract. Diversity and correlation between composition, texture characteristics and sensory features of twenty kinds of purebred rice from Heilongjiang China were studied. Experimental results showed significant differences in content of fat, amylose and protein, however those differences were not extended to perceived taste evaluation by sensory evaluation. More protein led to lower viscosity but better hardness and springiness, higher amylose content resulted lower taste but higher springiness. Moisture content was significantly negatively correlated with resilience; the content of protein was significantly positively correlated with resilience. The adhesiveness of texture characteristic and the viscosity of taste showed significant positive correlation.

1. Introduction

Rice is one of the most popular staple foods, and today half of the world population are living depend on it[1]. Rice is being produced in Asia, Southern Europe, tropical America and some parts of Africa, and the total production is ranked 3 among the world's total crop yields[2]. The area of Heilongjiang is located in the center of the northeastern Asia economic zone, which is one of the three world famous black soil zone and the rice produced from Heilongjiang is popular with acceptable quality[3].

The chemical composition of rice determines its nutritional value and sensory properties such as taste and texture[4]. Amylose content in the starch has been identified as one of the main composition components that affect its textural properties[5]. Moisture, protein and fat content also have some effects on perceived taste and hardness of rice when being consumed[6]. Guoxingfeng and Muyundong [7]determined the texture properties of rice after cooking from different regions using standard textural protocols, and the research indicated that there existed significant difference between hardness and viscosity through variance analysis. For that the chemical composition of 20 types of rice coming from this region was evaluated. The following properties of cooked rice were evaluated using Textural Profile Analysis (TPA) and sensory evaluation. Correlations among the chemical composition of the rice types and their mechanical and sensory properties were evaluated at the same time.

2. Materials and Methods

2.1. Materials

Heilongjiang rices: No.1-5 from Fangzheng County, No.7-9 from Wuchang City, No.10 produced in Wangkui County, No.11 produced in Suihua City, No.12 produced in Qingan County, No.13 produced



in Yilan County, No. 14 and 15 produced in Jiamusi City, No.16 from Muling City, No.17 from Dongning County, No.18, made in Ning'an county, No.19 and 20 made in Qiqihar City.

Preparation of rice flour

Rice was ground using a roll mill and sieved using a 100 mesh screen. The moisture content was between 12% and 14% by dry milling.

2.2. Chemical composition analysis of rice flours

Water, ash, protein and fat contents were determined according to the AACC International 2002 methods (methods 44-01.01, 08-01.01, 46-09.01, 30-10.01, respectively). Carbohydrates was determined by difference as carbohydrates = 100 - (water + protein, fat and ash). Amylose content was determined according to the AACC 2002 International method 61-03.01

Sensory evaluation of rice

Texture index was measured by sensory method. The rice was steamed with rice cooker by a cup of sample and 2 cups of water for 30 minutes. Sensory attributes of the cooked rice sample were evaluated using a descriptive analysis method. Seven female and three male subjects participated in the sensory evaluation. Grading rules are shown in table 1.

Table 1 Valuator Texture scoring criteria of rice

Project	Grading standard	Score
Viscous (10 分)	smooth, viscous, non-stick teeth	7-10
	viscous, basic non-stick teeth	4-6
	sticky or non-stick teeth	0-4
Hardness (10 分)	soft hard moderate	8-10
	hard or soft	4-7
	very hard or very soft	0-3
Springiness (10 分)	chewy	7-10
	texture slightly	4-6
	loose, dry	0-4

2.3. TPA analysis of rice

Texture Profile Analysis (TPA) was performed using a texture analyzer (TA-XT2i; Stable Microsystems, Surrey, UK) with a 5kg load cell, fitted with a 35mm diameter cylinder aluminum probe. Tweezers were used to pick up 10 grains of steamed rice from the middle of the container, and evenly placed them individually in the center of the platform area of round layer. Compression force was measured during the test, the pretest speed was 2.0 m/s, test speed 1.0 m/s, and after test speed was 1.0 m/s, a compression ratio 30% was used.

Data analysis was conducted using SPSS and Excel 2003 17.0.

