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Quality Characteristics Of Noodles Containing Various Levels of Black Rice Flour

Doaa F. Bedier[1]; Rabab H. Salem[1]; Aliaa A . Almashad[1] and Ekram H. Barakat[2*]

[1] Food science and Technology Department, Faculty of Home Economics, Al-Azhar University, Tanta
[2] Nutrition and food science Department, Faculty of Specific Education, Kafr El-Sheikh University.

ABSTRACT

This study was conducted to the effect of replacement wheat flour with various levels of black rice flours on the quality characteristics of prepared noodles. The obtained results revealed that black rice (BR) variety had a higher level of crude protein, crude fat, ash and fiber contents than wheat flour. Black rice contained the highest values of vitamins B complex group content. From the obtainedresults, BR could be considered as a good source of anthocyanin and antioxidant activity. The quality of noodles prepared with wheat flour supplemented with black rice flour was investigated. The protein, fat and ash of noodles increased as the amount of black rice flour increased. Sensory evaluation of noodles showed that supplemented of 5 and 10% black rice flour had the best overall preference compared with 15 and 20%. Generally, black rice has been added to noodles in place of wheat flour to obtain healthier trends.

Keywords: Black rice, antioxidant activity, anthocyanin and instant noodles.

INTRODUCTION

Black rice (BR) is the native of the common rice variety (*Oryza sativa*) and is used as functional food due to the effectiveness to health (Kitsada *et al*., 2013). Black rice is a rich source of iron, antioxidants including phenolic compounds, which defend against illnesses (Saenkod *et al*., 2013), such as cardiovascular diseases and cancer (Sompong *et al*., 2011). Black rice is respectable source of vitamin E, thus ensures good power (Oikawa *et al*., 2015). BR has a quantity of nourishing welfares over common rice as higher protein with exceptional biological value besides minerals. It has low fat content; also, it is a dressed source of vitamins besides insoluble fiber (Oko *et al*., 2012 and American Culinary Federation Education Foundation 2016).

Noodles are one of the main foods consumed in many countries. Instant noodles have developed internationally recognized food, and worldwide consumption is on the increase. Taste, nutrition, safety, convenience, longer shelf-life, and affordable price as properties of instant noodles have made them popular (Neelam *et al*. 2014). Noodles are long thin portion of food made from a mixture of flour, eggs and water which cooked in boiling water or soup (Parvez, 2009). However noodles have lot of advantages among the purchasers, it also has some disadvantages for most of the nutrients are lost during refining process of wheat flour. Examination the possibility of supplementing BR flour as an ingredient in noodles is becomes a target.

The present work was carried out to evaluate the chemical composition of black rice (BR) as well as to investigate the probability of using black rice flour as substitution materials of wheat flour in preparing functional noodles.

MATERIALS AND METHODS

Materials

Black rice (*Oryza sativa*) was obtained from Rice Research and Training Center, Sakha, Kafr El-Sheikh, Egypt. Corn oil, eggs, garlic powder, onion powder, zinger powder, cumin powder , salt, starch and wheat flour (72%) were purchased from a local market of Tanta City, Egypt. All chemicals were purchased from El-Gomhoria Company for Chemicals and Drugs, Tanta, Egypt.

Methods

Preparation of Black rice flour (BRF)

Whole black rice was purified from impurities and grinding the grain into flour with Laboratory Mill (Mlynek Laboratory JNY Tip WZ/2) to obtain black rice flour (BRF). The resulted flour was stored in paper bags at cold storage (5°±2C) for further analyses (Tawfek, 2018).

