Journal of Microbiology and Microbial Infections

JMMI, 1(1): 14-22
www.scitcentral.com

Original Research Article: Open Access

Study on Physical, Physicochemical, Functional and Antioxidant Properties of Organic and Conventionally Grown Rice Cultivars

Kamaldeep Kaur* and Rajan Sharma

**Department of Food and Sciences Technology, Guru Nanak Dev University, Amritsar, Punjab, India.*

Received June 07, 2019; Revised June 11, 2019; Accepted June 13, 2019

ABSTRACT

Analytical data studied the difference between organic and conventionally grown rice cultivars. Four cultivars two from organic farming and two from conventional farming were milled and their parameters like physical, physicochemical, functional and antioxidant properties were analysed. Examined data revealed that there was no significant difference between physical, physicochemical, functional and color parameters but there was significant difference between antioxidant properties. Rice obtained from organic farming showed higher antioxidant range than the conventional rice. Similarly, reducing power and total phenolic count of organic rice showed higher range than conventional rice.

Keywords: Organic cultivars, Conventionally grown cultivars, Rice, Antioxidant properties

INTRODUCTION

Rice (*Oryza sativa* L.) is a cereal grain which serves as a staple food worldwide [1] and belongs to grass family which is Graminee, consumed from almost 5000 years by humans. The production of rice in 2015 worldwide was reported to be 74.09 million tonnes whereas in India it was 15.87 million tonnes.

The rice kernel comprises of pericarp (1-2%) aleurone plus seed coat and nucleus (4-6%) embryo (2-3%) and starchy endosperm (89-94%). The rice grain comprises of 16-18% hull [2] and removal of the hull during milling leads to production of brown rice.

Further milling to remove pericarp, seed coat, testa, aleurone layer and embryo to yield milled or white rice results in a disproportionate loss of lipid, protein, fibre, reducing sugars and total sugars, ash and minor components including vitamin, free amino acids and free fatty acids

The broken grains are a significant loss to rice producers and processors. To minimize or prevent the occurrence of fissures, knowledge of the dependence of the mechanical and thermal properties of whole rice grain on moisture content is important for the optimization of drying and storage processing conditions [3].

Rice grains are mainly classified on the basis of size and shape. They may be classified as long, medium or short grain varieties on the basis of length, width and weight. Another way of classification mainly depends on the composition of amylose and amylopectin present in rice. Waxy rice has an opaque endosperm consist mainly of amylopectin with only 0-2% amylose whereas non waxy rice contains mainly amylose plus small amount of amylopectin and has a translucent endosperm [3].

Rice can also be classified as organic and inorganic based on its method of production. Nowadays, organic farming has become the latest trend as it reduces environmental damage and chronic diseases like cancer to humans. India is ranked 10th globally for organic farming whereas total area under organic certification worldwide is 4.72 million hectare in 2013-2014. Among all the states in India, Uttar Pradesh had highest area under organic farming followed by Himachal Pradesh, Madhya Pradesh and Maharashtra in 2011-2012. Excessive and inappropriate uses of fertilizers and pesticides have polluted soil, water and agricultural workers. Although, the use of fertilizers and insecticides increases the productivity it imparts negative effect on grain quality. Chemical fertilizers, pesticides, insecticides and other synthetic feed additives can be replaced by natural animal

Corresponding author: Kamaldeep Kaur, Department of Food and Sciences Technology, Guru Nanak Dev University, Amritsar, Punjab, India, Tel: 8427132282; E-mail: kamaldeepkaur@81gmail.com

Citation: Kaur K & Sharma R. (2019) Study on Physical, Physicochemical, Functional and Antioxidant Properties of Organic and Conventionally Grown Rice Cultivars. J Microbiol Microb Infect, 1(1): 14-22.

manures, organic wastes like fruits and vegetables waste, crops residues, tillage, cultivation practices and crop rotation in case of organic farming. Previous research has been carried out to compare the properties of crops produced by both organic and inorganic methods [4].

Various quality parameters like physical, physicochemical and functional properties can be useful in designing grain hoppers, storage facilities and aeration fans. Rice grains considered to have greater nutritional benefits such as it is good source of antioxidants. Many antioxidative compounds such as ferulic acid, tannins and other substances are present in rice grains [5]. Grains that contain high amount of antioxidative compounds prevent many diseases by scavenging free radicals and promoting good health. It has been shown that rice bran contains more than 100 natural occurring antioxidative compounds. Natural antioxidants present in rice bran include tocopherols, tocotrienolos and γ-oryzanols. The concentration of polyphenols in the rice grain varies among genotype as well as also affected by processing Melissa Walter.

