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Physico-chemical and Sensory Properties of Biscuits Fortified by With Red Table Beetroot (*Beta Vulgaris*) Powder

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ABSTRACT

This study was carried out to evaluate the physio-chemical and organoleptic properties of biscuits which were prepared by partially replacing wheat flour (72% extraction rate) with 10, 20, 30, 40, and 50% red beetroot powder. The obtained results indicated that red table beetroot powder was found to possess a higher amount of protein, ash, crude fibers, dietary fibers, and minerals than wheat flour, which was characterised by higher lipids and total carbohydrates. Results also showed that both water absorption, degree of softening, and dough energy of wheat flour were gradually increased as the level of substitution with red table beetroot powder increased. Furthermore, substituting red table beetroot powder for wheat flour increased the chemical composition percentage (moisture, crude protein, lipids, ash, and crude fibers), minerals content (Na, K, Ca, Mg, Mn, Fe, Zn), and dietary fibre content (total, soluble, and insoluble dietary fibers) of biscuit samples. However, total carbohydrates decreased in parallel with increasing the level of substitution compared with the control biscuit sample. In addition, both of the biscuits' weight, diameter, and spread ratio were gradually increased by the rising amount of substitution in compared to the control sample, while the biscuits' volume, specific volume, and thickness were decreased. The sensory evaluation characteristics, taste, odor, crispy, color, and general appearance, have no significant difference between the control sample and the biscuit samples substituted with 10 and 20% of red beetroot powder.

Keywords: Biscuit, red table beetroot powder, proximate composition, physical properties, sensory evaluation.

1. Introduction

Dried beetroots can be consumed directly in the form of chips as a substitute of traditional snacks, that are rich in trans fatty acids (Aro *et al.,* 1998), or after easy preparation as a component of instant food (Krejcova *et al.,* 2007). The bakery industry is one of the largest organized food industries all over the world and in particular biscuits (Sindhuja *et al.,* 2005).

The red table beetroot have been used in traditional medicine to treat wide variety of diseases (Vali *et al.,* 2007), where it is known to be a powerful antioxidant where it contains a group of phenolic compounds called betalains which are a water soluble pigments and responsible for the intense red color of red table beetroots (Azeredo, 2009 and Wruss *et al.,* 2015). Therefore, it could be used as sources of natural colorants in many fields of the food industry (Chranioti *et al.,* 2015).
Alsuhaibani, (2013) study the effect of used red table beetroots powder in the preparation of biscuits. He found that, red table beetroot powder incorporation to biscuits led to increased moisture, protein, ash, fiber contents and caloric value. Also, he mentioned that, biscuit fortified with beetroot powder showed higher sensory values in comparing with control biscuit sample.

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Beetroot (*Beta vulgaris* L.) is an important raw material of plant origin with proven positive effects on the human body. They can be eaten raw, boiled, steamed and roasted. Red table beetroot is a rich source of minerals (manganese, sodium, potassium, magnesium, iron, copper). Beetroot contains a lot of antioxidants, vitamins (A, C, B), fibers and natural dyes. Red table beetroot is also rich in phenol compounds, which have antioxidant properties. These colorful root vegetables help to protect against heart disease and certain cancers (colon cancer) (Kavalcova *et al.,* 2015).

Murlidhar *et al.* (2017) study the effect of using 0, 5, 7, 10, 15 and 20 % of red table beetroot powder on the physical properties, chemical composition and nutritional qualities of cookies. They found that, gradually increased in protein, crude fibers and ash contents with increasing beetroot level. Also, the mentioned that, the incorporation of beetroot powder in cookies lowered the lightness (L*) and yellowness (b*) but increased redness (a*) of cookies. The hardness of the cookies was increased with increasing the level of beetroot powder. Finally, the sensory attributes of cookies indicated that the cookies prepared with addition of 10% beetroot powder were more acceptable as compared to others cookies samples.