Preparation of instant noodles

Control instant noodles dough was prepared as formulae according to Taneya *et al*. (2014). The substituted instant noodles with black rice flour were prepared using the same formula by replacing wheat flour (72%) with black rice flour at 5, 10, 15 and 20% on a flour basis. The formulae of noodles treatments used were as follows:

All the ingredients such as 100g of wheat flour (72% extraction), black rice powder blends, 2g of starch, 1g of $NaHCO_3$, 1g of salt, 1g of zinger powder, 0.5g of onion powder, 0.5g of cumin powder, 0.1g of citric acid and 0.1g of garlic powder, 37 ml warm water 10 ml of egg (fresh), 5 ml of corn oil were weighed. The composite flour mixed with warm water and kneaded for 10 minutes to prepare dough. The dough was transferred to a vertical noodles making machine (Atlas180, 1048534, Italy) and longer types of noodles were made. The prepared raw noodles were then steamed at 100°C for 3 minutes. The

[*] **Corresponding author.**
E-mail address: ekrambarakt@yahoo.com
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noodles were then fried in oil at 170°C for 3 minutes. The cooled instant noodles were packed in polyethylene bags of 100g instant noodles then keep at a temperature -18°C for further analyses.

Chemical analysis

Moisture, protein, ash, fat, crude fiber and ascorbic acid of studied samples were determined according to A.O.A.C. (2005). The content of available carbohydrate was calculated by difference as follow: 100 – (protein% + fat% + ash% + fiber %) as reported by (Tadrus, 1989). The approximate energy was calculated according to (FAO/WHO, 1985) using the following equation: Total energy (Kcal / 100g) = 4 x (% carbohydrate + % protein) + 9 x (% fat)

Determination of B-complex vitamins

Samples were submitted to successive hydrolysis with hydrochloric acid and enzyme hydrolysis using diastase following a procedure described by Vinas *et al.* (2003). HPLC analysis was carried out using Agilent Technologies 1100 series liquid chromatography equipped with an auto sampler and a diode-array detector, at Central Laboratory, Agricultural Research Center, Cairo, Egypt.

Determination of Tocopherols

Samples were determined using the HPLC according the methods described by Ryynänen *et al.*, (2004). Peaks were identified by congruent retention times and ultra-violate spectra and compared with those of the standards at the Central laboratory, Agricultural Research Center, Cairo, Egypt.

Determination of total anthocyanin

About 5 g of sample was mixed with 10 mL of acidified methanol (0.1% HCl), and then the mixture was wrapped with aluminum foil and kept for about 60 minutes under cooling at 4°C, centrifuged at 12,000 x g for 10 minutes under cooling at 4°C. The supernatant was carefully collected and the remained residue was washed with small amount of an extractor solution to eliminate all the pigments (Gao *et al.*, 2016).

Determination of antioxidant activity

The antioxidant activity of extract was carried out at the Regional Center for Mycology and Biotechnology (RCMB), Al- Azhar University Cairo, Egypt by the DPPH free radical scavenging assay according to Blois (1958).

Color characteristics

The color of samples were measured following the method reported by Feng *et al.*(2013) using a chromameter with the Hunter color system (Hunter, Lab Scan XE- Reston VA, USA).

Sensory evaluation of noodles

Noodles samples were scored for sensory properties by a regular taste panel from 10 persons of Food Science and Technology Department, Faculty of Home Economics, Al-Azhar University, Tanta, Egypt. Noodles were sensory evaluated using a scheme of 10 points for taste, odour, texture, appearance, colour and overall acceptability according to Watts *et al.*(1989).

Statistical analysis

The statistical analysis was carried out using SPSS. Statistical software was (Version 11.0 SPSS, Chicago, USA). The results were expressed as mean. Data were subjected to analysis of Variance (ANOVA). The differences between means were tested for significance using Duncan's test at (P<0.05) according to Armitage and Berry (1987).

RESULTS AND DISCUSSION

Chemical composition of flour materials

The chemical composition of wheat flour (WF72% extraction) and black rice flour (BRF) namely moisture, crude protein, crude fat, ash and available carbohydrate were determined. The obtained results are recorded in Table (1).

Table 1. Chemical composition (% on dry weight basis) of wheat flour (72%) and black rice flours.

Materials Parameters	Wheat flour(WF 72% extraction)	Black rice flour (BRF)
Moisture (%)	14.54^{a}	12.90^{b}
Crude protein (%)	11.49^{a}	14.08^{b}
Ash (%)	0.63^{b}	1.17^{a}
Crude fat (%)	0.29^{b}	1.76^{a}
Fiber (%)	0.35^{b}	0.44^{a}
*Available carbohydrate (%)	87.24^{a}	82.55^{b}

***Available carbohydrate was calculated by differences**
Values are means deviation of triplicate trails. In a row, means having the same superscript letters are not significantly different at 5% level.