The present research was undertaken to evaluate and compare the physicochemical, color characteristics, cooking and antioxidant properties of rice grown by both organic as well as conventional method of farming.

MATERIALS AND METHODOLOGY

Materials

Two conventional rice varieties PR-386 and BAS-1121 from PAU District Ludhiana (Punjab) and two organic rice varieties PR-386 and BAS-1121 from Pingalwara Amritsar District (Punjab), India were procured. Seeds were cleaned for dirt and other foreign material and stored until further use in a refrigerator.

Method

Dehusking and milling: The paddy samples of both organic and conventional varieties were dehusked in rubber roller huller (Lab Scale Mini Rice Mill, New Delhi, India) having 500 g capacity per batch and was separated from brown rice manually. Some of the brown rice obtained were milled (6% degree of milling) in emery surface frictional system using whitening machine (Lab Scale Mini Rice Polisher, New Delhi, India) having 80 g capacity per batch. After milling, the sieving was done for removal of loose bran. Whole brown and white rice grains were separated from broken rice grains for the evaluation of physicochemical, cooking, functional and antioxidant properties.

Brown and milled rice characteristics

Physicochemical and color properties: Both brown and white organic and conventional rice varieties were tested for their physicochemical characteristics that is moisture, ash, fat and protein content by employing the standard methods of analysis (AOAC,1990). One thousand head rice weight of both brown and white organic and conventional rice varieties were counted randomly in triplicate. Mean of three replications was reported as thousand kernel weight (TKW). Bulk density was calculated as the ratio of known weight of rice grains to their volume and reported as g/ml. Digital vernier caliper was used to calculate length-breadth (l/b) ratio. Reading was reported by taking mean of 10 replications. Ultra scan VIS Hunter Lab (Hunter Associates Laboratory Inc., Reston, VA, USA) was used to evaluate color characteristics (L* value indicates representing dark to light, a* value gives the degree of red-green color and b* value indicating the degree of the yellow blue color) and the total color difference (ΔE) was calculated by applying the following equation:

$$\Delta E = [(\Delta L *) + (\Delta a *) + (\Delta b)]½$$

Cooking properties: Sample (1 g) of both brown and white organic and conventional head rice were cooked in test tube with10 mL distilled water in a boiling water bath until no white core was left which was checked by pressing the cooked rice grains between two glass plates. Cooking time was noted after removing the grains from water bath.

Flour characteristics

Swelling power: The swelling power of both brown and white organic and conventional rice varieties was determined by the method described by Schoch with some modification. The flour (2 g) was added in 98 ml distilled water heated at different temperatures of 90°C for 1 h. The heated samples were cooled rapidly in ice water bath for 1 min, equilibrated at 25°C for 5 min and then centrifuged at 3000x g for 30 min. The supernatant was dried and evaporated in a hot air oven at 100°C and cooled to room temperature in desiccators before drying. The swelling power was calculated by applying the following equation:

$$\text{Swelling power (g/g)} = \frac{\text{Weight of sediments}}{\text{Initial weight of the dry starch}}$$

Water solubility index

Water Solubility Index of both brown and white organic and conventional rice varieties was determined by using the method of Sosulski. The flour sample (500 mg) was dispersed in about 10 ml of water, mixed thoroughly and agitated for 1 h. Then sample was centrifuged at 2000 rpm for 30 min. The supernatant was collected in pre-weighed petri plates and dried in hot air oven for 24 h at 105°C temperature and the remaining solid was weighed. The results were expressed as water solubility index (%) by applying the following equation:

Water solubility index (%) = (Weight of solids after drying / weight of sample taken) × 100

Oil absorption capacity

The oil absorption capacity of both brown and white organic and conventional rice varieties was determined using the method of Lin. The flour sample (500 mg) was added to about 10 ml of oil, mixed thoroughly and agitated for 1 h. Then sample was centrifuged at 2000 rpm for 30 min. The supernatant was discarded and sediment weighed by applying the following equation:

