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Quality assurance of functional biscuits produced from red kidney beans flour

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Abstract

The aim of this work was to produce functional biscuits from wheat flour substituted with different ratios of red bean flour (RBF). Red kidney beans subjected to chemical analysis, vitamins content and antioxidant activity. Red beans flour is a good source of protein, ash and fiber contents than wheat flour, RB consider as a good source of antioxidant activity. The rheological properties of dough samples prepared by using wheat flour substituted with 5, 10, 15 and 20% of RBF were evaluated by both farinograph and extensograph apparatus. It is obvious that by increasing the substitution levels in the blends from 5 to 20% of RBF, the water absorption was increased in all the blends as compared with control sample (100% WF). The addition of RBF in the blends at all ratios led to decrease in the resistance to extension of the dough as compared to the control sample. The quality of biscuits prepared with wheat flour supplemented by red beans flour was investigated. Sensory evaluation show that supplemented of 5, 10 and 15% red beans flour have the best overall acceptability compare with 20% red beans flour. It is evident from the study that acceptable biscuits of improved nutritional value could be produced from whole-wheat flour supplemented with different ratios of RBF. This will increase the use of this locally grown grain while reducing the amount of wheat imported into Egypt.

Keywords: plant diet**,** baked product**,** nutritional profile, rheological properties.

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1. Introduction

Red kidney beans are the most important economic variety of the genus *Phaseolus;* scientifically known as *Phaseolus vulgaris* (Common Beans), and referred as Rajmah, Bakla in Hindi, Haricot bean in English and Haricot common in French (Uebersax, 2006). Red kidney beans have greatest popularity in the U.S.A. as well as play long been a part of traditional plant-based diet in many cultures of most of the world's developing countries (Shimelis and Rakshit, 2007). Red bean can use for the ready-to-eat, snack food markets and some other baked products such as tortillas (Anton *et al*., 2008). Dry beans consumed primarily as whole products or parts of the product, the potential of dry bean market classes as a highly effective functional food capable of providing multiple health benefits (Cristiane *et al.*, 2013). Red kidney beans have high nutritive and health benefits, raw kidney beans contain large amount of anti-nutritional factors including phytic acid, trypsin inhibitors, tannins and saponin which can affect the absorption of protein and certain minerals (Shimelis and Rakshit, 2007). Wang *et al.* (2009) estimated that red kidney beans have 21.5-27.1% protein, 1.1-1.2% fat, 61.7% carbohydrates (36.1% starch), 7.0-20% fiber and 3.0-4.4% ash lies in their composition**.** Red kidney beans possess excellent nutritional profile with 22.7% protein, 3.5% mineral, 1% fat and 57.7% carbohydrates out of which total carbohydrates have 38.6% starch and 18.8% dietary fiber (60% insoluble and 40 % soluble). Its protein has highest lysine content about 5% (Qayyum *et al.*, 2012; Thapa, 2012). Beans provide optimum amount of essential amino acids when utilized with cereals and other sulphur containing products (Boye *et al*., 2010). The glutamic and aspartic acids are mainly acidic in nature and present in raw as well as processed beans (Audu and Aremu, 2011). Chaudhary and Sharma (2013) suggested that processing methods-hot water blanching applied to kidney beans could be more beneficial for enhancing the nutrient profiles and reducing the ant nutrients for better absorption of nutrients. Orak *et al.* (2015) reported that phenolic compounds, such as phenolic acids, flavonols, flavones, isoflavones, anthocyanin, and tannins that identified and characterized in food legumes have wide range of physiological properties, such as anti-allergic, anti-inflammatory, anti-atherogenic and antimicrobial. A red kidney bean contains some ant nutritional factors such as phytates, protease and amylase inhibitors, lectins and tannins, which reduce the activity of some enzymes and the absorption of metabolites (Singh *et al.*, 2019). Biscuits are the most favoured and consumed bakery products globally because they are ready to eat food, reasonable cost, high nutritional value, available in different flavour, taste and extended shelf life (Carleja *et al.*, 2017; Elhassaneen, *et al.*, 2016). Consumers' awareness on the need to eat healthy and functional foods is increasing worldwide and health-conscious consumers prefer food that furnishes extra health benefits beyond the basic nutritional requirements (Baba *et al.*, 2015; Ndife *et al.*, 2009). Therefore, there is a trend to produce functional biscuits made from wheat flour and health promoting compounds from non-wheat flours known as functional ingredients (Dewettinc *et al.*, 2008). This study aims to produce functional biscuits made from wheat flour substituted with different ratios of health promoting compounds as red bean flour (RBF). Chemical analysis, rheological properties, colour characteristic and sensory evaluation of preparing functional biscuits were measured.