The obtained results showed that wheat flour had higher content of moisture and carbohydrate, but had lower content of protein, ash, fat and fiber comparing to black rice flour.

As shown in Table (1) indicated the chemical composition of the two flours under investigation. The moisture of WF as presented in the table are higher (14.54%) than the values detected for BRF (12.90%). On the other hand, black rice flour contained higher values of crude protein 14.08% as compared to 11.49% for wheat flour. On the other hand, black rice flour contained higher values of ash and crude fat 1.17 and 1.76 % as compared to 0.63 and 0.29% for wheat flour. For fiber content of BRF proved to be relatively higher (0.44%) as compared to 0.35% for WF. In the same Table, available carbohydrate in WF was (87.24%) higher than that found in BRF (82.55%) on dry basis. Therefore, BRF is considered to be good sources of protein, fiber and crude fat.

Several authors showed that wheat flour had relatively the same chemical composition with little difference. For examples; Hefnawy *et al.* (2012) who reported that moisture content of wheat flour (72%) was 10.50%, crude protein 8.30%, total fats 1.94%, ash 0.85% and carbohydrates 72.20%. Sirichokworrakita *et al.* (2015) showed that moisture content of wheat flour (72%) was 11.96%, protein 11.87%, fat 1.15%, ash 0.74%, fiber 0.35%. Moawad *et al.* (2019) mentioned that moisture content of wheat flour (72%) was 12.60%, crude protein 12.25%, lipids 0.70%, ash 0.63%, crude fiber 0.64%. This trend of results black rice flour (BRF) were obtained by Ma *et al*, (2018) decided that the black rice flour (BRF) contains 7.94% protein, 2.17% fat, 1.38% ash and 12.71% water. Tawfek (2018) who reported that black rice flour contain dry matter 88.76%, total protein 9.24%, fat 2.59%, carbohydrate 83.66%, fiber 2.59% and ash 1.92%. Rathna Priya *et al.*, (2019) mentioned that black rice contain moisture 11.6%, protein 8.8%, fat 1.0%, crude fiber 0.3%, crude ash 0.5% and carbohydrate 78.0%. Jung and Eun

(2003) studied that black rice flour contains 11.4% moisture, 1.49% ash and 9.4% crude protein.

Vitamins composition of black rice flour (BRF)

Table (2) showed that vitamins composition of black rice flour. From the tabulated data it could be noticed that, vitamins content in BRF was thiamin (165.49mg/100g), pyridoxine (9.53mg/100g), niacin (1.65mg/100g), cobalamin (0.25mg/100g), riboflavin (0.11mg/100g), folic acid (0.12mg/100g) and ascorbic acid (0.63mg/100g). From the same table, it could be reported that, α- tocopherols (5.64 μg/g) for BRF, δ-tocopherols in BRF (0.49 μg/g).

Data given in Table (2), indicate that, anthocyanin in black rice flour was (18.35 mg cyanidin 3-glucosids/100g).

Table 2. Vitamins composition (mg/100g) and anthocyanin of black rice flour.

Vitamins	Black rice flour(BRF)
Thiamin(B_1)	165.49
Riboflavin(B_2)	0.11
Niacin(B_3)	1.65
Pyridoxine(B_6)	9.53
Folic acid(B_9)	0.12
Cobalamin(B_{12})	0.25
Ascorbic acid(V.C)	0.63
Alphatecopherol (μg/g)	5.64
Gamatecopherol (μg/g)	0.49
Delta tecopherol (μg/g)	*ND
Anthocyanin(mg cyanidin 3-glucosids/100g)	18.35