3. Test results

3.1. Chemical composition of different regions rice

Chemical composition from different regions rice is shown in Fig.1. Results showed that rice from different regions had different composition. Protein content ranged between 5.7 ~ 8.2%. Sample 7, 6, 18, 14 and 8 had protein content higher than 8%. Fat content ranged between 0.3% and 1.1%, the lowest one was sample 4 while the highest one was sample 6. Carbohydrate content ranged from 76.4 to 79.2%. A few difference between them. Amylose content of sample 5 Qiuran rice was lowest of 14.93% and the highest level was sample 16 of 23.81%. Difference of rice moisture content was smaller, between 12% and 14%, which is beneficial for rice storage.

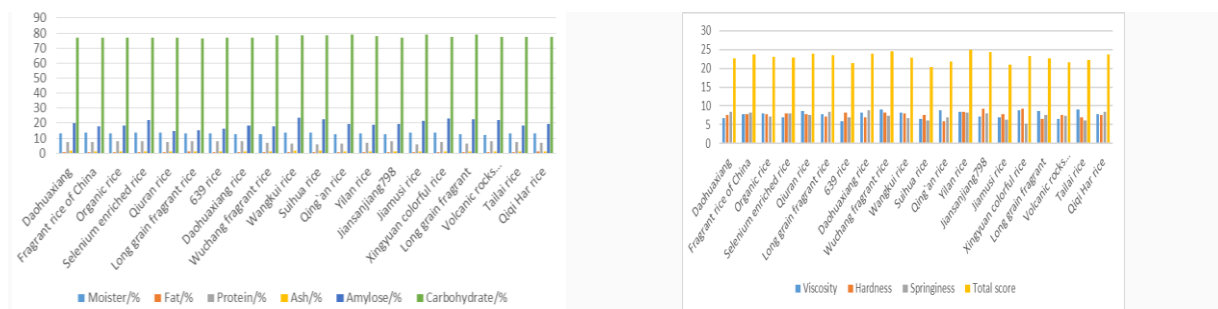


Fig. 1 Chemical composition (%) of different regions rice and mathematical analysis

Fig.2Comprehensive evaluation of rice texture index

3.2. Difference analysis of rice texture characteristics

As shown in Fig.2 the texture indicators of twenty kinds of cooking rice had no significant difference. There were five kinds of rice whose total score was beyond 24 points respectively which sample numbers are 9, 13, 14, 5 and 8. There were fourteen kinds of rice whose total score was between 21 and 24 points, including sample 20, 2, 6, 16, 3, 10, 4 and 1. Only sample 1 scored about 20 points whose taste was poor.

3.3. Difference analysis of rice TPA

The variation range of rice hardness, adhesiveness, springiness, cohesion, gumminess and resilience was from 6103.7 g(15) to 11641.1g(17), 363.6gs(10) to 1120.3gs(19), 0.38(9) to 0.59(14), 0.4(9) to 0.6(14), 2538.9(15) to 6373.9(17), 0.2(15) to 0.3(14) respectively. Larger hardness illustrates the rice has tight inner structure, so its cohesiveness and gumminess is bigger, which increase elasticity and resilience of rice.

Table 2TPA Results

Sample number	Hardness/ g	Adhesiveness s/gs	Springiness ss	Cohesiveness ess	Gumminess ss	Resilience
Daohuaxiang	9595.7	-737.7	0.46	0.5	5057.6	0.3
Fragrant rice of China	8680.8	-791.5	0.45	0.4	3876.8	0.2
Organic rice	8339.1	-877.4	0.48	0.5	3787.2	0.2
Selenium enriched rice	8689.0	-601.4	0.47	0.5	4405.7	0.3
Qiuran rice	7679.3	-445.6	0.41	0.4	3346.0	0.2
Long grain fragrant rice	8156.9	-669.4	0.43	0.5	4233.1	0.3
639 rice	8569.6	-1011.3	0.46	0.5	4414.5	0.3
Daohuaxiang rice	9177.7	-731.6	0.40	0.5	4761.1	0.3
Wuchang fragrant rice	6988.6	-470.6	0.38	0.4	2797.6	0.2
Wangkui rice	9804.3	-1120.3	0.53	0.5	5179.9	0.3
Suihua rice	6613.2	-868.9	0.39	0.4	2731.0	0.2
Qing'an rice	8836.2	-452.4	0.43	0.5	4467.7	0.3
Yilan rice	7013.3	-747.3	0.39	0.45	3155.9	0.3
Jiansanjiang798	10093.4	-425.1	0.59	0.6	5687.8	0.3
Jiamusi rice	6103.7	-741.7	0.45	0.4	2538.9	0.2
Xingyuan colorful rice	8334.8	-438.6	0.40	0.5	3934.2	0.3
Long grain fragrant	11641.1	-612.0	0.49	0.5	6373.9	0.3
Volcanic rocks nutritional rice	9640.0	-532.4	0.40	0.5	4927.3	0.3
Tailai rice	9118.5	-363.6	0.441	0.5	4506.5	0.3
Qiqi Har rice	9769.6	-466.7	0.50	0.5	5328.8	0.3