2. Materials and methods

2.1 Materials

Red beans (*Phaseolus vulgaris* L.) purchased from Agricultural Research station, Sakha, Kafr El-Sheikh city, Kafr El-Sheikh governorate, Egypt. Commercial wheat flour (72% extraction), whole egg, baking powder, sugar, shortening, corn oil, vanilla and fresh whole raw buffalo's milk were purchased from local market, Tanta, Egypt.

2.1 Methods

2.2.1 Preparation of red bean flour

Red beans were purified from impurities and soaked in distilled water for 24 hours with changing the water every 12 hours and spread in the shadow until completely dry for 3day. Finally, crushed in a laboratory mill to obtain a red beans flour (RBF). The resulting flour was stored in paper bags at cold storage (5±2°C) for further analyses.

2.2.2 Preparation of biscuit

The control biscuit dough was prepared according to (Leelavathi and Haridas, 1993). The substituted biscuit treatments made by substituting red beans flour (RBF) for wheat flour at levels of 5, 10, 15 and 20% (w/w) of total flour weight. The formulae of biscuit treatments used were as follows: 100 g wheat flour (72% extraction), 40 g sugar, one g baking powder and one g vanilla essence, 17.5 g shortening, 17.5 ml corn oil, 12 ml milk and 10 ml whole egg. The ground powder sugar, oil and shortening were creamed in mixer for 6minutes (speed 1), added vanilla and egg by mixed for 3 minutes at (speed 2) to obtain a homogenized and creamy texture. Flour, baking powder and milk added to the cream and mixed for 2 minutes at (speed 1). The dough pieces sheeted, cut and baked at 180°C for 15 minutes. After baking, the biscuits left at room temperature and then packed biscuits in airtight polyethylene bags.

2.3 Chemical analysis

Moisture content, crude protein, total ash, crude fat, crude fiber of wheat flour, red kidney bean and biscuits treatments were measured according to the method of A.O.A.C. (2005). The available carbohydrates calculated by the difference according to Tadrus (1989). The approximate energy calculated according to FAO/WHO (1985).

2.4 Vitamin's content

Determination of vitamin C according to

the method of A.O.A.C. (1995). Determination of B-complex vitamins according to the method by Vinas *et al.* (2003). Determination of tocopherols values were determined using HPLC according to the methods described by Ryynänen *et al.* (2004).

2.5 Antioxidant activity

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

2.6 Rheological properties

Farinograph instrument (Brabender Duis Bur G, type 810105001 No. 941026, West Germany), used to determine mixing characteristics of dough prepared from the various blends under investigation. The following parameters obtained from the farinograms except the percentage of water absorption, which recorded directly from the farinograph instrument as described in the A.A.C.C. (2000), at Central Laboratory for Millers and Bakeries Alexandria Company, Alexandria, Egypt. As follows: water absorption (%); arrival time (min), dough development time (min), dough stability time (min) and degree of softening (B.U.). Extensograph test carried out according to the method described in the A.A.C.C. (2000). Using Extensograph (Barabender Duis Bur G, type 860001 No. 946003, West Germany), at Central Laboratory for Millers and Bakeries Alexandria Company, Alexandria, Egypt. To measure the following parameters: dough extensibility (mm), dough resistance to extension (B.U) and proportional number.

2.7 Colour characteristics

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

2.8 Sensory evaluation

Sensory evaluation of biscuits carried out by staff from Food Science and Technology Department, Faculty of Home Economic, Al-Azhar University, Cairo, Egypt. They evaluated for taste, odour, texture, appearance, surface colour, interior colour and acceptability (Noor aziah and Komathi, 2009).

2.9 Statistical analysis

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

3. Results and Discussion

3.1 Chemical composition of wheat flour and red beans flour

The chemical composition of wheat flour (72% extraction) and red beans flour

(RBF) namely moisture, crude protein, ash, crude fat, fiber and carbohydrate were determined, the obtained results recorded in Table (1).

Table (1): Chemical composition percentage on dry weight basis of wheat flour (72%) and red beans flour.