***ND Not Detected**

From these results, it could be found the highest values of thiamin (B_1), anthocyanin and pyridoxine (B_6) in black rice flour suggest this application as good substitution materials. The results of the vitamins composition of black rice flour in the present study are in accordance with those reported by Bernatal *et al*. (2019) studied that thiamin content in BRF was (0.23mg/100g). Shammugasamy and Ramakrishnan, (2014) reported that tocopherols content in BRF *α*- tocopherols (11.18mg/kg^{-1}), *β*-tocopherols (0.73mg/kg^{-1}), *δ*-tocopherols (5.48mg/kg^{-1}). Anthocyanin content in black rice flour was higher than that reported by Abdel-Aal *et al.* (2006) mention that cyanidin-3-glucoside constitutes 80% of the total anthocyanin content of black rice. Sutharut and Sudarat (2012)) mentioned that total anthocyanin content of raw black rice was 2.00 mg/100g compared with the study done by the where anthocyanin content Hom Nil rice (black non-waxy rice) was 1.89 – 3.32 mg/100 g. Carmen and Camelia (2017) reported that the black rice contained the highest amount of anthocyanins was 0.119 mg/g fresh weight. Rathna Priya *et al*. (2019) mention that total anthocyanin content of Chak-hao amubi (Manipur black rice) were 1.81mg cyanidin-3-glucoside equivalent 100−1 g. The anthocyanin components in black rice are about 26.3 %, cyanidin-3-O-glucoside and peonidin-3-O-glucoside are the main effective constituents accounting for about 90 % (Chang *et al.* 2010). Also this value was lower than that reported by Sompong *et al*. (2011) found that the anthocyanin content in two types of black rice were 137.41 and 19.39 mg Cyanidin 3-glucoside/100g for Niaw Dam Pleuak Khao (PK) and Niaw Dam Pleuak Dam (PD), while in China Black Rice (CNB) were 140.83mg Cyanidin 3-glucoside /100g.

Antioxidant activity of Black rice flour (BRF)

The DPPH method was evidently introduced by Blois (1958) and it is widely used to test the ability of compounds to act as free radical scavengers or hydrogen donors, and to determinate antioxidant capacity. The parameter IC_{50} (efficient concentration value), is used for the interpretation of the results from the DPPH method and is defined as the concentration of substrate that causes 50% loss of the DPPH and activity. The finding for free radical scavenging activity DPPH of black rice flour extract in this study were presented in Table (3).

Table 3. Antioxidant activity of Black rice flour using DPPH scavenging

Sample conc. (µg/ml)	DPPH scavenging (%)
128	90.27
64	76.27
32	42.91
16	18.00
8	9.91
4	2.91
2	1.36
1	0.55
0	0
IC_{50}	38.8

At the concentration of 128.00µg/ml black rice flour extract caused 90.27% inhibition of the DPPH radical. The value for 50% scavenging activity (IC_{50}) was observed 38.8µg/ml or 0.039g/ml for black rice flour extract. These data were agree with Pengkumsri *et al*. (2015) who showed the highest anti-oxidant activity in DPPH assay (0.08g as IC_{50}) for black rice. Sompong *et al.* (2011) reported that the black rice varieties ranged from 16.0 to 30.3% remaining DPPH. Carmen and Camelia (2017) reported that the total content of polyphenols as part of antioxidant in black rice flour was 483 mg/g fresh weight.

Chemical composition of noodles supplemented with different levels of black rice flour (BRF)

Data presented in Table (4) indicated the effect of black rice flour (BRF) on the properties of noodles. Crude protein and fiber content present increased by increasing the addition level of black rice flour which values in control sample were 10.42% and 0.57% respectively increased in samples with 5, 10, 15 and 20% BRF. The highest values noted in samples contain 20% BRF which values score 12.56% and 0.83% respectively. In 20% BRF, the ash content also significantly increased (7.72%) as compared with the control sample (4.65%).On the other hand, there was decreased in moisture, fat and carbohydrate content by increasing the addition levels of black rice flour which values in control sample were 9.77, 8.22 and 76.14% decreased to 9.57, 6.77 and 71.80% respectively. The high content of protein, fiber and ash in BRF as Table (1) in the present study, contributed to an increase of the content of these components in the noodles. The noodles with the addition of BRF were characterized by significantly higher values of these components in comparison with the control sample.