Oil Absorption (g/g) = Weight of sediment / Weight of sample

Antioxidant activity

Antioxidant activity of the extracts of bran, brown and white organic and conventional rice varieties was determined by using a modified version of the method described by Brand-Williams. Flour samples (100 mg, dwb) were extracted with 1 ml of methanol (pure) for 2 h and centrifuged at 3000x g for 10 min. The supernatant (100 µl) was reacted with 3.9 ml of a 6×10^{-5} mol/L of DPPH solution. Absorbance (Abs.) at 515 nm was read at 0 and 30 min using pure methanol as blank with spectrophotometer (Shimadzu, UV-1800, Japan).

$$\text{Antioxidant activity (\%)} = 1 - (\text{Abs. of sample}_{t=30}/\text{Abs. of control}_{t=0})] \times 100 \quad (1)$$

Reducing power

Reducing power of the extracts of bran, brown and white organic and conventional rice varieties was determined by procedure as described by Zhou [5]. Flour samples (500 mg, dwb) were weighed in polypropylene tubes and 6.6 ml of methanol (80%) was added and shaken on shaker for 4 h. After that, the tubes were centrifuged at 3000 g for 10 min and supernatant (extract) was collected. The extract (1 ml) was mixed with phosphate buffer (2.5 ml, 0.2 mol/l, pH 6.6) and 2.5 ml potassium ferricyanide (potassium hexacyanoferrate (III)) (1%) was added followed by incubation at 50°C. Trichloroacetic acid solution (10%) was added to mixture and was then centrifuged at 10000x g for 10 min. Supernatant (2.5 ml) was mixed with 2.5 ml of de-ionized water and 0.5 ml of ferric chloride (0.1%). The absorbance of the mixture was measured at 700 nm with spectrophotometer (Shimadzu, UV-1800, Japan). A standard curve was prepared using different dilutions of ascorbic acid and results were reported as µg ascorbic acid equivalents (AAE)/g of sample.

Total phenolic content

Total phenolic content of the extracts of bran, brown and white organic and conventional rice varieties was determined according to the method described by Kaushal [6]. Sample (200 mg, dwb) was extracted with 4 ml of acidified methanol (HCl/methanol/water, 1:80:10, v/v/v) at room temperature (25°C) for 2 h using a shaker (Narang Scientific, Delhi, India). The mixture was centrifuged at 3000x g for 10 min and the supernatant was used for determination of total phenolic content. 200 µl aliquot of extract was added to 1.5 ml freshly diluted (10 fold) Folin & Ciocalteu's phenol reagent. The mixture was allowed to equilibrate for 5 min and then mixed with 1.5 ml of sodium carbonate solution (6%). After incubation at room temperature (25°C) for 90 min, the absorbance of the mixture was read at 725 nm with spectrophotometer (Shimadzu, UV-1800, Japan).

A standard curve was prepared using pure ferulic acid standard solutions of different concentrations and an equation number 2 with coefficient of determination (R^2)=0.995 was obtained. The results were expressed as µg ferulic acid equivalents (FAE)/g of sample using that equation.

RESULTS AND DISCUSSION

Milling parameters

The percentage yield of brown rice was 0.76-0.79 of both varieties conventional as well as organic whereas yield of white rice was in range of 0.63-0.67. The range of milled rice lies in between 78-84 both for organic and inorganic rice varieties.

Color characteristics

The degree of lightness of rice flour L*, a*, b* and *ΔE showed varietal difference. Both conventional and organic varieties of BAS-386 showed the highest L* (73.59) as compared to BAS-1121 (68.10). Whereas a* of BAS 1121 of both cultivars was observed to be highest (4.30) as compared to BAS 386 (2.68). Both cultivars showed almost same b*values, however, *ΔE of BAS 386 both cultivars observed highest value (76.13) as compared to BAS 1121 with lowest value of 71.00. It was found that difference in color characteristics of rice flour may be attributed to difference in the color pigments of the rice flour which in turn depend on the composition of the flour and botanical origin of the plant [7].

Physical parameters

Treatment did not show any significant changes on the physical parameters of white rice obtained from both varieties. However, varietal difference in physical parameters of white rice was observed. Sphericity, seed volume and surface area of white rice showed significant varietal differences. Sphericity of conventional white rice grains from both varieties was found to be higher as compared to organic variant. Surface area and sphericity of white rice grains from BAS-1121 was higher as compared to organic BAS-386. Singh [8-10] reported that chalky grains of different varieties IR-8, PR-106 and Basmati showed lower length/breadth ratio as compared to translucent grains. Liu suggested that parameters of the length, width and porosity of the brown rice may be used as an initial basis for optimizing milling process in order to achieve desired degree of milling. It was found that the sphericity and aspect ratio of the kernels varied from 33.33 to 43.57 (± 1.915%), 22.22 to 30.65 (± 2.137%) [11].