Materials / Parameters (%)	Wheat flour (WF 72% extraction)	Red beans flour (RBF)
Moisture	14.54[a]	12.35[b]
Crude protein	11.49[c]	28.11[a]
Ash	0.63[c]	4.14[a]
Crude fat	0.29[b]	1.16[a]
Fiber	0.35[b]	7.89[a]
Available carbohydrate	72.70[a]	45.35[c]

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

Table (1) indicated the chemical composition of the two flours under investigation. The moisture of WF is higher (14.54%) than the value detected for RBF (12.35%). On the other hand, red bean flour contained higher values of crude protein 28.11% as compared to 11.49% for wheat flour. On the other hand, red bean flour contained higher values of ash and crude fat 4.14 and 1.16 % as compared to 0.63 and 0.29% for wheat flour. Fiber content of RBF proved to be relatively higher (7.89%) as compared to 0.35% for WF. In the same Table, available carbohydrate in WF was (72.70%) higher than that found in RBF (45.35%) on dry basis. Therefore, RBF considered good sources of protein, fiber, and crude fat. These results are in the range of the data obtained by Aly *et al*. (2018) mentioned that moisture content of wheat flour (72%) was 10.7%, protein 9.70%, fat 1.46%, ash 0.52%, fiber 0.77% and carbohydrate 76.85%. moisture content of wheat flour (72%) was 12.60%, crude protein 12.25%, lipids 0.70%, ash 0.63%, crude fiber 0.64% (Moawad *et al.*, 2019). Red kidney bean and small red kidney bean contain ash 5.00–5.01%, fat 1.4–1.57%, protein 20.31–22.46% and carbohydrate 64.92–68.03% (Ibeabuchi *et al.*, 2017). Red bean flour contains moisture 7.60%, ash 2.70%, protein 22.53%, fat 1.11% and carbohydrate 66.50% (Ratnawati *et al.*, 2019).

3.2 Vitamin's content

Table (2) showed that vitamins composition content of red beans flour. Vitamins content in red beans were niacin (102.69 mg/100g), Thiamin (16.16 mg/100 g), Pyridoxine (4.67 mg/100g), Folic acid (1.11 mg/100g), Cobalamin (0.67 mg/100g), Ascorbic acid (0.55 mg/100 g) and Riboflavin (0.09 mg/100g) .From the same Table, it could be noticed that, α - tocopherols (1.77 μg/g), δ -tocopherols (4.59 μg/g) and delta tocopherols (0.68 μg/g) for RBF. These results are in the range of the data shown by Imran *et al*. (2013) reported that the vitamins in RBF with γ – tocopherols being the dominant followed by δ-tocopherols and very small amount of α - and β -tocopherols. Thiamine, riboflavin, niacin, pyridoxine and folic acid content of raw beans were in the range of 0.81–1.32, 0.112–0.411, 0.85–3.21, 0.299-0.659, and 0.148–0.676 mg/100g, respectively.

Table (2): Vitamin's composition (mg/100g) of red beans flour.

Vitamins \ Materials	Red beans flour (RBF)
Thiamin (B_1)	16.16
Riboflavin(B_2)	0.09
Niacin(B_3)	102.69
Pyridoxine (B_6)	4.67
Folic acid (B_9)	1.11
Cobalamin (B_{12})	0.67
Ascorbic acid	0.55
Alpha tocopherol (μg/g)	1.77
Gama tocopherol (μg/g)	4.59
Delta tocopherol (μg/g)	0.68

Vitamins in RBF Ascorbic acid (0.002 mg/g), Niacin (0.021 mg/g), Pyridoxine (0.0039 mg/ g), Riboflavin (0.0022 mg/g), Thiamin (0.0061 mg/g) and α-tocopherols (0.0021 mg/g) (Saleem *et al*., 2016).

3.3 Antioxidant activity

A single procedure cannot identify all possible mechanism characterizing an antioxidant. DPPH (1,1-diphenyl-2-picrylhydrazyl) is stable free radicals that can accept an electron or hydrogen radical to become stable diamagnetic molecule. DPPH method introduced by Blois (1958). 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 red bean flour extract in this study presented in Table (3). At the concentration of 128.00 μg/ml red bean flour extract caused 64.18% inhibition of the DPPH radical. The value for 50% Scavenging activity (IC_{50}) observed 102.2 μg/ml for red bean flour extract.

Table (3): Antioxidant activity of red beans flour using DPPH scavenging.