Biscuits are most popular bakery product worldwide. They are high in carbohydrates, fat and calorie but low in fibers, vitamin, and mineral which make it unhealthy for daily use. Because of its acceptability in all age group, longer shelf life, better taste and its position as snacks it is consider as a good product of for protein fortification and other nutritional improvement (Kumar *et al*., 2018).

The utilization of red table beetroot powder with wheat flour in bakery products has not been studied extensively. Therefore, the research was designed to evaluate the effect of substitution of wheat flour with different levels of red table beetroot powder on the physio-chemical and sensory properties of biscuit.

2. Materials and Methods

2.1. Materials

Wheat flour (72% extraction rate), fresh whole egg, dry milk, high fructose (42 E.D), shortening, oil, sugar (sucrose), vanilla and all other materials used in baking were obtained from local market, El-Mansoura, Egypt.

Fresh red table beetroot (*Beta vulgaris* L.) was purchased from a local market, El-Mansoura, Egypt.

All chemicals used in this study for analysis were of analytical grade and were obtained from Al Gomhouria Chemical Company,cairo Egypt.

2.2. Methods

2.2.1. Preparation of red table beetroot powder:

Red Table beetroot powder was prepared according to the method described by Odoh and Okoro (2013) as follow:

Fresh red table beetroots were washed and thick slices were made (1-3 mm) using sharp knife. These slices were dried in tray dryer at 60-65˚C for about 7-8 h. The dried red table beetroot slices were subjected to grinding in grinder. Then ground material was passed through 60 mesh sieve and packed in polyethylene bags and stored at (-18˚C) until used.

2.2.2. Preparation of composite flour blends:

Different composite flour blends were prepared by partially substituting of wheat flour (ext.72%) with 10, 20, 30, 40 and 50% of red table beetroot powder to prepare different flour blends which used in preparation of experimental biscuits samples.

2.2.3. Preparation of Biscuits

Sweet biscuit was prepared by partially replacing the wheat flour (72% ext.) with 10, 20, 30, 40 and 50% of red table beetroot powder. The biscuit recipe was carried out according to the method with some modification as follow: The experiment was conducted at the Food Technology Center, Giza, Cairo, Egypt.

Table A: Biscuit ingredients

Ingredients	(g)
Flour (ext.72%)	350
Sugar	115
Shortening	50
Milk powder	5
High fructose (42 E.D)	10
Ammonium bicarbonate	5.5
Sodium bicarbonate	2
Fresh whole egg	65
Vanillin	0.04
Water	As require

Sugar and shortening were creamed in the mixer for 2 min., fresh whole egg and vanillin were blended for 2 min. Flour and baking powder were mixed and added, the mixture was gently mixed for 5 min by using a wooden rolling pin. Water was added as required. The dough was sheeted to a uniform thickness of 4 mm. Circular sheeted dough 3.0 cm in diameter was cut. The cut pieces were placed over a perforated tray and baked at 180˚C for 15 minutes. After baking biscuits were left for cooling at room temperature, wrapped in polyethylene bags, and then the bags were stored at room temperature (25±2˚C). The experiment was conducted at the Food Technology Center, Giza, Cairo.

2.3. Analytical methods

2.3.1. Chemical analysis

Moisture, ash, crude protein, crude fibers and lipids were determined according to the method described in A.O.A.C (2000). The experiment was conducted in the Rheology Laboratory (Institute of Food Technology - Agricultural Research Center in Giza).

Lipids were extracted in Soxhlet apparatus using N-hexane as a solvent. Total carbohydrates were calculated by difference from the sum of the protein, fat, ash and crude fibers content.

Total carbohydrates=100%-(crude protein + total lipid + ash + crude fibers)

Mineral contents (Na, K, Ca, Mg, Fe, Mn and Zn) were determined according to the method of A.O.A.C (2000) using atomic absorption spectrophotometery. (Farinograph instrument (Brabender duis Bur G, type 810105001 No.941026 made in West Germany).