Proximate composition

The chemical composition of rice flour varies depending on environment, soil and cultivator. A significant difference in moisture content, ash content and fat content was observed in both conventional and organically grown rice .The white rice from organic BAS-386 showed the highest moisture content (11.03%) as compared to conventional BAS-1121 (6.31%). No significant difference in the ash content, protein content, carbohydrate content and fibre content was observed for both conventional and organic varieties of white rice. Higher fat content was found in flour from conventional BAS-386 showed the higher fat content (1.33%) as compared to organic BAS-386 (0.25%). Sodhi et al. [9] reported that the moisture content of different varieties of rice was in limits of 11.0-11.4%. It was found that resulted moisture content can help to suggest the stability in storage of rice reported by Ghadge [11]. The ash content of rice flour was reported to be about 0.48% [12]. The variation in ash content is mainly because of mineral matter present in rice Hee-Jin [13] reported that in milled rice ash content ranged between 1-2%. In rice, outer layer contains more amount of ash, which linearly decreased with increase in polishing. Fat content greatly dependent on the bran removal from outer surface. The protein content of rice flour was reported to be about 7.0% [12].

Functional properties

The cooking time of both conventional and organic varieties of white rice showed significant difference. However, the white rice from organic BAS-1121 showed the highest cooking time (18.98 min) as compared to conventional BAS-386 (10.49 min). Similarly, brown rice of both organic varieties showed highest cooking time. There is no difference between oil absorption capacity, swelling power and water solubility between conventional and organically grown rice. It was reported that water solubility index is related to the presence of soluble molecules differed significantly among different flours. For different flours, water solubility index varied from 2.666 to 27.733 g/100 g [6]. Oil absorption capacity was defined as ability of flour protein to bind fat physically by capillary attraction, as fat increases the mouth feel of food and acts as a flavor retainer [6]. It was reported that both the type and the protein content of flour contribute to the oil-retaining properties of food materials [14]. To consumer, rice cooking quality is considered very important, and is mainly influenced by degree of milling, cooking methods, cultivation, variety and post-harvest practices [15]. It was reported that time of cooking varies with the condition of rice and cooking methods [8].

Antioxidant activity

The antioxidant activity of conventional rice flour from both the varieties showed significant difference. Bran of organically grown cultivars both varieties showed maximum antioxidant activity (90.82%) as compared to bran of conventional varieties with minimum antioxidant activity BAS-386 (60.16%). Similarly, organically grown brown rice also showed highest antioxidant activity BAS-386 (85.70%) as compared to conventional BAS-386 (58.85%) with lowest antioxidant activity. However, conventional BAS-1121 flour showed the higher antioxidant activity (60.82%) as compared to conventional BAS-386 (52.29%). Similarly their organic counterparts also showed significant difference. Flour from organic BAS-1121 showed the higher antioxidant activity (71.64%) as compared to organic BAS (47.41%). It was found reported that vitamin E, phytic acid, γ-oryzanol are lower in paddy as compared to whole grain but higher as compared to husk and endosperm;).When the whole rice grain stored at about room temperature of 25°C for storage period of 6months result in 18% loss of γ-oryzanol and 70% vitamin E [6]. Walter [16] reported that non-pigmented rice varieties possess lower antioxidant activity as compared to pigmented rice.

Reducing power

The reducing power of both organically grown and conventionally grown cultivars bran showed no great significant difference whereas organically grown brown rice BAS-1121 (1.15%) had higher reducing power than conventionally grown brown rice both varieties [17-21]. Similar results by were showed for rice bran extract with range between (1.68-8.51) [22,23].

Total phenolic count (TPC)

Bran of organically and conventionally grown varieties showed greater difference ,organic BAS-386 (1524.5) had maximum TPC as compared to conventional BAS-1121 (849) with minimum TPC [24-26]. Organically grown brown rice BAS-386 (1070.5) showed maximum TPC as compared to conventional brown rice BAS-1121 (30.5) with minimum TPC [27]. The TPC of brown and white rice in this study is close to the range (65-943) of light brown, red and black pericarp colors rice grains reported by Walter et al. [10] **(Tables 1-5)**.

Table 1. Proximate composition of organically and conventionally grown rice cultivars (n=3).

