Technological properties and acceptability of spaghetti supplemented with orange peels powder or barley flour

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ABSTRACT

The quality attributes of spaghetti that produced from semolina and spaghetti with different levels of barley flour or orange peels powder as a dietary fiber sources were studied. Three levels of barley flour were used (15 %, 30 % and 45 %) and three levels of orange peels powder were used (5 %, 10 % and 15 %). Chemical composition, farinograph test, cooking quality parameters and sensory evaluation were determined. . The results indicated that increasing the level of barley flour or orange peels powder cause an increase in dietary fiber and ash content and decrease in calories. Cooking quality parameters were also decreased with increasing the level of barley flour or orange peels powder except swelling index which increased. Semolina could be replaced by barley flour at levels up to 45 % and orange peels powder at level of 5 % to produce spaghetti having good characteristics and not significantly different from control for most of the evaluated sensory characteristics. Spaghetti contained 15 % of barley flour could be considered a source of dietary fiber, while other treatments (30 and 45 % of barley flour or 5, 10 and 15 % of orange peels powder) represent food high in dietary fiber according to ***codex Alimentarius (2009)****.*

Keywords*: Spaghetti, Farinograph, Dietary fiber, Orange peels powder, barley flour*

INTRODUCTION

Pasta is a staple food in many countries. It has an excellent nutritional profile, being a good source of complex carbohydrates and a moderate source of protein and vitamins. Besides it is being easy to prepare and a very versatile food. Pasta has a relatively long shelf life when it is stored appropriately. It is also considered an adequate vehicle for food supplementation with minerals, proteins, and many other valuable healthy components ***(Boroski et al., 2011)***.

Sissons (2008) reported that Pasta represents an excellent base food for improving human health. The development of pasta with added soluble and insoluble fiber, antioxidants, resistant starch, for example, would improve pasta nutritional value, like lowering glycemic index, reducing cancer and diabetes risk.

Recently, more attention has been dedicated to using the fruit processing by-products. The use of by-products containing dietary fiber is of interest due to functional, technological and nutritional characteristics, as well as health benefits. It also reduced risks of industrial environmental contamination and lower costs ***(Schieber et al., 2001)***.

Potential sources of dietary fiber are orange juice industrial by-products because this material is available in huge quantities. It also has a low cost and has bioactive compounds ***(Romero-Lopez et al., 2011)***. The fiber obtained from orange juice by-products may be used as an ingredient in food industries, mainly for high content of total dietary fiber and bioactive compounds such as phenolics and carotenoids ***(Crizel et al., 2013)***.

Moreover, orange by-products was reported to have dietary fiber concentrates with better nutritional quality than those found in cereals, because of their significant contents of associated bioactive compounds (carotenoids) and more balanced composition (higher overall fiber content, greater soluble dietary fiber/ insoluble dietary fiber ratio, greater water and fat-holding capacities, lower metabolic energy value, and lower phytic acid content) ***(Chau and Huang, 2003)***. Also, consumption of orange by-products was associated with significant reduction of both serum total and HDL-cholesterol levels as reported by ***Elleuch et al. (2011)***.

Barley, one of the earliest cultivated cereals, is now gaining renewed interest as a food component because of its dietary fiber and β-glucan content specially. Compared with other cereals, The highest β-glucan level reached to 16.9 % (dry base) ***(Newman et al., 1992)***.

The beneficial effects are attributed to the bioactive factors in barley grain such as phytochemicals and non-digestible carbohydrates (β-D-glucans). The important part of phytochemicals with low molecular weight present in barley grain is group of antioxidants such as tocopherols, lignins, flavonoids and phenolic acids. Higher concentrations of these compounds are found in the outer layers of the kernel which constitute the bran ***(Dykes and Rooney, 2007)***.

Although numbers of studies illustrate the benefit of consuming β-glucan-rich products, there is a few of studies that document the changes to the physiochemical properties of food products that β-glucan inclusion brings about. These changes have importance with regard to product palatability and consumer acceptance and must be studied for good palatability and low glycemic index pasta ***(Cleary and Brennan, 2006)***.

