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Chemical, Rheological, Sensorial and Functional Properties BuckwheatSemolina Flour Composite Pasta

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Abstract

This study intended to prepare pasta by mixing to species of Buckwheati.e.Fagopyrum esculentum (FE) orFagopyrumtataricum (FT) flour in semolina at three mixing levels (10, 20 and 30%) to produce pasta characterized its good sensorial properties and higher nutritional value. Chemical composition, rheological properties, colour attributes, cooking quality, sensory properties and texture analysis of pasta were studied. Fagopyrum esculentum and Semolina were characterized by higher contents of protein and fat than Fagopyrumtataricum and Semolina. Fagopyrumtataricum was more elevated in fibre and ash contents compared with Semolina and Fagopyrum esculentum. Semolina higher percentage of total carbohydrates than Fagopyrum esculentum and Fagopyrumtataricum. Farinograph parameters showed that water absorption, arrival time, dough development time, mixing tolerance index, and dough weakening was increased as the percentage of Fagopyrumesculentum or Fagopyrumtataricum in blends increased while dough stability was decreased. Substitution of FE and FT to Semolina decreased the peak viscosity, trough, breakdown, final and set back peak time and pasting temperatures as the percentage of FE or FT in blends increased. Results also showed that Hunter colour parameters (L*, a* & b*) of pasta were darker as the mixing level of FE or FT increased. However, this result was confirmed by the obtained sensorial results. The cooking quality of pasta showed that the weight, volume and cooking loss of formulated pasta with FE or FT (10-30%) increased as compared to the control sample (pasta 100% semolina). Moreover, sensory evaluation of pasta indicated that all samples were acceptable, but the mouth feels and overall acceptability of pasta fortified with 20% FE and 30% FT doesn't significantly affect as compared to the control sample, while flavour didn't significantly affect pasta with 30 % Fagopyrum esculentum (FE) or Fagopyrumtataricum (FT). The obtained results of this study are recommended that the need to shed light on adding each of Fagopyrum esculentum (FE) or Fagopyrumtataricum (FT) flour to increase the characteristics satisfactory technological attributes to pasta.

Keywords:Fagopyrumtataricum, Fagopyrumesculentum, semolina, pasta, dough, flour, buckwheat, cooking

1. Introduction

Pasta products as basic foods are growing with the requirements of modern life. Besides sensory attributes, which are well accepted by the consumer, their low cost, ease of cooking and long shelf life compared with other foods have made them popular. Pasta contains 74–77% carbohydrates [1]. Wheat pasta (WP) is usually prepared using semolina and water and preserved by drying. This product is popular among consumers mainly due to its short time and ease of preparation. WP is also energy-dense, low in sodium and fat with no cholesterol, and a common ingredient in many dishes. Classic pasta is characterized by a high content of starch, with minor amounts of dietary fiber, vitamins, and minerals; however, its nutritional and health value can be improved by enrichment with different raw materials[2].

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Buckwheat is a pseudocereal belonging to the genus *Fagopyrum*, but never planted in Egypt due to several challenges. However, within the current challenges of food insecurity and as an attempt to provide individuals diagnosed with Celiac Diseases (CD) and Non-Celiac gluten sensitivity (NCGS)[3]in Egypt with highly nutritional safe foods, the study used locally produced buckwheat of two species FE & FT The most predominant buckwheat species is the common buckwheat (*FagopyrumesculentumMoench*) [4]. Buckwheat is characterized by good adaptability and hence can grow in different environments [5]. The flavonoids in Buckwheat are quercetin, vitexin, orientin, isovitexin and isoorientin. The content of flavonoid depends on various factors such as the difference in growth factors of seed, testa, size and shape of the seed, color of the flower, time of sowing, soil location, environmental fluctuations, climate conditions, growth stages and area of collection[6].It is also rich in dietary fiber which has a positive physiological effect on the gastrointestinal tract and also significantly influences the metabolism of other nutrients[7].Buckwheat seeds contain no gluten so they are safe for people with celiac disease [8], and around 10% of people worldwide self-report gluten-related complaints, including intestinal and extra-intestinal symptoms[9].Buckwheat flour iscontemplated as a potentially healthy ingredient in preparing different food items such as pasta, noodles, pancakes, bread, biscuits, etc. [10].(Recently, there is an increasing interest revolving globally forbuckwheat products as a nutritious food and as a substitutefor gluten-allergic persons[11].It contains higher protein content compared to rice, wheat, millet, sorghum, maize and other cereals.Buckwheat contains starch (65–75%), protein (10–12.5%), lipids (4.7%), minerals, and vitamins[12]. It is also a good source of fiber, gluten-free, and rich in various bioactive compounds (e.g., rutin, quercetin, kaempferol-3-rutinoside); and therefore increasingly considered a potential functional food[13].It contains a high-quality protein, i.e., well-balanced amino acids with a high biological value. Predominant minerals of buckwheat include potassium, magnesium, phosphorus, calcium, iron, copper, zinc, and manganese; andvitamins include A (b-carotene), B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), C (ascorbic acid), and E (tocopherols) [14]-[15]-[16]. The present study was therefore conducted to evaluate the adding buckwheat is gluten-free in the manufacture of pasta for reducing the level of gluten in pasta to suit gluten intolerance. So, the effects of FE or FT enrichment on some quality parameters of pasta such as chemical composition, rheological properties, colour (L, a, b), cooking quality (weight increase, volume increase, cooking loss), sensory characteristics and texture profile were evaluated and compared with pasta produced from Semolina in this study.