3.4. The correlation between chemical composition and rice taste index of different regions rice

According to the report that amylose content of rice was important factors that affect the rice texture[8]. The results showed that amylose content was positive correlated with rice elastic. Meanwhile from table 3 we concluded that protein content was significantly positively correlated with its springiness too, a similar tendency was reported by [9].

Table 3Correlation analysis between sensory parameters and chemical composition

Comprehensive index	Stickiness	Hardness	Springiness	Total score
Water	-0.058	-0.159	0.281	0.012
Fat	0.159	0.369	-0.127	0.083
Protein	-0.230	0.271	0.444*	0.336
Ash	-0.287	0.111	0.069	-0.336
Amylose	-0.118	0.087	0.467*	-0.387
Carbohydrate	0.310	-0.365	-0.419	-0.316

Note: * at 0.05 level (double side) significant correlation.

3.5. Correlation analysis of chemical composition and texture characteristics of different regions rice

From table 3 it is indicated that moisture content was negatively correlated with resilience of rice. It could be the reason that there was moisture difference between grain abdomen and back after soaking for the rice with low moisture content (< 14%) which led to the volume difference and made instant cracks that was the flowering phenomenon. Starch grains come out from cracks, and rice loses elasticity and becomes tacky[10]. While protein content was positively correlated with resilience. It might be because that higher protein content meant more closely grain structure and smaller space between the starch grains which made water absorption slow and little, so more time were needed for cooking which made rice hard and high resilience[11].

Table 4Correlation analysis between TPA results and chemical composition

Structure characteristics	Chemical components					
	Moisture/%	Fat/%	Protein/%	Ash/%	Amylose/%	Carbohydrate/%
Hardness	-0.376	0.123	0.278	0.258	0.212	-0.121
Adhesiveness	-0.289	0.202	-0.127	-0.316	-0.141	0.010
Springiness	0.144	-0.020	0.067	0.325	-0.195	-0.121
Cohesiveness	-0.357	0.316	0.366	0.335	0.113	-0.265
Gumminess	-0.387	0.200	0.286	0.320	0.204	-0.146
Resilience	-0.428*	0.322	0.461*	0.223	0.076	-0.309

Note: * at 0.05 level (double side) significant correlation.

3.6. Correlation analysis on rice texture characteristic and TPA index

From table 5, viscosity value of rice taste index and adhesiveness of structure properties showed significantly positive correlation, so it is visible that viscosity of rice taste index can be replaced by adhesiveness of textural characteristic.

Table 5Correlation analysis between TPA results and sensory evaluation

Texture characteristics	Taste index			
	Viscosity	Softness	Elasticity	Total score
Hardness	-0.264	0.273	-0.229	0.111
Adhesiveness	0.444*	-0.023	-0.059	0.276
Springiness	-0.192	0.152	0.185	0.089
Cohesiveness	-0.133	0.357	0.143	0.083
Gumminess	-0.016	0.309	0.201	0.097
Resilience	-0.063	0.350	0.116	0.146

Note: * at 0.05 level (double side) significant correlation.

4. Conclusions

There were differences in chemical composition and texture characteristics, but a few in taste of different regions rice. The correlation between rice chemical composition, and texture and sensory characteristics was that the fat, ash, amylose and protein content of different regions rice had influence on its taste quality and structure characteristics. Adhesion is important factor to determine the final rice taste.

Acknowledgments

This research was supported by State Research and Development Major Project of Application Technology funded by Office of Science and Technology of Heilongjiang China.

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