The incorporation of fiber into products that consumed every day by the population is important. Among these products, pasta stands out due to a good acceptance and high consumption due to low cost, versatility, sensory attributes and long shelf life ***(Bergman et al., 1994)***.

This study was carried out to produce spaghetti with high dietary fiber content using barley flour or orange peels powder and evaluate its quality characteristics and sensory acceptance.

MATERIALS & METHODS

Materials

Durum wheat Semolina (*Triticum durum*) was obtained from Regina Company for pasta and food industries, Sadat City, Industrial Area Zone 2, Egypt.

Orange peels (*Citrus sinensis*) were isolated from orange fruits, which obtained from local market, Egypt. Season 2015.

Hulled barley (*Hordeum vulgare* L.) (Giza 129 variety) was obtained from agricultural research center, Giza, Egypt. Season 2014.

Methods

Preparation of raw material:

Hulled barley flour

The grains of barley were prepared according to ***Marconi et al. (2000)***. The grains were cleaned from broken kernels and any foreign materials. The cleaned barley grains were tempered then milled in a laboratory mill (yücebaş machinery combined mills, Turkish) to produce barley flour and other residues of mill sifted through a sieve of 50 mesh. The flour extraction ratio was 89 %, the obtained flour was stored in poly ethylene bags at room temperature until further use.

Orange peels powder

According to ***Figuerola et al. (2005)***, orange peels powder was obtained after cutting of the fruits and extraction of juice then peels residue was grinding, washing with warm water (30°C) and drying at 50°C for 24 hours in an oven drier then ground to a particle size path through 50 mesh.

Spaghetti production

The spaghetti was prepared from semolina that replaced by different concentrations of orange peels powder (5 %, 10 % and 15 %) or different concentration of barley flour (15 %, 30 % and 45 %) beside the control (100 % semolina) according to the method of ***Fares and Menga (2012)***. The dough was processed into spaghetti (1.80 ± 0.03 mm diameter) using a laboratory apparatus. The dough extrusion conditions were: temperature, 45 ± 2 °C and vacuum, 700 mm Hg. The extruded spaghetti samples were dried in a laboratory drier, using a low temperature (18 hr at 50 ± 3 °C and 95-65 % R.H.).

Chemical composition

All the dried spaghetti samples were analyzed for moisture, ash, crude fiber, lipids and protein contents according to ***A.O.A.C. (2005)***. Total carbohydrates were calculated by difference. Soluble, insoluble and total dietary fiber (TDF) was determined according to the method described by ***A.A.C.C. (2000)***.

Caloric values estimation

The caloric values were estimated according to Atwater factors which were based on the basis that the caloric values produced by one gram of protein, carbohydrates and lipids was 4, 4 and 9 Kcal, respectively ***(FAO, 2002)***.

Cooking loss % and dry matter of spaghetti samples were performed according to the methods described in ***A.A.C.C. (2000)***. Three determinations were performed and the mean values was obtained.

Swelling index

The swelling index of cooked spaghetti (grams of water per gram of dry spaghetti) was determined according to the procedure described by ***Cleary and Brennan (2006)***. A 10 g sample of spaghetti was weighed, cooked at optimal cooking time, weighed then dried at 105 °C until a constant weight was reached. The swelling index was expressed as:

(Weight of cooked spaghetti)-(Weight of spaghetti after drying) / (Weight of spaghetti after drying)

Weight increase index

Weight increase index was calculated by dividing the weight of the spaghetti after cooking by the weight of uncooked spaghetti ***(Sobota et al., 2015)***.

Sensory evaluation of spaghetti samples

Sensory analysis was performed according to the method of ***Sozer et al. (2007)***. Spaghetti samples were cooked in distilled water to the optimum cooking time. The sensory test panel consisted of 10 panellists. The sensory assessment included the following parameters: appearance, color، taste, hardness, adhesiveness, chewiness and springiness. Hardness was the resistance of cooked spaghetti to compression by the teeth. Adhesiveness was evaluated by placing the spaghetti in the mouth, pressing it against the palate and determining the force required to remove it with the tongue. Chewiness was measured as the number of chews to masticate a known amount of sample at a constant rate of force application to reduce it to a consistency ready for swallowing. Springness was measured as the degree to which the product returns to its original shape after partial compression between the tongue and palate. Each of the studied parameters was evaluated on a scale ranging from 0 to 10, where 10 was the maximum value of the study parameter.