Sample concentration (μg/ml)	DPPH scavenging (%)
	Red beans flour
128	64.18
64	29.00
32	12.18
16	8.09
8	4.55
4	2.82
2	1.09
1	0.27
0	0
IC_{50}	102.2

3.4 Rheological properties of wheat flour supplemented with different levels of red bean flour

The rheological properties of dough samples prepared by using wheat flour substituted with 5, 10, 15 and 20% of RBF were evaluated by both farinograph and extensograph apparatus.

3.5 Farinograph parameters of wheat flour supplemented with different levels of red bean flour

Rheological properties of wheat and dough supplemented with different levels of red bean flour (RBF) evaluated using the farinograph as shown in Table (4). Farinograph properties of wheat flour dough as affected by substitution at different levels of RBF is presented in Table (4), it is obvious that by increasing the substitution levels in the blends from 5 to 20% of RBF, the water absorption was increased in all the blends as compared with control sample (100% WF). With increasing of RBF levels in the blends, the water absorption was gradually increased. The increase in water absorption in this study was likely due to the increase in total protein content of the composite flours and the higher water absorption capacity of the legume proteins (Ribotta *et al.*, 2005). Arrival time of all blends with RBF found to be as the same time (1.5 min). Arrival time increased from 1.5 to 2.0 min by increasing the amount of RBF to 20% in the blends. When the substitution levels of RBF increased from 5 to 20%, the dough development time gradually increased from 2.0 to 7.0 min.

Table (4): Effect of partial replacement of wheat flour with red beans flour on Farinograph properties of dough.

Treatment / Parameters	Control (100% WF)	Additives levels of RBF			
		5%	10%	15%	20%
Water absorption (%)	62.1	62.2	63.2	63.8	65
Arrival time (min)	1.5	1.5	1.5	1.5	2
Dough development (min)	2	2	9	7.5	7
Dough stability (min)	6.5	15	15	16.5	15.5
Degree of softening (B.U)	60	20	50	80	80

RBF= Red beans Flour, B.U=Brabender Unit.

Increasing proportion of RBF in blends from 5 to 20% with wheat flour led to progressive increase in the dough stability (min), from 15.0 to 16.5 min as the increasing levels of RBF from 5 to 15%. These results were higher than that obtained in the control sample that represented about 6.5 min, might be due to increasing ratio of RBF in the blends, which increased the protein content, as compared with that found in wheat flour. Increasing dough stability attributed to the increase in protein content, which could render the dough more stable. Replacement of RBF at 10% ratios reduced the dough weakening from 60 B.U. for the control sample to 20 and 50 B.U., respectively. However, the dough weakening increased of RBF at 15 and 20% ratios. Eissa *et al.* (2007) decided that Water absorption, Arrival time, Dough development time and Dough stability, increased from 57%, 2.5 min, 6.5 min and 10 min in wheat flour to 73%, 3 min, 6 min and 22 min in 15% kidney peas.

3.6 Extensograph parameters of wheat flour supplemented with different levels of red beans flour

Regarding extensogram parameters *i.e*., resistance to extension (Elasticity), extensibility, and proportional number of wheat flour dough and wheat flour substituted with red bean flour presented in Table (5). The addition of RBF in the blends at all ratios led to decrease in the resistance to extension of the dough as compared to the control sample, which was lower than that found in the control sample except the addition of RBF in the blends at all ratios 15%. These results might be due to the higher content of crude fiber in red bean flour. Dough extensibility increased in the blends at ratios from 5% and 10% of RBF represented about 170 and 170 mm, as compared to the control sample (120 mm), substitution of wheat flour with RBF at ratios 15 and 20% caused a gradual decrease in the extensibility of dough from 95 to 90 mm as compared to the control sample (120 mm). With regard the proportional number of the dough (R/E), as indicated in Table (5), it could be exhibited that increasing the substitution levels of RBF the (R/E) increased recorded 7.6 and 4.6 for 15 and 20%, respectively but the proportional number of the dough was decreased ratios of RBF in 5 and 10% as compared the control sample. Eissa *et al.* (2007) decided that extensibility, resistance to extension and Proportion number increased from 125 mm, 240 BU and 1.92 in wheat flour to 170 mm ,1000 BU and 14.29 in 15% kidney peas.

Table (5): Effect of partial replacement of wheat flour (WF) with red beans flour (RBF) on extensograph properties of dough.