Varieties	Treatment	Moisture (%)	Ash (%)	Fat (%)	Crude Fibre (%)	Crude Protein (%)	Carbohydrate (%)
Brown Rice							
1121	O	10.19 ± 0.02	1.36 ± 0.08	1.7 ± 0.14	1.72 ± 0.24	5.65 ± 0.77	79.37 ± 0.81
	C	9.74 ± 0.19	1.25 ± 0.07	0.72 ± 0.12	2.58 ± 0.33	6.36 ± 0.63	79.94 ± 0.00
386	O	10.51 ± 0.30	1.25 ± 0.07	0.61 ± 0.26	1.83 ± 0.40	5.54 ± 0.62	80.25 ± 1.66
	C	9.73 ± 0.10	1.07 ± 0.00	2.20 ± 0.19	1.02 ± 0.19	6.47 ± 0.60	79.73 ± 1.23
White Rice							
1121	O	10.75 ± 0.95	1.91 ± 0.02	0.79 ± 0.08	0.71 ± 0.08	5.47 ± 0.54	80.35 ± 1.64
	C	6.31 ± 0.03	1.36 ± 0.07	1.14 ± 0.21	0.55 ± 0.60	5.78 ± 0.32	84.84 ± 0.82
386	O	11.03 ± 0.27	1.12 ± 0.15	0.25 ± 0.12	0.24 ± 0.06	5.73 ± 0.52	81.62 ± 1.14
	C	7.23 ± 0.31	1.58 ± 0.02	1.33 ± 0.79	0.19 ± 0.07	6.31 ± 0.82	83.34 ± 1.99

Table 2. Physical parameters of paddy grains by organic and conventional methods.

Varieties	Treatment	Length (mm)	Breadth (mm)	L/B	Thickness (mm)	Bulk density	Aspect Ratio	Equivalent diameter (mm)	Sphericity	Seed Volume	Surface Area (m^2)	True Density	Porosity	1000 seed wright	1000 seed volume
Paddy															
1121	O	11.27 ± 0.02	2.14 ± 0.01	5.26 ± 0.04	1.69 ± 0.08	0.50 ± 0.00	0.19 ± 0.00	3.44 ± 0.05	30.53 ± 0.39	22.85 ± 0.84	41.84 ± 0.21	1.61 ± 0.00	16.65 ± 1.12	2.67 ± 0.13	2.16 ± 0.18
	C	11.00 ± 0.28	2.46 ± 0.33	4.53 ± 0.5	1.91 ± 0.04	0.51 ± 0.10	0.22 ± 0.02	3.72 ± 0.22	33.70 ± 1.17	23.60 ± 0.41	48.00 ± 8.34	1.68 ± 0.05	17.10 ± 0.99	2.38 ± 0.46	1.46 ± 1.75
386	O	10.10 ±	1.98 ±	5.12 ±	1.96 ±	0.59 ±	0.20 ±	3.37 ±	33.30 ±	28.10 ±	34.80 ±	1.49 ±	19.70 ±	2.19 ±	2.17 ±