Statistical analysis

Data are presented as means and standard deviations where appropriate. They were compared by one way analysis of variance (ANOVA). Where significant differences were observed at5%. Statistical software (Assistat Version 7.7, Brazil) was used for all statistical analyses according to ***Silva and Azevedo (2009)***.

RESULTS & DISCUSSION

Chemical constituents of the semolina and its blends under study, i.e., moisture, protein, lipids, ash, total carbohydrates and crude fibers were determined, and results are shown in table (1). The addition of orange peels powder and barley flour as a source of fibers resulted in an increase of crude fiber of semolina blends compared to control sample (semolina). The percents of increase were 41.75, 84.02 and 125.77 % for blends contained 5, 10 and 15 % orange peels powder, respectively, while, for semolina-barley formula, the percents of increase were 8.76, 17.53 and 26.29 % for blends contained 15, 30 and 45 % of barley flour, respectively. All samples were found to be significantly different from the control.

However, addition of orange peels powder or barley flour to semolina was found to have no clear effect on lipids content since all samples were found to be not significantly from control with exception of samples contained 30 % and 45 % barley flour.

Moreover, addition of orange peels powder to semolina at levels of 5, 10 and 15 % lead to slight decrease of the total carbohydrate content by 0.71, 1.40 and 2.10 %, respectively, meanwhile, slightly increase was found by addition of barley flour. However, all samples were significantly different from the control except formula contained 15 % of barley flour were statistically similar with control.

The results presented in table (1) showed also that total calories (Kcal/100 g dry spaghetti) were slightly decreased with addition of orange peels powder and the lowest value was found with 15 % level (386.45 kcal/100

However, the blends which contained 15 % and 30 % barley flour were not significantly different from control sample for ash. Concerning protein content, all samples were differed significantly from control with exception of sample that contained 5 % of orange peels powder.

Soluble, insoluble, and total dietary fiber contents of the semolina blends with barley flour and orange peels powder are given in table (2). Addition of barley flour to semolina at levels of 15, 30 and 45 % lead to increase the total dietary fiber contents by 23.92, 46.92 and 71.07 %, respectively. While, addition of orange peels

g) compared to the control spaghetti (397.12 kcal/100 g). Blends contained 15 % and 30 % barley flour were not significantly

Results are means of three determinations ± standard deviation. Values in the same column with different letter(s) are significantly different ($p \leq 0.05$) different from control, while sample that contained 45 % barley flour was found to differ significantly from control sample.

powder to semolina at levels of 5, 10 and 15 % lead to increase total dietary fiber contents by 77.22, 153.99 and 230.75 %, respectively.

Moreover, semolina-orange peels powder blends showed low soluble dietary fiber values since it were 0.92, 1.33 and 1.75 % for blends contained 5, 10 and 15 % orange peels powder, respectively, while semolina-barley flour blends showed the highest soluble dietary fiber values since it were 1.33, 2.15 and 2.98 % at 15, 30 and 45 % replacement levels, respectively compared with the control (0.50 %). The results also indicated that replacement of semolina with either barley flour or orange peels powder lead to increase the insoluble dietary fiber contents, the percentages of increase were 5.38, 10.77 and 16.15 % with replacement levels by barley flour 15, 30 and 45 %, respectively. Concerning orange peels powder, the percentages of increase were 75.90, 151.54 and 227.44 % for blends contained 5, 10 and 15 % of orange peels powder, respectively. However, the results of statistical analysis showed that all blend samples were significantly different from control for the total, insoluble and soluble dietary fiber values. These results were in agreement with ***Marconi et al. (2000)*** and ***Nassar et al. (2008)***.

