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Quality Characterizations of Pasta Fortified with Red Beet Root and Red Radish

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Abstract: The current research aimed to study the potential of using the red beet root and red radish as a component for pasta production and its effect on quality characterizations of pasta. Pasta produced using powder of red beet root and red radish instead of wheat flour (w/w) by 0, 3, 5 and 7% levels substitution. The prepared pasta was evaluated for its chemical composition, cooking quality, textural, color and sensory attributes. Results showed that substitution with powder of red radish and red beet root increased fiber, ash and iron (Fe) content in the pasta samples relative to semolina and wheat flour (72%) control. All samples had a high overall acceptability, particularly at 5% level the red beet root. Pasta prepared with red beet root or radish powder, at all the levels of incorporation, exhibited higher antioxidant activity than control sample. In addition, Weight gain of past samples was increased with increasing substitution levels. Utilization of radish and beet root powder enhanced the color of pasta samples compared with control.

Keywords: Red Beet Root, Red Radish, Pasta, Physicochemical Properties, Cooking Quality

1. Introduction

Pasta is a highly popular cereal-based food product worldwide, because of its convenience, versatility, sensory and nutritional value. Nowadays eating pasta is perceived as one of the “healthy options”, since it is supremely versatile as a base to a meal, easy to prepare it in a way to satisfy both our notions of “healthy eating” and our appetite [1]

To improve nutritional quality and /or make special pasta some ingredients can be added to semolina. Pasta is enriched with vitamins and mineral. Other examples of materials added to pasta are wheat bran and other fibers used for the purpose of increasing dietary fiber content. Flour of edible legumes, buckwheat, amaranth, lupin, a variety of nontraditional products have been used to reduce to improve cooking or textural quality of pasta [2].

Traditionally pasta products are made from wheat semolina, although more recently other cereals have been used to partially replace it. Common wheat flour also can be useful for pre-cooked pasta products, but because of the low protein content, addition of high protein components such as whole grain flour may enrich the products and result in improved functional properties and quality when the right processing conditions are used [3].

The radish *Raphanus sativus L.* is a member of the Brassicaceae family grown and consumed throughout the world and its request is on the increase.Radishes have been cultivated for thousands of years in both China and the Mediterranean area. Radishes were a common food in Egypt before the building of the pyramids and is one of our most ancient cultivated plants [4].

Radish is mostly eaten raw as salad but also cooked, dried and even pickled. The green leaves are also edible and eaten in some parts of the world, but the use of bulb is more common. Radish contain a high amount of protein, crude fiber, dry matter, nitrate, total soluble sugars, vitamin C, carotene and minerals. Medicinally, it is used in the treatment of heart disease and cancer. Vitamin C in radish reduces asthma, and crude fiber reduces the risk of diabetes and constipation[5].

Beetroot *Beta vulgaris* L. is botanically classified as an herbaceous biennial from *Chenopodiaceae* family and has several varieties with bulb colors ranging from yellow to red. Deep red-colored beet roots are the most popular for human consumption, both cooked and raw as a salad or juice. Beetroots *Beta vulgaris* L. are rich in valuable, active compounds such as carotenoids, glycine betalaine, saponins, betacyanines, folates, betalanin, polyphenols and flavonoids [6]. Beet pigments, betalains, have been examined as natural colorants in food products such as processed meat, ice cream, baked goods, candies, and yogurt. Beetroot juice contains a high level of biologically accessible antioxidants as well as many other health promoting compounds such as potassium, magnesium, folic acid, iron, zinc, calcium, phosphorus, sodium, niacin, biotin, B6 and soluble fiber [7].

The objective of this study was to evaluate characteristics of pasta fortified with red beet root *(B. vulgaris)* and red radish *(R. sativus)*

2. Materials and Methods

2.1. Materials

Wheat Flour (72%) and Durum semolina flour were brushed from the local market in Giza, Egypt. wheat flour (72% extraction) was obtained from South Cairo Mills Company, Giza, Egypt.

Red radish (*R. sativus*) and red beet root (*B. vulgaris*) were purchased from the local market at Giza.

2.2. Methods

2.2.1. Preparation of Plant Materials

Red radish and beet root tubers were cleaned, washed, cut to slides, crushed, and air dried then milled into powder. The roots were air-dried for four days and pulverized, using an electric blender into a fine powder of 60 mesh sieve size which was used for the various analyses.