Parameters / Treatments	Extensograph properties								
	Elasticity (B.U) (R.)			Extensibility (mm) (E.)			Proportional number (R/E.)		
	45 min	90 min	135 min	45 min	90 min	135 min	45 min	90 min	135 min
Control (100% WF)	480	600	540	130	135	120	3.6	4.4	4.5
5% RBF	420	540	260	120	115	170	3.5	4.7	1.5
10% RBF	420	500	300	135	120	170	3.1	4.1	1.7
15% RBF	380	400	730	105	100	95	3.6	4	7.6
20% RBF	390	300	420	115	120	90	3.4	2.5	4.6

RBF= Red beans flour, B.U=Brabender unit.

3.6 Chemical composition of biscuit treatments supplemented with different levels of red bean flour

Data presented in Table (6) showed the effect of red bean flour (RBF) on the properties of biscuits, Crude protein, fiber and ash content present increased by increasing the addition level of red bean flour. There was significant increase in protein content (11.71%) for 5% RBF, (13.11%) for 10% RBF, (14.51%) for 15% RBF and (15.91%) for 20% RBF compared with (10.31%) in control biscuits. There was noticeable increase in fiber content from 7.11% in control sample to 9.89% for 20% BRF, concerning ash the RBF substituted biscuits showed significant increases in ash from 5.14% in control sample to 10.22 % for 20% BRF. There were no significant differences in crude fat between control biscuits (12.22%) and (12.59%) in Biscuits supplemented with 5% RBF. In addition, there were no significant differences in fat between 10% RBF and biscuits supplemented with 15% RBF.

Table (6): Chemical composition (%) of biscuit supplemented with different levels of red beans flour.

Treatments / Parameters	Control (100% WF)	Wheat flour supplemented levels of RBP			
		5%	10%	15%	20%
Moisture	11.65[a]	10.03[ab]	9.93[ab]	8.73[b]	8.36[b]
Crude protein	10.31[d]	11.71[cd]	13.11[bc]	14.51[ab]	15.91[a]
Crude fat	12.22[b]	12.59[b]	13.09[ab]	13.14[ab]	14.55[a]
Fiber	7.11[b]	7.56[b]	8.00[ab]	8.44[ab]	9.89[a]
Ash	5.14[d]	6.54[cd]	7.94[bc]	9.34[ab]	10.22[a]
Available carbohydrate	53.66[a]	51.57[b]	47.93[c]	45.84[d]	41.07[e]
Energy (Kcal\100g)	365.80[a]	366.43[a]	361.97[b]	359.66[c]	358.87[c]

Available carbohydrate calculated by differences values are means of triplicate trails. In a row, means having the same superscript letters are not significantly different at 5% level, RBF= Red beans flour.

The results in Table (6) showed that, the addition of red bean flour to biscuits affected on the values of total carbohydrates. Biscuits substituted with different level of red bean flour decreased by increasing of BRF, were 53.66% in control sample decreased to 41.07% for 20% BRF. The biscuits with the addition of RBF characterized by significantly higher values of these components in comparison with the control sample except available carbohydrate. Our results agree with this reported by Inyang *et al*. (2018) who decided that RBF substituted biscuits showed increases in chemical components by increasing the RBF substitution levels. Noah and Adedeji (2021) study the effect of substitution of wheat flour with red kidney bean flour in cookies production. The proximate analysis results showed that moisture, ash, and protein content increased from 5.23% to 6.93%, 1.50% to 4.73%, and 10.77% to 13.98%, respectively, whereas fat, fiber and carbohydrate decrease from 33.31% to 17.37%, 2.65% to 1.21%, and 61.93%–40.10% with increased substitution of red kidney bean flour.

3.7 Colour characteristics of biscuit treatments supplemented with different levels of red beans flour

The effect of addition RBF on colour characteristics of biscuits presented in Table (7). Lightness in control was the highest 70.13 compared with 66.31 in addition 20% RBP. Redness decreased with the addition from 7.07 for control compared with 4.80 in the addition 20% RBF. Yellowness decreased with the addition from 34.82 for control compared with 30.56 in the addition 20% RBF.

Table (7): Colour characteristics of biscuit supplemented with different levels of red beans flour.