From these results it could be noticed that the obtained values meet the ***Codex Almintarius (2009)*** which recommended that any product claiming to be a source of fiber should contain 3 g of fiber per 100 g of serving, while to claim that a food is high in fiber, the product must contain at least 6 g of fiber per 100 g of serving. However, from the obtained results (Table 2) it could be observed that control sample and blends contained 15 % of barley flour could be considered a source of dietary fiber, while other treatments (30 and 45 % of barley flour or 5, 10 and 15 % of orange peels powder) represent food high in dietary fiber according to ***Codex Alimentarius (2009)***. ***Knuckles et al. (1997)*** found that pastas in which β-glucan barley fractions replaced 20 or 40 % of the wheat semolina provided 5.4 to 10.4 g total dietary fiber per serving (compared with 2 g in control). They also reported that, these pastas could be labeled as good or high fiber sources, respectively.

Table (3) showed the results of the farinograph test. The absorption of water was increased with the increase of the substitution levels of either barley flour or orange peels powder and this could be attributed mainly to the higher fiber content.

These results also confirmed those obtained by ***Sudha et al. (2007)***. They reported that the increasing of apple pomace content in the blend from 0 – 15 % led to increase the water absorption from 60.1 % to 70.6 %. ***Chen et al. (1988)*** also reported an increase in water absorption of about 71.2 -

88.7 % with incorporation of apple fiber from 0 to 12 %.

The results also indicated that the arrival time values sharply increased with addition of orange peels powder, while slightly decreases was observed for 30 % replacement level with barley flour. Also, dough stability values were decreased as the substitution percentage increased by barley flour and this might be due to the dilution of gluten structure ***(Wood, 2009)***. As a result of decreases of dough stability dough weakening are increase with increased substitution levels of barley flour. These results were in agreement with ***Giménez et al. (2012)***.

Moreover, dough stability was increased as the replacement levels of orange peels powder increased and dough weakening was decreased compared to control, these results were in agreement with ***Kalnina et al. (2015)***. They studied the effect of incorporation of whole grain flour into wheat flour and their results indicated that the rheological properties of dough become worse by increase the amount of whole grain flour in blends. Water absorption is higher and stability of dough with whole grain flour addition is longer than the control (wheat flour only). ***Kenijz and Sokol (2013)*** also reported that the presence of pectin keeps water bound up, this is caused by the formation of protein polysaccharide complexes. In addition, gluten membranes become thin and flexible, easily stretched and rupture resistant, this result explained the higher increase of dough stability and higher decrease in dough weakening which obtained with orange peels powder.

The ultimate test of acceptability of spaghetti product is its cooking quality. Cooking quality of spaghetti is important to consumers and thereby to wheat producers, breeders and processors ***(Aalami, 2006)***. Cooking quality parameters of spaghetti products prepared from 100 % semolina (control) and blends of semolina and barley flour or orange peels powder at different replacement levels (15, 30 and 45 % and 5, 10 and 15 %, respectively) were studied and the obtained results are shown in table (4).

From the results presented in table (4) it could be noticed that weight values of cooked spaghetti that contained 15 and 30 % barley flour were increased in comparison with control and the percents of increase were 21.53 and 6.91 %, respectively, while with replacement level of 45 % the weight of cooked spaghetti was less value than control and was significantly different. The same results also showed that weight values of cooked spaghetti prepared from blends contained semolina and orange peels powder at replacement levels of 5, 10 and 15 % were decreased in comparison with control and the percents of decrease were 12.63, 14.59 and 19.04 %, respectively and all samples were significantly differed from control.

Cooking loss values were increased compared to control with 15 % barley flour replacement level and the percent of increase was 15.83 %, while with 30 and 45 % replacement levels, the cooking loss values were approximately similar to control and were found to be not significantly different, While orange peels spaghetti were the highest for cooking loss and the percents of increase for 5, 10 and 15 % of orange peels spaghetti were 27.01, 60.65 and 284.87 %, respectively. These result were in agreement with the results obtained by ***Sozer et al. (2007)***, where found that by increasing replacement levels of semolina with resistant starch or wheat bran cooking loss was increased compared to the control.