Concerning ash the BRF substituted noodles showed increases in ash from 4.47 to 7.72 % by increasing the BRF substitution levels from 10 to 20 % as compared to the control sample. The noodles with the addition of BRF were characterized by significantly higher values of these components in comparison with the control sample.

Our results are in agreement with those reported by (Kumar and Murali, 2020) who mentions that, the BRF substituted noodles showed increases in chemical components by increasing the BRF substitution levels. Kong *et al*. (2012) found that addition of BRF lead to increase in moisture content of noodles, the sample contain 15% show the highest moisture content as compared with control and increase in protein, fat and ash content of samples. The sample of 15% BRF has the highest values, which were 11.88, 5.89 and 2.18% respectively compared with control which values were 10.94, 0.34 and 1.21% respectively.

Table 4. Chemical composition (% on dry weight basis) of noodles substituted with different levels of black rice flour

Materials	Wheat flour noodles	Noodles (Wheat flour substituted with different levels of **BRF)			
Parameters	**(Control)**	**5%**	**10%**	**15%**	**20%**
Moisture (%)	9.77^{a}	10.35^{a}	10.18^{a}	9.52^{a}	9.57^{a}
Crude protein (%)	10.42^{b}	9.67^{b}	10.18^{b}	10.31^{b}	12.56^{a}
Crude fat (%)	8.22^{ab}	8.72^{ab}	9.84^{a}	9.80^{a}	6.77^{b}
Crude fiber (%)	0.57^{c}	0.48^{c}	0.94^{b}	1.23^{a}	0.83^{b}
Total ash (%)	4.65^{b}	4.80^{b}	4.47^{b}	4.96^{b}	7.72^{a}
*Available carbohydrate (%)	76.14^{a}	76.33^{a}	74.57^{a}	73.70^{b}	72.12^{b}
Energy (kcal/100g)	420.22^{a}	426.48^{a}	431.56^{a}	424.20^{a}	398.39^{b}

***Available carbohydrate was calculated by difference**
****BRF black rice flour**
Values are means of triplicate trails. In a row, means having the same superscript letters are not significantly different at 5% level.

The addition of BRF decrease the carbohydrate content of muffins as reported by Croitoru et al. (2018) which carbohydrate content of muffins were 42.38g/100g as compared with other samples which was 45.44g/100g.

Colour characteristics of noodles supplemented with different levels of black rice flour (BRF)

The effect of addition BRF on colour characteristics of noodles was presented in Table (5). Lightness in control was the highest 53.92 as compared with 39.18 in 20% BRF. Redness decreased with the addition from 6.88 for control compared with 3.40 in the addition 20%BRF. Yellowness decreased with the addition from 38.45 for control compared with 19.59 in the addition 20%BRF.

From the above mentioned results it could be concluded that increasing the BRF substitution levels could be due to decreasing in colour characteristics values as compared to the control sample

Table 5. Colour characteristics of noodles supplemented with different levels of black rice flour.

Treatments	Wheat flour noodles	Noodles (Wheat flour substituted with different levels of *BRF)			
Parameters	**(Control)**	**5%**	**10%**	**15%**	**20%**
L^* (lightness)	53.92^{a}	45.89^{b}	41.11^{c}	39.55^{d}	39.18^{e}
a^* (redness)	6.88^{a}	4.04^{b}	3.72^{d}	3.99^{c}	3.40^{e}
b^* (yellowness)	38.45^{a}	27.14^{b}	21.19^{c}	19.74^{d}	19.59^{e}

***BRF black rice flour**
Values are means of triplicated trails. In a row, means having the same superscript letters are not significantly at 5% level.