2.2.2. Pasta Preparation

Pasta formulas were prepared using a mixture of commercial wheat flour, water and vegetable plant powder (red radish or beet root 3.0, 5.0and 7.0% w/w). The mixture was manufactured as macaroni using an Imperia Trading S.r.I. 10098 RIVOLI (TO)-C.so Susa, 242. The pasta samples were dried at 45-50°C for 24 h. Pasta with wheat flour or semolina only without vegetable plant powder (control) was also prepared.

2.2.3. Cooking Quality of Pasta

Cooking tests of pasta including determination of weight gain and cooking loss were performed in triplicates by the following methods: Samples of pasta (10 g) were cooked in 250 ml of boiling water, pasta samples were then drained and weighed immediately. The cooking water was retained and boiled to evaporate most of the water and then dried in an oven at 105 ºC until constant weight. The weight gain and cooking loss of pasta were calculated according to the method described by Lai [8]

Weight gain (%) = [(weight of cooked pasta -10)/10] x100

Cooking loss (%) = [(weight of dried residue in cooking water/10)] x 100

2.2.4. Chemical Composition

Proximate chemical analysis: moisture, crude protein, crude fat, crude fiber and carbohydrate (by difference) were evaluated according to AOAC [9]. Iron content was determined according to the method outlined in AOAC [9] by using the Perkin Elmer (Model 3300, USA) Atomic Absorption Spectrophotometer.

2.2.5. Color Measurement

The color of pasta samples was measured instrumentally using a hand-held Chromameter (model CR-400, Konica Minolta, Japan). The results were expressed in terms of: L (lightness), a (redness-greenness), and b (yellowness-blueness).

The total color difference between uncooked and cooked pasta were determined according to the following equation: ΔE= [(ΔL) 2+ (Δa) 2+ (Δb) 2]1/2.

2.2.6. Texture Profile Analysis

The firmness of cooked pasta was measured using a Texture Analyser, Brookfield Engineering Lab. Inc., Middleboro, MA 02346-1031, USA. Three pieces of cooked pasta were placed perpendicularly to the probe so that they touched each other along their entire length. The samples were compressed twice at a rate of 2.0 mm/s and at a ratio of 70% AACC [9].

2.2.7. DPPH Radical Scavenging Activity

DPPH radical scavenging activity was determined using the method originally developed by Sun et al. [10].

2.2.8. Sensory Evaluation

Pasta was evaluated for overall acceptability (color, texture, aroma and taste) and was carried out as per a 9- point hedonic scale by the help of 10 semi-trained judges [11]

2.3. Statistical Analysis

The obtained data were exposed to analysis of variance. Duncan's multiple range tests at ($p \leq 0.05$) level were used to compare between the means [12]

3. Results and Discussion

3.1. Chemical Composition

3.1.1. Chemical Composition of Raw Materials

Chemical composition of raw materials which used to prepare pasta samples are presented in Table (1).

Results in Table (1) indicated that the highest content of protein was observed in radish powder (14.7%) followed by beet root (12.8%). Also, beet root had the higher value of fiber and ash content (20.26 and 8.2%, respectively) followed by radish (17.35 and 7.7%, respectively). Whereas the fat content was slightly higher in semolina and wheat flour (1.12 and 1.06, respectively) relative to radish and beet root powder. Carbohydrate content was significantly higher in semolina and wheat flour (85.87 and 86.59%, respectively) compared to radish and beet root powder. This result in agreement with Odoh and Okoro [13] and Abd-Elhak et al. [14].

In addition, Odoh and Okoro [13] reported that *B. vulgaris* contain appreciable amount of protein, fiber, carbohydrate and calorific value needed for normal body functioning, maintenance of the body, and reproduction.

Table 1. *Chemical composition of raw materials (% on dry weight basis).*

Samples	Protein%	Ash%	Fat%	Fiber%	Carbohydrates %
Red radish	14.70 ± 0.14^{a}	7.70 ± 0.28^{a}	0.49 ± 0.014^{b}	17.35±0.098^{a}	59.76 ± 0.226^{d}
Red beet root	12.80 ± 0.28^{b}	8.20 ± 0.28^{a}	0.43 ± 0.014^{b}	20.26± 0.11^{b}	58.31 ± 0.127^{c}
Semolina flour	12.20 ± 0.28^{b}	0.52 ± 0.014^{b}	1.12 ± 0.028^{a}	0.43 ± 0.04^{c}	85.73 ± 0.282^{b}
Wheat flour	11.4 ± 0.11^{c}	0.46 ± 0.04^{b}	1.06 ± 0.056^{a}	0.35± 0.04^{c}	86.73± 0.254^{a}

Values are means of three replicates ± SD, numbers in the same column, followed by the same letters, are not significantly different at 0.05 level.