2.3.2. Determination of dietary fibers

Total dietary fibers were measured according to the method described by A.O.A.C. (2000). Soluble and insoluble dietary fibers were determined according to method described by Prosk *et al.,* (1988). The experiment was conducted in the Rheology Laboratory (Institute of Food Technology - Agricultural Research Center in Giza)

2.3.4. Rheological properties

Rheological properties of the various blends were determined by Barbender Farinograph and Extensograph according to A.A.C.C (2000).

Farinograph instrument (Brabender duis Bur G, type 810105001 No.941026 made in West Germany).

Extensograph (Brabender duis Bur G, type 860001 No.916003 made in West Germany).

2.3.5. Physical properties of biscuit

According to the method described by **Sai-Manohar and Haridas-Rao (1997)**. The diameter (D) and thickness (T) of six biscuits were measured in millimeter by placing them edge to edge and by stacking one above the other, respectively. To obtain the average, measurements were made by rearranging and restacking. Spread factor (SF) was calculated by dividing diameter of the biscuit (mm) by their thickness (mm).

$$\textit{Spread Factor of biscuits (SF)} = \frac{\textit{Diameter (mm)}}{\textit{Thickness (mm)}}$$

The weight of six biscuits was determined after cooling. The volume was measured by rape seed displaced by six biscuits. Specific volume was calculated by dividing volume (cm^3) by biscuit weight (g).

$$\textit{Specific volume of bisccuits} = \frac{\textit{Volume } (cm^3)}{\textit{Weight gr}}$$

2.3.6. Sensory evaluation of Biscuit

Biscuit samples produced were evaluated according to the method described by Ranngana (1977), using ten panelists from the Food Industries Department, Faculty of Agriculture, Mansoura University.

The biscuits were evaluated for their taste, color, odor, texture and overall acceptability. The experiment was conducted at the Food Technology Center, Giza, Cairo, Egypt.

2.4. Statistical analysis

Data were analyzed by analysis of variance using General Liner Model (GLM) procedure according to the procedure described by Snedecor and Cochran (1997). Means were separated using Duncan's test at a degree of significance ($P \leq 0.05$). Statistical analyses were made using the producer of the SAS software system program (SAS, 1997).

3. Results and Discussion

3.1. Chemical composition of wheat flour and red table beetroot powder

The chemical composition of wheat flour and red table beetroot powder are presented in Table (1). The obtained results detected that, the highest value of crude protein and crude fibers were recorded (12.68%) and (16.25%), respectively for red table beetroot powder (10.12%) and (0.62%), for wheat flour (72% ext.). respectively. Meanwhile, wheat flour had the highest lipids and total carbohydrates content followed by red table beetroot powder. These results are in agreement with Bala *et al.,* (2015) they found that, soft wheat flour contained crude protein 10.7%, ether extract 0.93 %, crude fibers 0.54 %, ash 0.98% and carbohydrate 74.78 %. In addition, Alshehry, (2019) mentioned that, red table beetroot powder contain 12.88% protein, 1.36% fat, 20.40% crude fibers, 11.30% ash and 54.06% total carbohydrates (on dry weight basis).

Also, from the results presented in the above mentioned Table (1), it could be observed that, red table beetroot powder contains the highest percentage of total, reducing and non-reducing sugar which amounted in 7.20, 3.02 and 4.18%, respectively. While, wheat (72% exit) flour contained 3.82% total sugars, 0.97% reducing sugars and 2.85% non-reducing sugars. These results are in accordance with those obtained by Kharode *et al.* (2019) they mentioned that, red table beetroot powder was containing 7.20% total sugars, 3.02 % reducing sugars and 4.18% non-reducing sugar.