With respect to dry matter all values were lower than that of control and the obtained values were decreased as levels of replacement by either barley flour or orange peels powder were increased except blend contained 5 % of orange peels powder. However, the percentages of decrease were 20.34, 14.28 and 11.40 % for blends contained 15, 30 and 45 % of barley flour, respectively and it were 1.17 and 14.86 % for blends contained 10 and 15 % of orange peels powder, respectively. However spaghetti contained 5 and 10 % of orange peels powder were not different statistically from control, other samples (spaghetti contained 15, 30 and 45 % of barley flour or 15 % orange peels powder) were found to be significantly different with control. These results were in agreement with ***Chillo et al.***

(2011), who reported that the significant reduction in the dry matter content of spaghetti blends may be due to the higher water absorption of spaghetti as a result of the higher concentration of fiber in the blends. The presence of water in the product also suggests that the calories of spaghetti which contain orange peels powder or barley flour would be lower than that of the control. The low calories and high satiating properties of these products may therefore potentially make them a weight loss food ***(Guillon and Champ, 2000)***.

The results presented in the same table indicated also that swelling index values were increased by 35.09, 23.02 and 17.74 % for blends contained 15, 30 and 45 % of barley flour, respectively compared to control and these blends were significantly differed from the control. These results were in agreement with ***Chillo et al. (2011)*** they found that by increasing replacement of semolina by β-glucan of barley the swelling index had been increased.

Addition of orange peels powder to semolina at replacement level of 15 % lead also to increase the swelling index value by 24.15 % compared to control. However, substitution levels of 5 and 10 % showed swelling index for samples similar to control and they were not significantly different from control.

Concerning weight increase index the obtained results (Table 4) indicated that addition of orange peels powder to semolina at replacement levels of 5, 10 and 15 % lead to decrease the values by 12.73, 14.55 and 18.70 %, respectively compared to control and it were significantly different from control, while it were not significantly different in between levels of treatment. ***Sant'Anna et al. (2014)*** found that the incorporation of grape marc powder in fettuccini pasta ingredients up to 7.5 % caused a decrease in values of weight increase of pasta, but don't differed statistically with control.

However addition of barley flour to semolina at replacement levels of 15 and 30 % lead to increase the weight increase index by 21.56 and 6.75 %, respectively compared to control, while at replacement levels 45 % the sample was not significantly different from control for the weight increase index parameter.

The cooked spaghetti samples were evaluated for their sensory characteristics, i.e., appearance, color, taste, hardness, springness, adhesiveness and chewiness and the obtained data are shown in table (5). From these results it could be noticed that spaghetti contained 15 % barley flour was found to be not significantly different from control for all the evaluated characteristics. The same trend was observed for spaghetti contained 30 % barley flour with exception of appearance and color which were significantly different from control sample.

Moreover, the spaghetti contained barley flour at level of 45 % was also not significantly different from control for all the evaluated characteristics except colour. These results were in agreement with ***Kaur et al. (2012)***. They found that spaghetti made from cereal bran enrichment was significantly darker than those made from durum wheat semolina. ***Gajula et al. (2008)*** also reported that the barley bran had a reddish brown color, thus higher levels of barley bran substitution led to darker products.

Concerning spaghetti contained orange peels powder, the same results indicated that at replacement levels of 5 %, the produced spaghetti was not significantly different from control sample for all the evaluated characteristics with exception of appearance and color, while at replacement levels of 10 % the produced spaghetti showed no significant difference from control for taste, hardness, springness and adhesiveness. It was significantly different from control for appearance, color, chewiness and over all acceptability.

On the other hand, spaghetti samples which contained 15 % orange peels powder were found to be significantly different from control for all the evaluated characteristics. The sensory results presented in this work were similar to those obtained by ***(Crizel et al., 2015)***. They found that the pasta formulation with 2.5 % of orange fiber did not differ from control pasta for all the sensory attributes and presented an acceptance greater than 7.5 %.

From the obtained results it could be noticed that semolina could be replaced by barley flour at levels up to 45 % and orange peels powder at level of 5 % to produce spaghetti having very good degree and not significantly different from control for most of the evaluated sensory characteristics. However, addition of orange peels powder at level of 10 % could be also used but the resulted spaghetti was lesser in their quality characteristics although it scored good degree. Spaghetti contained 15 % of barley flour could be considered a source of dietary fiber, while other treatments (30 and 45 % of barley flour or 5, 10 and 15 % of orange peels powder) represent food high in dietary fiber according to ***Codex Alimentarius (2009)***.