3.1.2. Chemical Composition of Pasta Samples

Chemical composition of pasta samples as shown in Table (2) indicated that the incorporation of radish and beet root powder increased significantly the content of protein in the pasta from 11.21% to 12.17%. Furthermore, fiber content increased significantly by increasing the substitution level of radish or beet root powder. The highest value of fiber content was observed in B7 (1.7%) followed by R7 (1.51) relative to wheat flour control and other samples. Meanwhile, the substitution wheat flour with radish or red beet root powder had no effect on fat content of pasta samples. Result also, indicated that slightly reduction in carbohydrates of pasta prepared with radish and beet root powder compared to semolina and wheat flour control. Ash content increased in vegetables pasta relative to wheat and semolina flour control pasta (0.48 and 0.42%, respectively). the difference than control pasta attributed to chemical composition of radish and red beetroot.

Alsuhaibani [15] stated that red beet powder or extract incorporation to biscuits increased protein and ash contents as well as fiber, moisture contents and caloric value. However, such supplementation decreased carbohydrate content and fat.

Regarding to iron content, Fig 1 illustrated that pasta prepared with red beet root or radish powder, at all the levels of incorporation, exhibited higher Iron (Fe) content than in the control sample and R7 had the highest Fe content relative to other samples. Wootton-Beard et al. [7] reported that Beetroot contains many other health promoting compounds such as iron.

Table 2. *Chemical composition of different pasta samples (% on dry weight basis).*

Treatments	Protein %	Ash %	Fat %	Fiber %	Carbohydrates %
C s	12.10 ± 0.14^{ab}	0.48± 0.04^{d}	1.06 ± 0.08^{a}	0.4 ± 0.03^{f}	85.96 ± 0.24^{b}
C f	11.21 ±0.12^{e}	0.42 ± 0.06^{d}	0.98 ± 0.03^{a}	0.33 ± 0.05^{f}	87.06 ± 0.15^{a}
R3	11.59 ± 0.04^{d}	0.69 ± 0.04^{c}	0.94 ± 0.07^{a}	0.83 ± 0.03^{e}	85.95 ± 0.04^{b}
R5	11.88 ± 0.05^{bc}	0.84 ± 0.06^{b}	0.91 ± 0.06^{a}	1.14 ± 0.08^{d}	85.23± 0.14^{c}
R7	12.17 ± 0.06^{a}	0.96 ± 0.07^{ab}	0.90 ± 0.03^{a}	1.51 ± 0.04^{b}	84.46 ± 0.14^{d}
B3	11.52 ± 0.06^{d}	0.71± 0.04^{c}	0.96± 0.01^{a}	0.90 ± 0.06^{e}	85.91± 0.06^{b}
B5	11.82 ± 0.06^{c}	0.87±0.03^{b}	0.94 ± 0.07^{a}	1.31 ± 0.04^{c}	85.00 ± 0.06^{c}
B7	12.02±0.08^{abc}	1.02 ± 0.04^{a}	0.91 ± 0.06^{a}	1.70 ± 0.06^{a}	84.36 ± 0.03^{d}

R3, R5, and R7: pasta prepared with 3,5 and 7 g of radish powder /100 g of wheat flour, respectively. B3,B5 and B7: pasta prepared with 3,5 and 7 g of red beet root powder/100 g of wheat flour, respectively. Cf: wheat flour control sample. Cs semolina control sample.Values are means of 3 replicates ± SD, numbers in the same column, followed by the same letter, are not significantly different at 0.05 level.

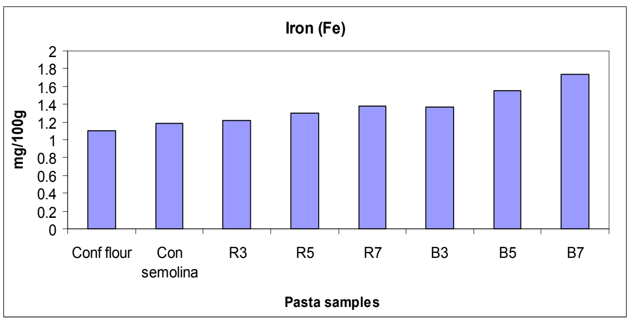

Fig. 1. *Iron (Fe) content of pasta samples.*

3.2. Sensory Evaluation of Pasta Samples

Sensory evaluation of pasta samples can be an important step to consider the possibility towards an industrial and commercial approach [16]. Mean scores of the sensory parameters and the total quality scores are shown in Table (3).