Concerning the dietary fibers content the obtained results show that, red table beetroot powder contains the highest percentage of total dietary fiber(TDF), soluble dietary fiber (SDF) and insoluble dietary fiber(IDF), which amounted in 23.70, 3.70 and 20.00 (g/100g on dry weight basis), respectively. Alternatively, wheat flour (72% ext.) showed the lowest content of total dietary fibers being 2.84 (g/100g dry weight basis). These results are in accordance with those obtained by Abd El-Maniem and Yaseen, (1993) they found that, the TDF of wheat flour (72% ext.) was 2.90% (on dry weight basis). Also, Zaki *et al.*, (2004) they mentioned that, the TDF of wheat flour (72% ext.) was 2.64% (on dry weight basis).

For minerals content,(table), it could be noticed that red table beetroot powder contained the highest content of Na, K, Ca, Mg, Mn, Fe and Zn being 38.15, 116.82, 23.46, 22.69, 0.50, 2.28 and 0.45 mg/100g, respectively. Meanwhile, wheat flour (72% ext.) was contained 20.13, 84.05, 16.48, 13.63, 0.18, 0.94 and 0.14 mg/100g, respectively. The obtained results confirmed with those obtained by Neha *et al.,* (2018) found that, minerals content of red table beetroot powder were as follows: 40.0, 78.0, 16.0, 23.0, 325.0, 0.80 and 0.35 mg/100g fo Na, Ca, Mg, K, Fe and Zn, respectively. While, El-Sharnouby *et al.,* (2012) found that, minerals content of wheat flour (72% ext) were as follows: 15.0, 2.0, 107.0, 1.30, 108.0, 0.6, 20.0, 0.6 and 0.1 mg/100g powder for calcium, sodium, potassium, iron, phosphorus, zinc, magnesium, manganese and copper, respectively.

Table 1: Chemical composition of wheat flour (72%ext.) and red table table beetroot powder

	Wheat flour (72% extraction)	Red table beetroot powder
	Chemical composition (%)	
Moisture	12.36±0.36	10.82±0.27
Crude protein	10.12±0.17	12.68±0.41
Total Lipids	1.24±0.05	0.54±0.01
Ash	0.56±0.01	8.32±0.08
Crude fibers	0.62±0.00	16.25±0.06
*** Total carbohydrates**	100 87.46±0.12	100 62.21±0.28
	Sugar (g/100g dry basis)	
Total sugars	3.82±0.06	7.20±0.08
Reducing sugars	0.97±0.04	3.02±0.02
Non-reducing sugars	2.85±0.02	4.18±0.11
	Dietary fiber (g/100g dry basis)	
Total dietary fibers (TDF)	2.84	23.70
Soluble dietary fibers (SDF)	1.28	3.70
Insoluble dietary fibers (IDF)	1.56	20.00
	Minerals content (mg/100g on dry weight basis)	
Na	20.13	38.15
K	84.05	116.82
Ca	16.48	23.46
Mg	13.63	22.69
Mn	0.18	0.50
Fe	0.94	2.28
Zn	0.14	0.45

* Calculated by difference.
Blends
Control=100%wheat flour
Blend(1)=90%wheat flour +10% red table beetroot
Blend(2)=80%wheat flour +20% red table beetroot
Blend(3)=70%wheat flour +30% red table beetroot
Blend(4)=60%wheat flour +40% red table beetroot

3.2. Rheological properties of wheat flour (72% ext.) rate and its blends with red table beetroot powder

The results presented in Table (2) show that the effect of substitution of wheat flour (72% ext.) with 10, 20, 30 and 40% of red table beetroot powder on Farinograph and Extensograph parameters.

From the obtained data, it could be noticed that the water absorption of wheat flour (72%ext.) was gradually increased as the level of substitution with red table beetroot powder increased which reached to 60.2, 62.4, 65.1 and 67.7% for wheat flour dough's replaced with 10, 20, 30 and 40% of red table beetroot powder, respectively in compared to 58.4% for the control wheat flour dough. The increased in water absorption of the dough which prepared by using red table beetroot powder probably due to the higher fibers content of red table beetroot powder than wheat flour(72ext.) These results are in agreement with Abd El-Moniem and Yassen, (1993) they reported that, addition of fibers sources to wheat flour caused an increased in water absorption of the produced dough. This may be due to higher water hydration capacity of fibers (Chen *et al.,* 1988).