		0.01	0.12	0.31	0.78	0.14	0.01	0.53	5.24	0.39	2.52	0.45	8.77	0.12	0.19
	C	10.53 ± 0.26	1.88 ± 0.07	5.59 ± 0.08	1.75 ± 0.07	0.56 ± 0.00	0.17 ± 0.00	3.26 ± 0.11	30.98 ± 0.31	19.72 ± 0.15	34.25 ± 2.33	1.47 ± 0.07	18.21 ± 0.64	2.65 ± 0.35	2.87 ± 0.10
Brown Rice															
1121	O	8.01 ± 1.37	1.18 ± 0.11	4.46 ± 0.48	1.55 ± 0.11	0.77 ± 0.00	0.22 ± 0.02	2.81 ± 0.29	35.27 ± 2.45	9.92 ± 0.07	25.47 ± 5.63	1.44 ± 0.01	13.20 ± 2.29	1.95 ± 0.05	2.22 ± 0.30
	C	9.54 ± 0.57	1.82 ± 0.09	5.22 ± 0.04	1.50 ± 0.14	0.60 ± 0.12	0.19 ± 0.00	2.96 ± 0.01	31.10 ± 1.70	14.38 ± 1.28	30.28 ± 3.30	1.72 ± 0.12	14.37 ± 1.46	2.17 ± 0.10	2.48 ± 0.25
386	O	7.17 ± 1.11	1.72 ± 0.05	4.19 ± 0.76	1.48 ± 0.08	0.80 ± 0.01	0.24 ± 0.04	2.62 ± 0.16	36.90 ± 3.53	8.98 ± 0.83	21.9 ± 2.21	1.66 ± 0.33	11.80 ± 2.44	2.08 ± 0.09	2.37 ± 0.35
	C	7.99 ± 0.21	1.82 ± 0.04	4.40 ± 0.03	1.70 ± 0.01	0.64 ± 0.06	0.23 ± 0.00	2.91 ± 0.04	36.40 ± 0.46	13.50 ± 1.46	25.70 ± 1.16	1.61 ± 0.50	14.50 ± 0.00	2.20 ± 0.09	2.74 ± 0.35
White Rice															
1121	O	8.88 ± 0.10	1.84 ± 0.28	4.82 ± 0.06	1.50 ± 0.04	0.79 ± 0.01	0.20 ± 0.00	2.90 ± 0.01	32.73 ± 0.59	12.88 ± 0.25	28.63 ± 0.32	1.61 ± 0.18	13.45 ± 0.29	1.90 ± 0.00	1.77 ± 0.03
	C	8.70 ± 0.20	2.20 ± 0.10	4.80 ± 0.20	1.50 ± 0.10	0.80 ± 0.10	0.20 ± 0.00	2.80 ± 0.00	33.00 ± 0.40	12.00 ± 0.50	28.00 ± 2.80	1.40 ± 0.10	13.00 ± 1.20	1.90 ± 0.10	1.90 ± 0.10
386	O	7.35 ± 0.11	1.66 ± 0.02	4.41 ± 0.00	1.55 ± 0.07	0.80 ± 0.05	0.22 ± 0.00	2.66 ± 0.01	36.28 ± 0.77	9.94 ± 0.14	21.66 ± 0.60	1.46 ± 0.20	13.03 ± 0.70	1.87 ± 0.04	1.79 ± 0.02
	C	7.06 ± 0.11	1.59 ± 0.18	4.48 ± 0.57	1.70 ± 0.40	0.75 ± 0.06	0.22 ± 0.03	2.66 ± 0.01	37.80 ± 0.74	9.93 ± 0.10	19.80 ± 2.23	1.67 ± 0.12	14.80 ± 2.94	1.94 ± 0.04	2.22 ± 0.16

Table 3. Color analysis of organically and conventionally grown rice cultivars (n=3).

Varieties	Treatment	L*	a*	b*	*ΔE	*Chroma
Paddy						
1121	O	58.99 ± 0.83	7.52 ± 0.02	21.14 ± 0.29	64.14 ± 0.58	22.43 ± 0.26
	C	59.40 ± 1.29	5.35 ± 3.10	18.50 ± 3.17	62.50 ± 0.08	19.40 ± 3.89
386	O	60.10 ± 0.99	7.43 ± 0.20	22.50 ± 0.86	64.50 ± 0.65	23.70 ± 0.76
	C	67.20 ± 9.32	7.09 ± 0.57	22.50 ± 0.27	64.50 ± 0.99	23.60 ± 0.43
Brown Rice						
1121	O	59.63 ± 0.45	6.84 ± 0.08	17.03 ± 0.12	62.59 ± 0.75	18.35 ± 0.14
	C	57.30 ± 0.31	6.83 ± 0.11	17.90 ± 1.07	61.2 ± 1.16	19.10 ± 0.97
386	O	65.90 ± 0.93	5.48 ± 0.09	20.70 ± 0.32	68.90 ± 1.58	21.40 ± 0.28
	C	65.10 ± 0.00	5.89 ± 0.32	19.90 ± 0.83	68.90 ± 0.44	20.80 ± 0.71
White Rice						
1121	O	68.10 ± 0.64	4.30 ± 0.33	18.76 ± 1.02	71.45 ± 1.28	19.24 ± 1.07
	C	68.40 ± 0.54	4.12 ± 0.08	19.10 ± 0.20	71.00 ± 0.42	19.50 ± 0.21
386	O	73.59 ± 0.28	3.18 ± 0.04	19.49 ± 0.11	76.13 ± 0.40	19.74 ± 0.12
	C	71.77 ± 2.79	2.68 ± 0.44	17.44 ± 2.46	76.13 ± 0.19	17.64 ± 2.49

Table 4. Functional Properties organically and conventionally grown rice cultivars.