From data in Table (3), it could be observed that substitution with beet root and radish enhanced the color compared with wheat flour pasta (8.08) particularly those with beet root. B7 sample had the higher color score (8.67) followed by B5 (8.42).

In terms of texture appreciation, analysis of variance showed that there was no significant difference among samples.

In addition, there were no significant differences in aroma and taste characters, sample B5 had the highest aroma and taste score (8.33), while sample R7 showed the lowest values of aroma and taste (7.87and 7.83, respectively) compared to wheat flour pasta (8.25 and 8.17).

Regarding overall acceptability, all samples had a high acceptance. B5 had the highest overall acceptability (8.45) followed by R5 (8.33). Also, in overall quality score, there was no significant difference between semolina wheat flour control and beet or radish samples except R7 (39.93). In general, all samples had a high acceptance, and B5 red beet pasta was preferred by the panel.

The present data are consistent with Alsuhaibani [15] who revealed that, Biscuit fortified with beet root showed higher values of exterior color, odor, taste and general acceptability in comparing with biscuit control. Also he advised to add beet root powder and extract to bakery product.

Table 3. *Sensory evaluation of pasta samples.*

Treatments	Color (9)	texture (9)	Aroma (9)	Taste (9)	Overall acceptability (9)	Total quality score (45)
Control (semolina)	8.33± 0.258^{ab}	8.50± 0.447^{a}	8.30 ± 0.25^{a}	8.45 ±0.33a	8.50 ±0.316^{a}	42.16± 0.87a
Control (wheat flour)	8.00 ± 0.0^{b}	7.80± 0.51^{a}	8.25 ±0.41^{a}	8.16± 0.68^{a}	8.08 ±0.20^{ab}	40.33 ±1.15^{ab}
R3	8.08± 0.20^{b}	8.08 ± 0.49^{a}	8.17± 0.68^{a}	8.08 ±0.491^{a}	8.30 ± 0.51^{a}	40.74 ±1.80^{ab}
R5	8.25 ±0.75^{ab}	8.25± 0.27^{a}	8.03 ±0.32^{a}	8.08 ±0.49^{a}	8.35± 0.61^{a}	41.00± 1.87^{ab}
R7	8.15± 0.19^{b}	8.3± 0.25^{a}	7.86± 0.29^{a}	7.80 ±0.60^{a}	7.85± 0.61^{b}	39.93 ±1.01^{b}
B3	8.20 ± 0.22^{ab}	7.92±0.37^{a}	8.20± 0.4^{a}	8.25 ±0.418^{a}	8.17 ±0.25^{ab}	40.77 ± 0.83^{ab}
B5	8.42± 0.37^{ab}	8.00 ± 0.45^{a}	8.30± 0.25^{a}	8.30± 0.51^{a}	8.45± 0.12^{a}	41.53± 0.49^{ab}
B7	8.67± 0.41^{a}	8.08 ±0.49^{a}	8.25± 0.27^{a}	8.28 ±0.40^{a}	8.20± 0.24^{ab}	41.48 ± 1.16^{ab}

R3, R5, and R7: pasta prepared with 3,5 and 7 g of radish powder /100 g of wheat flour, respectively. B3,B5 and B7: pasta prepared with 3,5 and 7 g of red beet root powder/100 g of wheat flour, respectively. Cf: wheat flour control sample. Cs semolina control sample.Values are means of 3 replicates ± SD, numbers in the same column, followed by the same letter, are not significantly different at 0.05 level.

3.3. Color

Colors are important quality indicators that determine the consumer acceptance of foods. The color system CIE-Lab was used to record the color parameters of the surface of the pasta samples. The L is the measure of the brightness (lightness) from black (0) to white (100). The a is the function of the red-green difference. Positive a indicates redness, negative a indicates greenness. The b is the function of the green blue difference. Positive b indicates yellowness, negative b indicates blueness. The units within the L, a, b system give equal perception of the color difference to a human observer. The L,a, b values of the pasta samples with different supplements are presented in Table (4).