Dough stability time is an important index for the dough strength based on the quantity and quality of dough gluten, so it could be observed that, the stability time of blends of wheat flour dough with 10, 20, 30 and 40% of red table beetroot powder were gradually decreased from 8.0 min. for control sample to 6.0, 4.0, 3.0, 1.5 min., respectively. The decrement in the stability time indicates weakness of dough strength. This weakness of the dough may be due to using red table beetroot powder which reduced the wheat gluten content (dilution effect) in the blends which make the dough more weak strength. Concerning the degree of softening, it could be noticed that the samples which recorded low dough stability, had higher softening values.

Also, from the obtained data table2), it could be noticed that the extensibility of wheat flour (72%ext.) dough was gradually decreased as a result to increase substitution levels with red table beetroot powder, it was 120, 110, 95 and 75 mm for wheat flour replaced by 10, 20, 30 and 40% of red table beetroot powder, respectively, in compared with 160 mm for wheat flour dough (control).

Furthermore, red table beetroot powder caused gradually decreased in the values of resistance to extension from 620 B.U for control sample to 400, 380, 220 and 160 B.U for wheat flour(72%ext.) replaced by the above mentioned levels with red table beetroot powder, respectively. This may be due to the dilution of wheat gluten as a result to addition of date or red table beetroot powder.

For the energy, the control sample recorded the highest value being 147 cm^2, while other treatments were lower in the energy values. It was 72, 54, 38 and 24 cm^2 for wheat flour (72%ext.) replaced with 10, 20, 30 and 40% red table beetroot powder, respectively.

Table 2: Farinograph and Extensograph parameters of dough behaviour of wheat flour (72% ext.) and its blends with red table beetroot powder

	Substitution level with red table beetroot powder (%)				
	Control sample	**10**	**20**	**30**	**40**
	Farinograph parameters				
Moisture	4.17	4.62	5.04	5.50	5.92
***Water absorption (%)**	58.4	60.2	62.4	65.1	67.7
Arrival time (min)	2.0	1.0	1.0	1.0	1.0
Development time (min)	4.0	1.5	1.5	1.5	1.5
Dough stability (min)	8.0	6.0	4.0	3.0	1.5
Degree of softening (BU)	90	130	140	150	160
	Extensograph parameters				
Maximum resistance to extension (BU)	620	400	380	220	160
Extensibility (mm)	160	120	110	95	75
Proportional number	3.88	3.33	3.45	2.32	2.13
Energy (Cm^2)	147	72	54	38	24

Blends
Blend (1) = 90%wheat flour +10% red table beetroot
Blend (2) = 80%wheat flour +20% red table beetroot
Blend (3) = 70%wheat flour +30% red table beetroot
Blend (4) = 60%wheat flour +40% red table beetroot
Control sample = 100 % wheat flour (72 % ext.)
* Expressed on 14% moisture basis.

3.3. Chemical composition of different biscuit samples

Results presented in Table (3) showed that chemical composition of biscuit produced by using 100% wheat flour (72% ext.) as a control sample and wheat flour composite with 10, 20, 30, 40 and 50% red table beetroot powder. It could be noticed that, the control sample containing 6.23% crude protein, 21.50% lipids, 1.28% ash, 0.97% crude fibers and 70.02% total carbohydrate. These results are in agreement with Abd El-Moniem and Yaseen, (1993) as they mentioned that, cookies sample which prepared from 100% soft wheat flour containing 4.97% moisture, 7.00% protein, 21.42% crude fat and 1.01% ash. Furthermore found that, biscuits sample which prepared from 100% weak wheat flour (72% ext.) were containing 5.11% moisture, 5.74% protein, 17.01% total lipids, 0.60% ash, 0.47% crude fibers and 76.18% of total carbohydrates (on dry weight basis).