Parameters / Treatments	Control (100%WF)	Wheat flour substitution levels of RBP			
		5%	10%	15%	20%
L (lightness)	70.13^{a}	68.37^{b}	66.69^{d}	66.99^{c}	66.31^{e}
A (redness)	7.07^{b}	7.47^{a}	5.68^{d}	5.75^{c}	4.80^{e}
B (yellowness)	34.82^{a}	34.35^{b}	32.65^{c}	32.07^{d}	30.56^{e}

RBF= Red beans flour. Values are means of triplicated trails. In a row, means having the same superscript letters are not significantly at 5% level.

From the mentioned results, it concluded that increasing the RBF supplemented levels could be due to decreasing in colour characteristics values as compared to the control sample.

3.8 Sensory evaluation of biscuit treatments supplements with different levels of red beans flour

Sensory evaluation is applied it to improving and predicting acceptability of new innovative products that developed. Sensory evaluation of control biscuit and supplements with different levels of RBF presented in Table (8), all parameter decreased as increasing the levels added of RBF, taste score in control sample was 9 decreased to 9, 8.88, 8.1 and 8.1 in samples with 5%, 10%, 15% and 20% RBF respectively. In addition, door score in control sample was 9.1 decreased non-significantly 9, 8.9, 8.5 and 8.2 in samples with 5%, 10%, 15% and 20% RBF respectively. Texture score in control sample was 9.1 decreased significantly 8.9, 8.5, 8.1 and 7.7 in samples with 5, 10, 15 and 20% RBF respectively. Surface appearance in control sample was 9.1 with no significantly decreased 8.7, 8.5, 8.1 and 7.9 in samples with 5, 10, 15 and 20% RBF respectively.

Table (8): Sensory evaluation of biscuit supplements with different levels of red beans flour.

Parameters / Treatments	Taste	Odour	Texture	Surface appearance	Surface colour	Interior colour	Acceptability
Control	9^{a}	9.1^{a}	9.1^{a}	9.1^{a}	9.1^{a}	8.9^{a}	54.3^{a}
5% RBF	9^{a}	9^{ab}	8.9^{ab}	8.7^{ab}	9^{a}	8.9^{a}	53.5^{a}
10% RBF	8.88^{ab}	8.9^{abc}	8.5^{abc}	8.5^{ab}	8.6^{ab}	8.5^{ab}	51.8^{ab}
15% RBF	8.1^{bc}	8.5^{abcd}	8.1^{bcd}	8.1^{bc}	8.3^{ab}	8^{bc}	49.0^{bc}
20% RBF	8.1^{bc}	8.2^{bcde}	7.7^{cde}	7.9^{bcd}	8^{bc}	7.9^{bcd}	47.8^{bcd}

RBF= Red beans flour. In a column, means having the same superscript letters are not significantly at 5% level.

From the tabulated data, noticed that interior colour in control sample was 8.9 with no significantly decreased 8.9, 8.5, 8 and 7.9 in samples with 5%, 10%, 15% and 20% RBF respectively. This decreases due to the addition of RBF caused darkening of the dough. Overall acceptability decreased with non-significant by increasing the addition of red bean flour, where in control was 54.3

decreased to 53.5, 51.8, 49.0 and 47.8 in samples with 5, 10, 15 and 20% RBF respectively.

References

AACC (2000), American Association of Cereal Chemists International approved methods of analysis, 10th Edition, AACC International, USA.

AOAC (2012), *Official methods of analysis association of official Agricultural chemists*, 18th Edition, The Association of Official Analytical Chemists, Washington, D.C., USA.

Aly, F. M., Hanaa, M. E., Hemeda, A. S. and El-Masry, H. G. (2018), "Functional and rheological properties of flour and protein isolate of different types of legumes (chickpea and soybean)", *Middle East Journal of Applied Sciences*, Vol. 8 No 01, pp. 112–125.

Anton, A. A., Ross, K. A., Lukow, O. M., Fulcher, R. G. and Arntfield, S. D. (2008), "Influence of added bean flour (*Phaseolus vulgaris* L.) on some physical and nutritional properties of wheat flour tortillas", *Food Chemistry*, Vol. 109 No. 01, pp. 33–41.

Armitage, P. and Berry, G. (1987), *Statistical methods in medical research*, Blackwell, Oxford, UK, pp. 93–213.

Audu, S. S. and Aremu, M. O. (2011), "Effect of processing on chemical composition of red kidney bean (*Phaseolus vulgaris* L.) flour", *Pakistan Journal of Nutrition*, Vol. 10 No.11, pp. 1069–1075.