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Table (1): Chemical composition (%) and calories content of semolina and its blends with different levels of barley flour or orange peels powder (on dry weight basis).

Treatments		Moisture	Ash	Lipids	protein	Crude fiber	Total carbohydrates	Total calories Kcal/100 g.
Control (semolina)		11.94 [a] ± 0.06	1.08 [d] ± 0.10	1.84 [c] ± 0.09	16.45 [a] ± 0.54	1.94 [g] ± 0.05	78.69 [c] ± 0.50	397.12 [a] ± 0. 66
Barley flour	15 %	11.92 [a] ± 0.10	1.11 [cd] ± 0.10	1.95 [bc] ± 0.04	15.76 [bc] ± 0.07	2.11 [f] ± 0.10	79.07 [bc] ± 031	396.87 [ab] ± 0.61
	30 %	11.91 [a] ± 0.10	1.15 [cd] ± 0.06	2.05 [b] ± 0.07	15.06 [d] ± 0.05	2.28 [e] ± 0.04	79.46 [ab] ± 0.11	396.53 [ab] ± 0.22
	45 %	11.89 [ab] ± 0.11	1.19 [bc] ± 0.02	2.16 [a] ± 0.02	14.36 [e] ± 0.05	2.45 [d] ± 0.04	79.84 [a] ± 0.01	396.24 [b] ± 0.05
Orange peels powder	5 %	11.73 [b] ± 0.15	1.18 [bc] ± 0.03	1.86 [c] ± 0.04	16.08 [ab] ± 0.16	2.75 [c] ± 0.06	78.13 [d] ± 0.17	393.58 [c] ± 0.28
	10 %	11.52 [c] ± 0.07	1.27 [ab] ± 0.02	1.87 [c] ± 0.08	15.70 [bc] ± 0.30	3.57 [b] ± 0.03	77.59 [e] ± 0.36	389.99 [d] ± 0.38
	15 %	11.31 [d] ± 0.08	1.37 [a] ± 0.02	1.89 [c] ± 0.04	15.32 [cd] ± 0.02	4.38 [a] ± 0.03	77.04 [f] ± 0.04	386.45 [e] ± 0.29

Table (2): Soluble, insoluble, and total dietary fiber content (%) of semolina and its blends with different levels of barley flour or orange peels powder (on dry weight basis).

Treatments		Soluble dietary fiber	Insoluble dietary Fiber	Total dietary fiber
Control (semolina)		0.50 [f]	3.90 [g]	4.39 [g]
Barley flour	15 %	1.33 [d]	4.11 [f]	5.44 [f]
	30 %	2.15 [b]	4.32 [e]	6.45 [e]
	45 %	2.98 [a]	4.53 [d]	7.51 [d]
Orange peels powder	5 %	0.92 [e]	6.86 [c]	7.78 [c]
	10 %	1.33 [d]	9.81 [b]	11.15 [b]
	15 %	1.75 [c]	12.77 [a]	14.52 [a]

Values in the same column with different letter(s) are significantly different ($p \leq 0.05$).

Table (3): Rheological properties of raw material blends at different replacement of semolina with barley flour or orange peels powder.

Treatments		Absorption (%)	Arrival time (Min.)	Stability (Min.)	Dough weakening (B.U)
Control (semolina)		63.20	2.00	13.00	30.00
Barley flour	15 %	65.00	2.00	10.50	60.00
	30 %	65.80	1.50	9.50	75.00
	45 %	68.00	2.00	9.50	80.00
Orange peels powder	5 %	78.20	3.00	21.00	20.00
	10 %	90.00	5.00	25.00	20.00
	15 %	100.00	10.50	28.50	0.00

Table (4): Cooking quality of spaghetti prepared from semolina and its blends with different levels of barley flour or orange peels powder.