Moreover, the replacement of wheat flour with 10, 20, 30, 40 and 50% of red table beetroot powder caused gradually increase in both of moisture, ash and crude fibers contents as the level of replacement increased, the increment in ash and crude fibers contents of prepared biscuit probably due to the relatively high content of these components in red table beetroot powder than wheat flour as previously mentioned in Table (3). While, the increment in moisture content of the biscuit which prepared by using red table beetroot powder probably due to the higher fiber content (which had strong water binding ability) than wheat flour. On the contrary, both of lipid and total carbohydrates were gradually decreased as the level of replacement increased. This is may be due to the low content of these components in red table beetroot powder than wheat flour, as shown in Table (1).

From the obtained results, it could be also show that, the control biscuit sample which prepared from 100% wheat flour (72%ext.) was contained 6.68% total sugars, 3.37% reducing sugars and 3.31% non-reducing sugars.

Also, the obtained results show that, the control sample which prepared from 100% wheat flour (72%ext.) was contained 6.03% TDF, 1.72% SDF and 4.31% IDF. These results are accordance with those previously reported by Assem and Abd El-Motaleb, (2004) they found that, biscuits sample which prepared from 100% soft wheat flour containing 2.23% TDF. Furthermore, Sudha *et al.,* (2007) they found that, biscuits sample which prepared from 100% soft wheat flour were containing 1.6% TDF, 1.2% SDF and 0.4% IDF. In the same time, it could be observed that, substitution of wheat flour with 10, 20, 30, 40 and 50% red table beetroot powder caused gradually increase in both of total, soluble and insoluble dietary fibers content as the level of replacement increased. The increment in the above mentioned components in prepared biscuit may be due to the high content of these components in red table beetroot powder in comparison with wheat flour (72% ext.) as show in Table (3).

Concerning to the minerals content of biscuit samples. It could be noticed that, the minerals content of control sample was 24.24, 119.93, 20.38, 15.68, 0.21, 1.37 and 0.28 mg/100g for Na, K, Ca, Mg, Mn, Fe and Zn, respectively (Table 3). These results are in accordance with those previously reported by El-Mihi, (2006) who mentioned that, biscuits sample which prepared from 100% soft wheat flour was containing 0.681mg/100g Fe and 0.282 mg/100g Zn. Moreover, substitution of wheat flour with 10, 20, 30, 40 and 50% of red table beetroot powder caused gradual increase in all the under investigation minerals content as the level of red table beetroot powder increased. The increment in minerals content of prepared biscuits may be due to the higher content of these minerals in red table beetroot powder in comparison with wheat flour 72% extraction rate as shown in Table (3).

Table 3: Chemical composition of different biscuit samples

	Substitution level with red table beetroot powder (%)					
	Control sample	**10 Blend(1)**	**20 Blend(2)**	**30 Blend(3)**	**40 Blend(4)**	**50 Blend(5)**
Chemical composition (%)						
Crude protein	6.23±0.02	6.88±0.00	7.52±0.04	8.17±0.01	8.81±0.03	9.46±0.02
Total Lipids	21.50±0.01	21.43±0.02	21.36±0.00	21.29±0.01	21.22±0.00	21.15±0.01
Ash	1.28±0.01	1.98±0.00	2.67±0.02	3.39±0.01	4.10±0.00	4.82±0.01
Crude fibers	0.97±0.00	1.50±0.03	2.03±0.00	2.55±0.02	3.08±0.01	3.61±0.03
*** Total carbohydrates**	70.02±0.48	68.21±0.22	66.42±0.41	64.60±0.18	62.79±0.39	60.96±0.44
Sugar (g/100g dry basis)						
Total sugars	6.68±0.15	6.74±0.02	6.79±0.00	6.85±0.01	6.90±0.02	6.97±0.03
Reducing sugars	3.37±0.04	3.35±0.02	3.34±0.01	3.32±0.00	3.30±0.00	3.29±0.02
Non-reducing sugars	3.31±0.02	3.39±0.02	3.45±0.01	3.53±0.00	3.60±0.02	3.68±0.01
Dietary fiber (g/100g dry basis)						
Total dietary fibers(TDF)	6.03	7.80	9.56	11.33	13.10	14.87
Soluble dietary fibers(TDF)	1.72	2.29	2.86	3.45	3.98	4.56
Insoluble dietary fibers(TDF)	4.31	5.51	6.70	7.88	9.12	10.31
Minerals content (mg/100g on dry weight basis)						
Na	24.24	34.62	37.63	40.25	42.18	44.16
K	119.93	149.78	156.36	159.88	165.12	171.24
Ca	20.38	22.88	23.31	34.32	38.91	44.52
Mg	15.68	18.86	22.28	24.26	27.28	29.06
Mn	0.21	0.26	0.37	0.45	0.52	0.58
Fe	1.37	1.44	2.18	2.82	3.38	4.14
Zn	0.28	0.34	0.38	0.46	0.50	0.56