Baba, M. D., Manga, T. A., Daniel, C. and Danrangi, J. (2015), "Sensory evaluation of toasted bread fortified with banana flour: a preliminary study", *American Journal of Food Science and Nutrition*, Vol. 2 No.2, pp. 9–12.

Blois, M. S. (1958), "Antioxidant determination by the use of stabile free radical", *Nature*, Vol. 181 No. 4617, pp. 1199–1200.

Boye, J., Zare, F. and Pletch, A. (2010), "Pulse proteins: Processing, characterization, functional properties and applications in food and feed", *Food Research International*, Vol. 43 No. 2, pp. 414–431.

Caleja, C., Barros, L., Antonio, A. L., Oliveira, M. B. P. and Ferreira, I. C. (2017), "A comparative study between natural and synthetic antioxidants: Evaluation of their performance after incorporation into biscuits", *Food Chemistry*, Vol. 216, pp. 342–346.

Chaudhary, R. and Sharma, S. (2013), "Conventional nutrients and antioxidants in red kidney beans (*Phaseolus vulgaris* L.): an explorative and product development endeavour", *Annals. Food Science and Technology*, Vol. 14 No. 2, pp. 275–285.

Câmara, C. R., Urrea, C. A. and Schlegel, V. (2013), "Pinto beans (*Phaseolus vulgaris* L.) as a functional food: implications on human health", *Agriculture*, Vol. 3 No. 1, pp. 90–111.

Dewettinck, K., Van Bockstaele, F., Kühne, B., Van de Walle, D., Courtens, T. M., and Gellynck, X. (2008), "Nutritional value of bread: Influence of processing, food interaction and consumer perception", *Journal of Cereal Science*, Vol. 48 No. 2, pp. 243–257.

Eissa, H. A., Hussein, A. S. and Mostafa, B. E. (2007), "Rheological properties and quality evaluation on Egyptian balady bread and biscuits supplemented with flours of ungerminated and germinated legume seeds or mushroom", *Polish Journal of Food and Nutrition Sciences*, Vol. 57 No. 4, pp. 487–496.

Elhassaneen, Y., Ragab, R. and Mashal, R. (2016), "Improvement of bioactive compounds content and antioxidant properties in crackers with the incorporation of prickly pear and potato peels powder", *International Journal of Nutrition and Food Sciences*, Vol. 5 No. 1, pp. 53–61.

FAO/WHO (1985), *Energy and protein requirement*, Report of joint FAO/Who/ UNU Expert Consultation, WHO Technical Report Series No.724, WHO, Geneva, Switzerland.

Joint, F. A. O. and World Health Organization (1985), *Energy and protein requirements*, Report of a Joint FAO/WHO/UNU Expert Consultation, World Health Organization, Rome, Italy.

Feng, M., Ghafoor, K., Seo, B., Yang, K. and Park, J. (2013), "Effects of ultraviolet-C treatment in Teflon®-coil on microbial populations and physico-chemical characteristics of watermelon juice", *Innovative Food Science and Emerging Technologies*, Vol. 19, pp 133–139.

Ibeabuchi, J. C., Okafor, D. C., Peter–Ikechukwu, A., Agunwa, I. M., Eluchie, C. N., Ofoedu, C. E., and Nwatu, N. P. (2017), "Comparative study on the proximate composition, functional and sensory properties of three varieties of beans *Phaseolus lunatus*, *Phaseolus vulgaris* and *Vigna umbellate*", *International Journal of Advancement in Engineering Technology, Management and Applied Science*, Vol. 5 No. 1, pp. 1–23.

Imran, M., Mahmood, A., Römheld, V. and Neumann, G. (2013), "Nutrient seed priming improves seedling development of maize exposed to low root zone temperatures during early growth", *European Journal of*

Agronomy, Vol. 49, pp. 141–148.

Inyang, U. E., Daniel, E. A. and Bello, F. A. (2018), "Production and quality evaluation of functional biscuits from whole wheat flour supplemented with acha (fonio) and kidney bean flours", *Asian Journal of Agriculture and Food Sciences*, Vol. 6 No. 6, pp. 193–201.

Leelavathi, K. and Haridas Rao, P. (1993), "Development of high fibre biscuits using wheat bran", *Journal of Food Science and Technology*, Vol. 30 No. 3, pp. 187–191.

Moawad, E., Rizk, I. R. S., Kishk, Y. F. M. and Youssif, M. R. G. (2018), "Effect of substitution of wheat flour with quinoa flour on quality of pan bread and biscuit", *Arab Universities Journal of Agricultural Sciences*, Vol. 26 No. 7, pp. 2387– 2400.