Results showed that the replacement of wheat flour with different amounts of radish or red beet root caused significant decrease of L values of pasta samples which ranged from 46.09 to 66.00 compared to the semolina control pasta (L = 78) and wheat flour control pasta (L= 68.01). The higher reduction of L values was observed in Red beet root pasta than Radish pasta. However, a values were increased via the substitution with radish or beet root but the higher increment of a values recorded by red beet root substitution where a values ranged from 13.70 to 44.01, this results due to high red pigments (Betalain) content of red beet root which used as alternative natural red colorants in some processed foods [17].

The similar results were found by Alsuhaibani [15] who reported that lightness decreased with increased levels of beetroot powder in biscuits.

Color losses resulting from pasta cooking process, are expressed in terms of total color difference (ΔE) between uncooked and cooked samples, as given in (Fig. 2).

Lower color loss was observed in pasta samples which indicates the resistance of the product to the thermal process, presenting values between 4.67 and 12.72 for R3and B7, respectively.

Table 4. *The L,a, b values of pasta samples* ***before and after cooking***

Treatments	L		a		b	
	Before	After	Before	After	Before	After
Cs	78.00 ± 0.28^{a}	70.10± 0.14^{a}	0.20 ± 0.012^{f}	0.10 ± 0.00^{f}	20.90± 0.11^{a}	17.96 ± 0.06^{a}
Cf	68.01±0.29^{b}	65.01 ± 0.13^{b}	0.14 ± 0.00^{f}	-1.05 ± 0.01^{g}	17.70± 0.00^{c}	14.05 ± 0.07^{c}
R3	66.00 ± 0.14^{c}	63.10± 0.07^{c}	2.35 ± 0.00^{e}	1.98± 0.01^{d}	19.90± 0.00^{b}	14.81± 0.01^{b}
R5	65.00±0.00^{d}	61.03 ± 0.04^{d}	3.06 ± 0.01^{d}	1.69± 0.01^{e}	16.30 ± 0.00^{d}	11.78 ± 0.01^{d}
R7	63.00 ± 0.28^{e}	59.10 ± 0.03^{e}	3.10 ± 0.00^{d}	1.63 ± 0.00^{e}	14.60 ± 0.01^{e}	9.20 ±0.01^{e}
B3	58.15 ± 0.07^{f}	52.05 ± 0.21^{f}	13.70 ± 0.14^{c}	8.06 ± 0.08^{c}	2.67 ± 0.00^{h}	2.72± 0.03^{h}
B5	52.04± 0.014^{g}	46.00 ± 0.03^{g}	24.69± 0.01^{b}	13.40± 0.009^{b}	3.13 ± 0.01^{g}	7.98 ± 0.04^{g}
B7	46.09 ± 0.014^{h}	45.05 ± 0.09^{h}	44.01± 0.01^{a}	28.10± 0.141^{a}	5.39 ± 0.01^{f}	8.80 ± 0.08^{f}

R3, R5, and R7: pasta prepared with 3,5 and 7 g of radish powder /100 g of wheat flour, respectively. B3,B5 and B7: pasta prepared with 3,5 and 7 g of red beet root powder/100 g of wheat flour, respectively. Cf: wheat flour control sample. Cs semolina control sample.Values are means of 3 replicates ± SD, numbers in the same column, followed by the same letter, are not significantly different at 0.05 level.

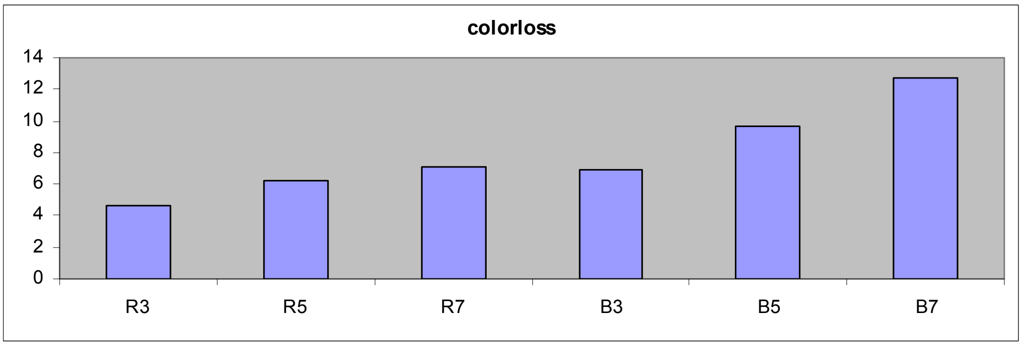

Fig. 2. *Total color difference (ΔE) between uncooked and cooked pasta samples prepared with beet root and radish.*

3.4. Antioxidants Activity

Antioxidants present in food are very important for human health since the reactive oxygen species are recognized as aging and carcinogenesis factor [18].