* Calculated by difference.

3.4. Physical properties of biscuit samples prepared by substitution of wheat (72%ext.) flour with red table beetroot powder

From the results presented in Table (4). It could be observed that, the control biscuit sample which prepared from 100% wheat flour had a weight of 17.83 g and volume of 30.92 cm^3 with specific volume of 1.73 cm^3/g. The replacement of wheat flour with 10, 20, 30, 40 and 50% of red table beetroot powder caused gradual increase in the weight of prepared biscuit parallel with increasing the level of substitution. The weight of biscuit samples were 19.08, 19.84, 20.45, 21.90 and 23.68 g for 10, 20, 30, 40 and 50% red table beetroot powder, respectively. The increase in biscuit weight may be due to the increase in biscuit fibers content which characterized by higher water holding capacity (Chen *et al.,* 1988).

On the other side, replacement of wheat flour with 10, 20, 30, 40 and 50% red table beetroot powder caused gradual decrease in biscuit volume by increasing level of red table beetroot powder in compared to control sample. The volume of the samples being 30.57, 30.02, 29.70, 28.94 and 28.36 cm^3, respectively, the reduction in biscuits volume may be due to the dilution of wheat gluten as a result to addition of red table beetroot powder plus the increase in fibers content as presented in Table (3). As expected, the values of specific volume recorded the similar trend as that of volume. It was 1.60, 1.51, 1.45, 1.32 and 1.20 cm^3/g for the above mentioned level of substitution, respectively.

Concerning biscuits diameter, the obtained results indicated that there were gradual increase in biscuits diameter by increasing level of red table beetroot powder in compared to control sample. The diameter of the biscuits samples being 6.20, 6.40, 6.50, 6.80 and 7.00 cm, respectively, compared to 6.20 cm for control sample. In contrast, gradual decrease in biscuits thickness of biscuits samples was observed by increasing the level of date and red table beetroot powder in compared to control sample (0.30cn). Spread of biscuit samples increased from 20.67 for control sample to 20.67, 22.86, 24.07, 27.20 and 29.17 respectively, for 10, 20, 30, 40 and 50% replacement with red table beetroot powder.

Table 4: Physical properties of biscuit samples prepared by substituted of wheat flour (72%ext.) with red table beetroot powder

Biscuit samples	**Substitution level (%)**	***Physical properties**					
		Weight (g)	**Volume (cm^3)**	**Specific volume (cm^3/g)**	**Diameter "D" (cm)**	**Thickness "T"(cm)**	**Spread ratio (D/T)**
****Control sample**		17.83^{d}	30.92^{a}	1.73^{a}	6.20^{c}	0.30^{a}	20.67^{c}
Red table beetroot powder	**10**	19.08^{cd}	30.57^{a}	1.60^{a}	6.20^{c}	0.30^{a}	20.67^{c}
	20	19.84^{c}	30.02^{ab}	1.51^{ab}	6.40^{b}	0.28^{a}	22.86^{bc}
	30	20.45^{bc}	29.70^{ab}	1.45^{b}	6.50^{b}	0.27^{ab}	24.07^{b}
	40	21.90^{ab}	28.94^{bc}	1.32^{bc}	6.80^{a}	0.25^{b}	27.20^{ab}
	50	23.68^{a}	28.36^{c}	1.20^{c}	7.00^{a}	0.24^{b}	29.17^{a}

* Means followed by different letters in the same column are significantly different by Duncan's multiple test ($p<0.05$).
** 100 % wheat flour (72 % extraction rate).