Varieties	Treatment	Oil Absorption Capacity	Swelling Power	Water Solubility Index	Cooking Time
Brown Rice					
1121	O	1.37 ± 0.08	6.80 ± 0.65	3.26 ± 0.03	19.36 ± 0.32
	C	2.00 ± 0.09	6.84 ± 0.20	2.15 ± 0.07	16.05 ± 0.21
386	O	1.82 ± 0.04	6.34 ± 0.12	2.55 ± 0.43	19.16 ± 0.35
	C	1.57 ± 0.07	6.28 ± 0.13	1.50 ± 0.14	15.28 ± 0.07
White Rice					
1121	O	1.39 ± 0.09	7.28 ± 0.10	2.90 ± 0.14	18.98 ± 0.19
	C	1.12 ± 0.13	6.67 ± 0.31	3.90 ± 0.14	11.56 ± 0.35
386	O	1.29 ± 0.07	7.99 ± 0.14	3.84 ± 0.23	17.30 ± 0.55
	C	1.64 ± 0.07	6.25 ± 0.19	1.72 ± 0.11	10.49 ± 0.09

Table 5. Antioxidant activity of organically and conventionally grown rice cultivars (n=3).

Varieties	Treatment	Antioxidant Activity	Reducing Power	TPC
Bran				
1121	Organic	90.40 ± 1.98	2.11 ± 0.05	915 ± 26.87
	Conventional	75.14 ± 4.72	2.47 ± 0.48	849 ± 72.12
386	Organic	90.82 ± 0.47	2.21 ± 0.40	1524.5 ± 50.20
	Conventional	60.16 ± 2.09	3.73 ± 0.05	1433 ± 74.95
Brown Rice				
1121	Organic	79.90 ± 5.42	1.15 ± 1.34	201 ± 42.43
	Conventional	70.21 ± 1.12	0.27 ± 0.03	30.5 ± 77.07
386	Organic	85.70 ± 2.12	0.27 ± 0.02	1070.5 ± 7.78
	Conventional	58.85 ± 1.16	0.50 ± 0.05	303.5 ± 10.61
White Rice				
1121	Organic	71.64 ± 0.23	0.13 ± 0.04	60 ± 2.83
	Conventional	60.82 ± 3.02	0.17 ± 0.04	67.5 ± 20.51
386	Organic	47.41 ± 4.82	0.13 ± 0.00	7.5 ± 13.44
	Conventional	52.29 ± 1.63	0.16 ± 0.07	63 ± 1.13

CONCLUSION

The physical properties of paddy, brown rice and white and physicochemical properties of white rice, brown rice and antioxidant, TPC, Reducing power of white rice, brown rice flour and bran of different varieties were evaluated [28,29]. It was found that both organic varieties have less protein content than conventional rice varieties whereas cooking time, antioxidant activity, reducing power and total phenolic count of organic rice varieties was higher as compared to conventionally grown rice varieties [30].

REFERENCES

1. Horrungsiwat S, Therdthai N, Ratphitagsanti W (2016) Effect of combined microwave-hot air drying and superheated steam drying on physical and chemical properties of rice. Int J Food Sci Technol 51: 185.
2. Juliano BO (1985) Criteria and tests for rice grain qualities. In: Rice Chemistry and Technology (edited by Juliano BO), pp: 443-524.
3. Zhou Z, Robards K, Helliwell S, Blanchard C (2002) Composition and functional properties of rice - Review. Int J Food Sci Technol 37: 849-868.
4. Juliano BO, Bechtel DB (1985) The rice grain and its gross composition. In: Rice: Chemistry and Technology, 2nd Edn. Juliano BO, ed. Am Assoc Cereal Chem, pp: 17-57.
5. Zhou Z, Robards K, Helliwell S, Blanchard C (2001) Ageing of stored rice: Changes in chemical and physical attributes. J Cereal Sci 33.
6. Kaushal P, Kumar V, Sharma HK (2012) Comparative study of physicochemical, functional, anti-nutritional and pasting properties of taro (*Colocasia esculenta*), rice (*Oryza sativa*) flour, pigeon pea (*Cajanus cajan*) flour and their blends. LWT - Food Science and Technology 48: 59-68.
7. Pascual CCI, Massaretto IL, Kawassaki F, Barros RMC, Noldin JA, et al. (2013) Effects of parboiling, storage and cooking on the levels of tocopherols, tocotrienols and c-oryzanol in brown rice (*Oryza sativa* L.). Food Res.
8. Singh V, Okadome H, Toyoshima H, Isobe S, Ohtsubo K (2000) Thermal and physicochemical properties of rice grain, flour and starch. J Agric Food Chem 48.
9. Sodhi NS, Singh N, Kaur M, Saxena SK (2003) Physicochemical, morphological, thermal, cooking and textural properties of chalky and translucent rice kernels. Food Chem 82: 433-439.
10. Singh N, Kaur L, Sandhu KS, Kaur J, Nishinari K (2006) Relationships between physicochemical, morphological, thermal, rheological properties of rice starches. Food Hydrocolloids 20: 532-542.