Sensory evaluation of noodles supplements with different levels of Black rice flour (BRF)

Sensory evaluation plays key role in modification improvement, development and acceptance of new food products. The organoleptic properties of control noodles and contain various level of black rice flour are presented in Table (6). From the obtained data shown, it is clear that, all parameter decreased as increasing the levels added of BRF, which taste score in control sample was 8.42 decreased to 7.75, 7.58, 7.33 and 6.75 in samples with 5%, 10%, 15% and 20% respectively. Also, odour score in control sample was 7.92 decreased significantly 7.25, 7.42, 7.00 and 6.92 in samples with 5%, 10%, 15% and 20% respectively. Texture score in control sample was 8.17 decreased significantly 7.92, 7.58, 7.33 and 6.92 in samples with 5%, 10%, 15% and 20% respectively. Appearance score in control sample was 8.42 decreased non significantly 7.83, 6.42, 6.58 and 6.92 in samples with 5%, 10%, 15% and 20% respectively. Colour score in control sample was 8.58 decreased significantly 7.67, 6.08, 6.67 and 6.58 in samples with 5%, 10%, 15% and 20% respectively. This decrease may be due to the addition of BRF caused darkening of the dough.

Overall acceptability decreased significant by increasing the addition of BRF, where in control was 41.50 decreased to 38.42, 35.08, 34.92 and 34.08 in samples with 5, 10, 15 and 20% BRF respectively.

Table 6. Sensory evaluation of noodles supplements with different levels of Black rice flour.

Noodles	Taste	Odour	Texture	Appearance	Colour	Overall acceptability
Control	8.42^{a}	7.92^{a}	8.17^{a}	8.42^{a}	8.58^{a}	41.50^{a}
*BRF 5%	7.75^{ab}	7.25^{abc}	7.92^{ab}	7.83^{a}	7.67^{b}	38.42^{b}
*BRF 10%	7.58^{abc}	7.42^{ab}	7.58^{abc}	6.42^{b}	6.08^{cd}	35.08^{c}
*BRF 15%	7.33^{bcd}	7.00^{bc}	7.33^{bcd}	6.58^{b}	6.67^{c}	34.92^{c}
*BRF 20%	6.75^{cd}	6.92^{bc}	6.92^{cd}	6.92^{b}	6.58^{c}	34.08^{d}

***BRF black rice flour**
Values are means of triplicated trails. In a row, means having the same superscript letters are not significantly at 5% level.

A similar decreasing trend was observed by Klunklin and Savage (2018) who reported that, colour decreased by increasing the addition of purple rice flour, were in control was 6.09, decreased to 6.00 , 5.83 , 5.71 and 5.02 in sample with 25, 50, 75 and 100% PRF. Overall acceptability decreased significantly by increasing the addition of purple rice flour, were in control was 6.14, decreased to 5.67 , 5.54 , 4.47 and 3.90 in sample with 25, 50, 75 and 100% PRF.

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خصائص الجودة للنودلز التي تحتوي على مستويات مختلفة من دقيق الأرز الأسود

دعاء فارس بدير[1]، رباب حسن سالم[1]، علياء عبدالستار المشد[1] و اكرام حفناوى بركات[2]

[1]قسم علوم وتكنولوجيا الأغذية – كلية الإقتصاد المنزلى – جامعة الأزهر – طنطا.

[2]قسم الأغذية وعلوم الأطعمة – كلية التربية النوعية – جامعة كفرالشيخ .

اجريت هذه الدراسة حول تأثير استبدال دقيق القمح بمستويات مختلفة من دقيق الأرز الأسود على صفات الجودة للنودلز المعده بالدراسة . واوضحت النتائج أن دقيق الارز الاسمر يحتوى على نسبة عالية من البروتين والدهن والرماد والالياف مقارنة بدقيق القمح، كما احتوى دقيق الارز الاسمر على نسبة مرتفعة من مجموعة فيتامين ب المركب ، كما يعتبر مصدرا جيدا للانثوسيانين والنشاط المضاد للاكسدة. كما تم تقييم جودة النودلز المحضر من دقيق القمح والمدعم بنسب مختلفة من دقيق الارز الاسمر حيث زادت نسبه كلا من البروتين والدهن والرماد بزيادة نسبة دقيق الارز الاسمر ، واظهرت نتائج التقييم الحسى للنودلز ان إضافة دقيق الأرز الأسمر بنسبة ٥ ،١٠ % كانت لها درجة قبول افضل مقارنه بنسب الإضافة ١٥ ، ٢٠% . بشكل عام ، إضافة الأرز الأسود بدلاً من دقيق القمح اثناء تصنيع النودلز يؤدي للحصول على اتجاهات صحية.