Ndife, J., and Abbo, E. (2009), "Functional foods: prospects and challenges in Nigeria", *Journal of Food Science and Technology*, Vol. 1 No. 5, pp. 1–6.

Noah, A. A. and Adedeji, M. A. (2020), "Quality assessment of cookies produced from wheat and red kidney bean flour", *International Journal of Food and Nutritional Sciences*, Vol. 10 No. 1, pp. 1–4.

Noor Aziah, A. A. and Komathi, C. A. (2009), "Acceptability attributes of crackers made from different types of composite flour", *International Food Research Journal*, Vol. 16 No.4, pp. 479–482.

Orak, H. H., Karamac, M. and amarowicz, R. (2015), "Antioxidant activity of phenolic compounds of red bean (*Phaseolus vulgaris* L.)", *Oxidation Communications*, Vol. 38 No. 1, pp. 67–76.

Qayyum, M. M. N., Butt, M. S., Anjum, F. M. and Nawaz, H. (2012), "Composition analysis of some selected legumes for protein isolates recovery", *The Journal of Animal and Plant Sciences*, Vol. 22 No.4, pp. 1156–1162.

Ratnawati, L., Desnilasari, D., Surahman, D. N. and Kumalasari, R. (2019), "Evaluation of physicochemical, functional and pasting properties of soybean, mung bean and red kidney bean flour as ingredient in biscuit", *IOP Conference Series: Earth and Environmental Science*, Vol. 251 No. 1, pp 1–10.

Ribotta, P. D., Arnulphi, S. A., León, A. E. and Añón, M. C. (2005), "Effect of soybean addition on the rheological properties and breadmaking quality of wheat flour", *Journal of the Science of Food and Agriculture*, Vol. 85 No. 11, pp. 1889–1896.

Ryynänen, M., Lampi, A. M., Salo-Väänänen, P., Ollilainen, V. and Piironen, V. (2004)," A small-scale sample preparation method with

HPLC analysis for determination of tocopherols and tocotrienols in cereals", *Journal of Food Composition and Analysis*, Vol. 17 No. 6, pp. 749–765.

Saleem, Z. M., Ahmed, S. and Hasan, M. M. (2016), "Phaseolus lunatus linn: Botany, medicinal uses, phytochemistry and pharmacology", *World Journal of Pharmacy and Pharmaceutical Sciences*, Vol. 5 No. 11, pp 87–93.

Shimelis, E. A. and Rakshit, S. K. (2007), "Effect of processing on antinutrients and *in vitro* protein digestibility of kidney bean (*Phaseolus vulgaris* L.) varieties grown in East Africa", *Food chemistry*, Vol. 103 No. 1, pp 161–172.

Singh, P., Singh, R., Kumar, P. and Jyoti, B. (2019), "Physical properties analysis in kidney beans (*Phaseolus vulgaris* L.)", *Journal of Plant Development Sciences*, Vol. 11 No. 3, pp. 165–168.

Tadrus, M. D. (1989), *Chemical and biological studies on some baby food*, M.Sc. Thesis, Faculty of Agriculture, Cairo University, Egypt.

Thapa, N. (2012), *Effect of tempering and other processing treatments on the antinutritional factors and a canning quality attribute of dark red kidney beans*, M.Sc. Thesis, University of Wisconsin, USA.

Uebersax, M. A. (2006), "Dry edible beans: indigenous staple and healthy cuisine", *Forum on Public Policy: A Journal of the Oxford Round Table*, https://link.gale.com/apps/doc/A175164830/AONE?u=anon~6126d74a&sid=googleScholar&xid=07e7a0f3.

Viñas, P., López-Erroz, C., Balsalobre, N. and Hernández-Córdoba, M. (2003), "Reversed-phase liquid chromatography on an amide stationary phase for the determination of the B group vitamins in baby foods", *Journal of Chromatography A*, Vol. 1007 No. 1–2, pp. 77–84.

Wang, X., Gao, W., Zhang, J., Zhang, H., Li, J., He, X. and Ma, H. (2009), "Subunit, amino acid composition and in vitro digestibility of protein isolates from Chinese kabuli and desi chickpea (*Cicer arietinum* L.) cultivars", *Food Research International*, Vol. 43 No. 2, pp. 567–572.