11. Ghadge PN, Prasad K (2012) Some physical properties of rice kernels: Variety-106. J Food Process Technol 8: 3-8.
12. Sabanis D, Tzia C (2009) Effect of rice, corn and soy flour addition on characteristics of bread produced from different wheat cultivars. Food Bioprocess Technol 2: 68-79.
13. Hee-Jin K, In-Kyeong H, Kyung-Soo K, Hae-Chune C (2006) Comparison of the physico-chemical properties and ultrastructure of Japonica and Indica rice grains. J Agric Food Chem 54: 4833-4838.
14. Falade KO, Semon M, Fadairo OS, Oladunjoye AO, Orou KK (2014) Functional and physicochemical properties of flours and starches of African rice cultivars. Food Hydrocolloids 39: 41-50.
15. Park JK, Kim SS, Kim KO (2001) Effect of milling ratio on sensory properties of cooked rice and on physicochemical properties of milled and cooked rice. Cereal Chem 78: 151-156.
16. Walter M, Marchesan E, Massoni PFS, da Silva LP, Sartori GMS, et al. (2013) Antioxidant properties of rice grains with light brown, red and black pericarp colors and the effect of processing. Food Res Int 50: 698-703.
17. Tome MM, Murcia MA, Frega N, Ruggieri S, Jimenez AM, et al. (2004) Evaluation of antioxidant capacity of cereal brans. J Agric Food Chem.
18. Haung M, He G, Chen S, Cui M, Ma L, et al. (2014) Optimisation of a quality improver for instant rice and its quality properties. Int J Food Sci Technol.
19. Iqbal S, Bhanger MI, Anwar F (2005) Antioxidant properties and components of some commercially available varieties of rice bran in Pakistan. Food Chem 93: 265-272.
20. Xiao R, Ma Y, Zhang D, Qian L (2018) Discrimination of conventional and organic rice using untargeted LC-MS-based metabolomics. J Cereal Sci 82: 73-81.
21. Kringel DH, da Silva FG, de Las Mercedes Salas-Mellado M (2017) Influence of phosphorylated rice flour on the quality of gluten-free bread. Int J Food Sci Technol 52: 1291-1298.
22. Rao AS, Reddy SG, Babu PP, Reddy AR (2010) The antioxidant and anti-proliferative activities of methanolic extracts from Njavara rice bran. BMC Complement Altern Med 10: 4.
23. Katekhong W, Charoenrein S (2014) Effect of rice ageing and freeze-thaw cycle on textural properties of cooked rice (*Oryza sativa* L.) cv. Khao Dawk Mali 105. Int J Food Sci Technol 49: 2283-2289.
24. Zhou ZK, Robards K, Helliwell S, Blanchard C (2004) The distribution of phenolic acids in rice. Food Chem 87.
25. Liu K, Cao X, Bai Q, Wen H, Gu Z (2009) Relationships between physical properties of brown rice and degree of milling and loss of selenium. J Food Eng 94: 69-74.
26. Tuncel NB, Yılmaz N (2011) Gamma-oryzanol content, phenolic acid profiles and antioxidant activity of rice milling fractions. Eur Food Res Technol 233: 577-585.
27. Aboubakar NY, Scher J, Mbofung CMF (2008) Physicochemical, thermal properties and microstructure of six varieties of taro (*Colocasia esculenta* L. Schott) flours and starches. J Food Eng, pp: 294-305.
28. Ravi R, Sushelamma NS (2005) Simultaneous optimization of a multi-response system by desirability function analysis of boondi making: A case study. J Food Sci, pp: S539-S547.
29. Park JK, Kim SS, Kim KO (2001) Effect of milling ratio on sensory properties of cooked rice and on physicochemical properties of milled and cooked rice. Cereal Chem, pp: 151-156.
30. Ren XL, Liu QL, Fu HW, Wu DX, Shu QY (2007) Density alteration of nutrient elements in rice grains of a low phytate mutant. Food Chem, pp: 1400-1406.