The antioxidant activity of methanolic extracts of pasta samples is shown in Fig. (3). Data reveals that the substitution with radish or beet root powder in pasta samples increased significantly their antioxidant activity in comparison with semolina and wheat flour control (4.9%). B7 extract had the highest antioxidant (9.53) followed by R7 (9.12).

These results may be due to the higher antioxidant of red beet root and radish [17].

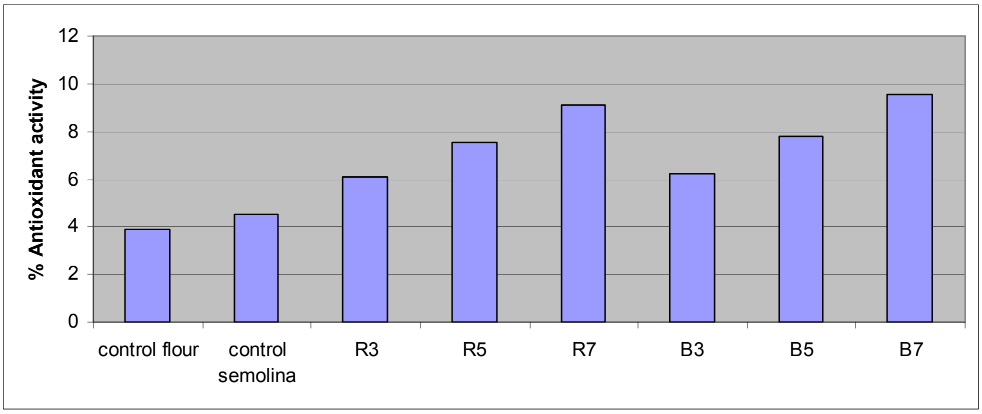

Fig. 3. *Antioxidant activity of pasta samples.*

3.5. Cooking Properties

Data in Table (5) presented the cooking properties of pasta samples. The cooking losses increased significantly with increasing beet root or radish substitution levels from 4.45 for wheat flour pasta control to 6.44 for B 7. While, semolina control had the lowest cooking loss value (3.32). However, all cooking loss values were less than 8%, which is the limit value considered desirable for spaghetti prepared from semolina. During cooking, a weak or discontinuous protein matrix results in a protein network that is too loose and permits a greater amount of leaching during starch granule gelatinization causing an increased cooking loss and adhesiveness. Also, since gluten-protein network is responsible for retaining pasta physical integrity during cooking, a weaker structure leaches more solids from pasta samples into cooking water, increasing cooking residues [19].

On the other hand, Pasta prepared with beet root or radish present weight gain percentage higher significantly than the wheat flour and semolina control (100.49 and 118.25, respectively). The highest weight gain observed in R7 pasta sample (156.25).

3.6. Texture

Texture of cooked pasta is generally recognized as its most important overall quality aspect. Protein content and quality are considered the most important of all the wheat grain components that affect cooking and texture quality. As gluten-protein content increases in wheat flour, cooked pasta becomes firmer and less sticky [20]. Texture profile of cooked pasta are presented in Table (6).

In the present study, replacing wheat flour with beet root or radish resulted in decrease of firmness, cohesiveness. However, chewiness values were increased with replacement.

Firmness decreased from 1.85 for wheat flour pasta to 1.2 for R7 control Moreover, semolina control had the highest firmness (4.0). The lowest values of cohesiveness and adhesiveness were in B7 (0.42 and 0.50, respectively). The lowest chewiness recorded in wheat flour pasta control (1.8). This result agreed with the result of Sozer and Kaya [21] who reported the adhesiveness and cohesiveness of durum semolina spaghetti samples were 0.77 and 0.74, respectively. Also, Chillo et al.[3] who found that the Firmness of durum semolina spaghetti samples was 4.