3.5. Sensory evaluation of biscuit samples prepared by substitution of wheat flour (72%ext.) with red table beetroot powder

The results in Table (5) show that, there were no significant differences for general appearance between the control sample and 10, 20% level of substitution with red table beetroot powder. On the other hand, a significant difference was observed between the control sample and 50% substitution level with red table beetroot powder.

Concerning to the odor no significant difference was recorded between control samples until 40% level of substitution with red table beetroot powder. The obtained results indicated that, there were sample differences between control sample and biscuit samples which substituted with 40 and 50% red table beetroot powder.

In addition, the obtained results indicated that, there were no significant differences between control biscuit sample and biscuit samples contained 10, 20% level of substitution with red table beetroot powder for biscuit color. While, significant difference was recorded in the same characteristic between the control sample which prepared by 100% wheat flour (72% ext.) and biscuit sample which prepared by using 40 and 50% red table beetroot powder.

Finally, the total score which consider a reflection of all the tested quality attributes and acceptability of the studied biscuit samples showed that, there were no significant differences between control sample and biscuit samples which substituted with 20% red table beetroot powder. But there were significant difference with biscuit samples which substituted with 40 and 50% red table beetroot powder. These results are in accordance with those found by **Alsuhaibani (2013)** mentioned that, biscuit fortified with beetroot powder showed higher sensory values in comparing with control biscuit sample. Also, Murlidhar *et al.,* (2017) found that, the sensory attributes of cookies prepared with addition of 10% beetroot powder were more acceptable as compared to control cookies sample (100% wheat flour).

Table 5: Sensory evaluation of biscuitsamples prepared by substituted of wheat flour (72%ext.) with red table beetroot powder

Biscuit samples	Substitution level (%)	*Organoleptic properties					
		General appearance (20)	Odor (20)	Taste (20)	Crispy (20)	Color (20)	Total score(100)
** Control		$19.80^{a}±0.63$	$19.60^{a}±0.70$	$19.40^{a}±1.16$	$19.30^{a}±1.06$	$19.90^{a}±0.32$	$98.00^{a}±2.77$
Red table beetroot powder	10	$19.70^{a}±0.67$	$19.30^{a}±1.06$	$19.30^{a}±2.01$	$18.50^{a}±1.78$	$19.40^{a}±1.26$	$96.20^{a}±6.17$
	20	$19.30^{a}±1.16$	$18.70^{a}±1.70$	$18.40^{a}±1.71$	$18.50^{a}±1.78$	$18.90^{a}±1.45$	$93.80^{ab}±5.92$
	30	$18.60^{ab}±1.78$	$17.50^{ab}±1.58$	$17.30^{ab}±2.11$	$17.30^{ab}±2.26$	$18.60^{a}±1.51$	$89.30^{ab}±6.77$
	40	$18.40^{ab}±2.37$	$17.20^{ab}±1.75$	$17.10^{ab}±2.08$	$16.50^{b}±1.65$	$17.70^{b}±1.95$	$86.90^{b}±8.56$
	50	$17.60^{b}±2.17$	$16.40^{b}±2.84$	$16.20^{b}±1.81$	$16.00^{b}±2.75$	$17.50^{b}±1.58$	$83.70^{b}±7.99$

* Means followed by different letters in the same column are significantly different by Duncan's multiple test ($p<0.05$).
** 100 % wheat flour (72 % extraction rate).

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