Treatments		weight of cooked spaghetti (g /100 g DM))	Cooking loss (%)	Dry matter (g DM / 100 g cooked spaghetti)	Swelling index (g water/g DM)	Weight increase index
Control (semolina)		384.86 c	8.59 e	27.38 a	2.65 c	3.85 c
Barley flour	15 %	467.68 a	9.95 d	21.81 d	3.58 a	4.68 a
	30 %	411.44 b	8.69 e	23.47 c	3.26 ab	4.11 b
	45 %	379.51 d	8.52 e	24.26 b	3.12 b	3.80 c
Orange peels powder	5 %	336.25 e	10.91 c	27.54 a	2.63 c	3.36 d
	10 %	328.69 f	13.80 b	27.06 a	2.69 c	3.29 d
	15 %	311.57 g	33.06 a	23.31 c	3.29 ab	3.13 d

Values in the same column with different letter(s) are significantly different ($p \leq 0.05$).

Table (5): Sensory evaluation of spaghetti made from semolina and its blends with different levels of barley flour or orange peels powder.

Treatments		Appearance	Colour	Taste	Hardness	Springiness	Adhesiveness	Chewiness	Over all acceptability
Control (semolina)		8.80 a	8.60 a	8.40 a	8.30 a	8.30 a	8.30 a	8.40 a	8.44 a
Barley flour	15%	7.30 ab	7.20 ab	7.50 a	7.70 a	7.30 a	7.80 a	7.70 ab	7.50 ab
	30%	6.50 b	6.40 bc	7.60 a	7.10 a	7.30 a	7.00 a	7.20 ab	7.01 ab
	45%	7.10 ab	6.80 bc	7.70 a	7.50 a	7.60 a	7.50 a	7.40 ab	7.37 ab
Orange peels powder	5 %	6.70 b	6.80 bc	7.60 a	7.70 a	7.60 a	7.20 a	7.70 ab	7.33 ab
	10%	6.50 b	6.50 bc	6.70 a	7.00 a	6.90 a	6.70 a	6.70 bc	6.71 b
	15%	4.20 c	5.10 c	4.40 b	4.70 b	5.00 b	5.10 b	5.70 c	4.89 c

Values in the same column with different letter(s) are significantly different ($p \leq 0.05$).

الخصائص التكنولوجية والحسية للمكرونة الإسباجيتى المدعمة بمسحوق قشور البرتقال أو دقيق الشعير

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الملخص العربى

تم تقييم خصائص الجودة للمكرونة الإسباجيتي المصنعة من السيمولينا والإسباجيتى المصنعة من السيمولينا مع نسب إحلال مختلفة من دقيق الشعير أو مسحوق قشور البرتقال المجففة كمصادر للألياف الغذائية. حيث تم إستخدام ثلاثة مستويات من دقيق الشعير ١٥٪، ٣٠٪ و ٤٥٪ بينما كانت مستويات الإحلال بمسحوق قشور البرتقال ٥٪ و ١٠٪ و ١٥٪ .وتم تقدير التركيب الكيميائي وإجراء إختبار الفارينوجراف و تقييم جودة الطهى والتقييم الحسي .وأشارت النتائج إلى أن زيادة مستويات دقيق الشعير أو مسحوق قشور البرتقال أدى الى زيادة محتوى الإسباجيتى من الألياف الغذائية والرماد وأدى الى إنخفاض السعرات الحرارية. بالإضافة الى ذلك، إنخفضت معايير جودة الطهى مع زيادة نسبة الإحلال بدقيق الشعير أو مسحوق قشور البرتقال بينما ارتفع مؤشر الزيادة فى الحجم .وأثبتت النتائج المتحصل عليها إمكانية الإحلال بدقيق الشعير حتى ٤٥٪، أو بقشور البرتقال المجفف حتى ٥٪ لإنتاج الإسباجيتى بخصائص جودة جيدة لا تختلف كثيرا عن الكنترول في معظم الخصائص الحسية. وتتميز جميع عينات الإسباجيتي المنتجة بأنها تدخل ضمن الأغذية المرتفعة فى محتواها من الألياف الغذائية عدا عينة الإسباجيتى المحتويه على ١٥ % دقيق شعير حيث إعتبرت مصدر جيد للألياف الغذائية وفقا لهيئة الدستور الغذائي (٢٠٠٩).

الكلمات الدالة : الإسباجيتي، الفارينوجراف، الألياف الغذائية، مسحوق قشور البرتقال ، دقيق الشعير