Table 5. *Cooking quality attributes of pasta samples.*

Treatments	weight of pasta before cooking	weight of pasta after cooking	Weight gain	Cooking loss
Cs	5.02 ± 0.02^{a}	10.95 ± 0.05^{e}	118.25 ± 1.91^{ab}	3.41± 0.13^{d}
Cf	5.50 ± 0.09^{a}	11.03± 0.04^{e}	100.50 ± 4.25^{b}	4.45± 0.21^{c}
R3	5.20 ± 0.28^{a}	11.95± 0.07^{d}	130.19 ± 13.8^{ab}	4.73 ± 0.13^{c}
R5	5.40 ± 0.42^{a}	13.06 ± 0.08^{a}	142.70 ± 20.6^{a}	5.50 ± 0.24^{b}
R7	5.11± 0.13^{a}	13.10 ± 0.014^{a}	156.24± 6.6^{a}	5.80± 0.14^{b}
B3	5.42 ± 0.25^{a}	12.30± 0.04^{c}	126.60± 9.8^{ab}	5.50 ± 0.14^{b}
B5	5.41 ± 0.26^{a}	12.90± 0.11^{a}	139.10 ± 9.7^{a}	5.60 ± 0.16^{b}
B7	5.11± 0.12^{a}	12.62 ± 0.14^{b}	147.10 ± 8.9^{a}	6.44 ± 0.17^{a}

R3, R5, and R7: pasta prepared with 3,5 and 7 g of radish powder /100 g of wheat flour, respectively. B3, B5 and B7: pasta prepared with 3,5 and 7 g of red beet root powder/100 g of wheat flour, respectively. Cf: wheat flour control sample. Cs semolina control sample.Values are means of 3 replicates ± SD, numbers in the same column, followed by the same letter, are not significantly different at 0.05 level.

Table 6. *Texture profile of cooked pasta samples.*

Treatments	Firmness (N)	Cohesiveness	Adhesiveness	Chewiness (N)
Cs	4.00 ± 0.14^{a}	0.79 ± 0.014^{a}	0.79 ± 0.01^{a}	2.05 ± 0.07^{ab}
Cf	1.85 ± 0.07^{b}	0.57 ± 0.03^{d}	0.60± 0.00 ^{b}	1.85 ± 0.07^{b}
R3	1.35 ± 0.07^{c}	0.68±0.00^{b}	0.57± 0.014^{c}	2.05± 0.07^{ab}
R5	1.25± 0.07^{c}	0.66 ± 0.01^{b}	0.56 ± 0.014^{cd}	2.20 ±0.00^{a}
R7	1.20 ± 0.28^{c}	0.61 ± 0.014^{c}	0.54±0.00^{cde}	2.20 ± 0.14^{a}
B3	1.65 ± 0.07^{bc}	0.54± 0.01^{d}	0.53± 0.014^{de}	2.30 ± 0.14^{a}
B5	1.45 ± 0.07^{c}	0.46±0.00^{e}	0.51 ± 0.014^{ef}	2.35 ± 0.07^{a}
B7	1.35 ± 0.07^{c}	0.42±0.00 ^{f}	0.50± 0.007^{f}	2.40 ± 0.14^{a}

R3, R5, and R7: pasta prepared with 3,5 and 7 g of radish powder /100 g of wheat flour, respectively. B3,B5 and B7: pasta prepared with 3,5 and 7 g of red beet root powder/100 g of wheat flour, respectively. Cf: wheat flour control sample. Cs semolina control sample.Values are means of 3 replicates ± SD, numbers in the same column, followed by the same letter, are not significantly different at 0.05 level.

4. Conclusion

Fortification with red radish or red beet root poweder as a component for pasta production improved the quality product and increase the nutritional value. Pastas prepared with red beet root or radish powder presented a chemical composition richer than the control pastas, particularly in fiber and ash. Also, pasta with red beet root or radish powder, at all the levels of incorporation, exhibited higher antioxidant activity than in the control sample. red beet root or radish powder. Sensory analysis showed that red beet root or radish powder pasta samples had higher color acceptance scores by the panellists than the control pasta.

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References

[1] Cavazza A, C. Corradini, M. Rinaldi, P. Salvadeo, C. Borromei, and R. Massini, 2013. Evaluation of Pasta Thermal Treatment By Determination of Carbohydrates, Furosine, and Color Indices. Food Bioprocess Technol., 6:2721-2731.

[2] Manthey, F. A. and W. Twombly, 2006. Extruding and drying pasta, in Handbook of Food Science Technology and Engineering, ed. by Hui Y H. Taylor and Francis, Boca Raton.

[3] Chillo, S., J. Laverse, P. M. Falcone, M. A. Del Nobile 2008. Quality of spaghetti in base Amaranthus wholemeal flour added with quinoa, broad bean and chick pea. J. Food Eng. 84: 101–107.

[4] Salemo, A., F. Pierandrei, E. Rea., G. Colla, Y. Rouphael, F. Saccardo. 2005. Floating system cultivation of radish (*Raphanus sativus* L):production and quality. Acta Horticulture 69, 87-92.

[5] Lu, Z. L., L.W. Liu, X.Y. Li, Y.Q. Gong, X.L. Hou, and X.W. Zhu,2008. Analysis and evaluation of nutritional quality in Chinese radish (*Raphanus sativus L.*). Agric Sci China 7:823–830.

[6] Vali, L., E. Stefanovits-Banyai, K. Szentmihalyi, H. Febel, E. Sardi, A. Lugasi, I. Kocsis, A. Blazovics, 2007 "Liver-protecting effects of table beet (*Beta vulgaris var.* Rubra) during ischemia-reperfusion," Nutrition 23, pp. 172–178.

[7] Wootton-Beard, P. C., A. Moran, and L. Ryan, 2011. Stability of the antioxidant capacity and total polyphenol content of 23 commercially available vegetable jucies before and after in vitro digestion as measured by FRAP, DPPH, ABTS and Folin Ciocalteu methods. Food Research International, 44, 217–224.

[8] Lai, H. M. 2002. Effects of rice properties and emulsifiers on the quality of rice pasta. Journal of the Science of Food and Agriculture 82, 203-216.

[9] AACC.2007. American Association of Cereal Chemists, Approved Methods of the AACC, 10th edition. AACC, St Paul.

[10] Sun, J., J. Y. Yao, S. X. Huang, X. Long, J. B. Wang and E. G. Garcia, 2009. Antioxidant activity of polyphenol and anthocyanin extracts from fruits of Kadsur acoccinea (Lem.) A. C. Smith. Food Chemistry, 117:276–281.

[11] Bashir, K., Dr Vidhu, A. and M. Lubna, 2012. Physiochemical and sensory characteristics of pasta fortified with chickpea flour and defatted soy flour. Journal of Environmental Science, Toxicology and Food Technology 1,34-39.

[12] Steel, R. G. D., J. H. Torrie, D. A. Dickey, 1997. Principles and Procedures of Statistics. A Biometrical approach. McGraw Hill Book Co., New York, USA.

[13] Odoh, U. E. and E. C. Okoro, 2013. Quantitative Phytochemical, Proximate/Nutritive Composition Analysis of *Beta vulgaris* Linnaeus (Chenopodiaceae). International Journal of Current Research, 5: 3723-3728.

[14] Abd-Elhak, N., A., Safaa E. Ali and Nahed L. Zaki. 2014. Innovative modification of traditional burger. Egypt. J. Agric. Res., 92 (3). 995-1008.

[15] Alsuhaibani, A. M. A. 2013. Nutritional, Sensory and Biological Study of Biscuits Fortified With Red Beet Roots. Arabia. Life Science Journal, 10(3) :1579- 1584.

[16] Fradique, M., B. Ana Paula, N. M. Cristiana, L. Gouveia, N. M. Bandarra, 2013. Anabela Raymundo Isochrysis gal- bana and Diacronema vlkianum biomass incorporation in pasta products as PUFA's source. LWT - Food Science and Technology 50, 312-319.

[17] Attia, Y.G., M. E. M. Moussa, and E. R. Sheashea, 2013. Characterization of red pigments extracted from red beet (BETA VULGARIS, L.) and its Potential USES AS Antioxidant and Natural food Colorants Egypt. J. Agric. Res., 91(3):1095-1110.

[18] Madsen, H. L. and G. Bertelsen, 1995. Spices as antioxidants. Trends Food Sci. Tech., 6: 271-277.

[19] Khan, I., A.Yousif, S. Johnson, and S. Gamlath, 2013. Effect of sorghum flour addition on resistant starch content, phenolic profile and antioxidant capacity of durum wheat pasta. Food Research International, 54: 578e586.

[20] Marchylo, B., J. Dexter, and L. Malcolmson, 2004. Improving the texture of pasta. In D. Kilcast (Ed.), Solid foods: Vol. 2. Texture in food. New York: Woodhead Publishing Ltd and CRC Press LLC.

[21] Sozer, N., A. C. Dalgıc, and A. Kaya, 2007. Thermal, textural and cooking properties of spaghetti enriched with resistant starch. Journal of Food Engineering 81: 476–484.