2.Materials and methods

2.1 Materials

Fagopyrum esculentum seeds are purchased from a trusted commercial company in the USA and the same occurred with Fagopyrumtataricum purchased from Hong Kong, China. However, all purchased seeds came with a state-certified identification label showing the species' scientific name, local names and English name beside the germination and purity ratios.

Both species were planted in two locations one is at Bilbies city (Sharkia) & second is at Sadat City (Monofiya), Egypt between the years of 2018/2019 and 2019/2020 consequently to evaluate the growth and quality response in different growing timings. However, the grains used are harvested manually at the end of each growing season and then subjected to primary drying in the field for 3 to 4 days before it moved to a clean piece of land away from direct sun to ensure completely full-dry, then kernels separated from the plant residuals. Semolina was obtained from the North Cairo Flour Mills Company, Egypt.

2.2 Methods

2.2.1 Technological treatment

Preparation of flour mixtures

Fagopyrum esculentum (FE) and *Fagopyrumtataricum* (FT) seeds were cleaned, tempered (15% moisture) and milled (Quadrumat Junior flour mill), passed through 40 mesh sieve and then kept in plastic sachets. Blends were prepared from semolina with FE or FT flour at different levels (100:0, 90:10, 80:20 and 70:30 w/w).

2.2.2 Chemical analysis

Moisture, protein, Fat, ash and crude fiber contents of raw materials and pasta were determined according to AOAC (2000). Carbohydrates were calculated by difference as mentioned as follows: Carbohydrates = 100 – (% protein + % fat + % ash + % crude fiber). AOAC (2000). Official Methods Of Analysis of AOAC International. 17th Edn., Association of Analytical Communities, Gaithersburg, MD., USA.

2.2.3 Rheological properties of dough

Rheological properties of the different produced doughs were carried out with farinograph and Rapid viscoanalyzer (RVA) tests according to AACC [17].

2.2.4 Pasta preparation

Briefly, 200 g Semolina (control) and Semolina replaced with FE and FT at level 10, 20 and 30% was mixed in a mixer bowl for 1 min. Pasta samples were prepared according to AACC [15]using a lab pasta machine (Matic 1000 Simac Machine Corporation, Milano, Italy). Pasta hydrated for 15 min under atmospheric air and dried in a cabinet dryer at 70ºC for 10 hrs. Then cooled at room temperature, packed in polyethene bags and kept at room temperature for analysis.

2.2.5Cooking quality

The cooking quality of pasta wascarried out by measuring the weight increases, volume and cooking loss after cooking according to the methods of AACC [17].

2.2.6Color determinations

Hunter a*, b* and L* parameters were measured with a colour difference meter using a Hunter colour meter (Tristimulus Colour Machine) with the CIE lab colour scale (Hunter, Lab Scan XE - Reston VA, USA) in the reflection mode. The instrument was standardized each time with the white tile of Hunter Lab Colour Standard (LX No.16379): X= 72.26, Y= 81.94 and Z= 88.14 (L*= 92.46; a*= -0.86; b*= -0.16)[18].

2.2.7Sensory evaluation of pasta

Pasta samples were cooked in distilled water to optimum cooking time, and after draining for 2 min served to the panellists. The sensory test panel consisted of seven panellists who were trained,by academic staff. The panellists evaluated the products for colour, flavour, mouthfeel, elasticity, and overall acceptability using a 10-point hedonic scale ranging from 10-5 (like extremely) to 4-1 (dislike extremely) for each sensory characteristic[19].

2.2.8Textural profile analysis (TPA)

Hardness, deformation at hardness, peak stress and fracture ability with 1% of load sensitivity analysis of cooked pasta samples was conducted using CT3 Texture Analyzer (Brookfield) according to Manual No. M08-372- C0113. Data were collected using Texture Pro CT Software.

2.2.9Statistical analysis

The obtained data were statistically analyzed using the SAS Systems for Windows software, version 6.12 TS020 (SAS, Statistical Analysis System, Institute Inc., Cary, NC, 1996). We performed the analysis of variance (ANOVA) and the least significant difference (LSD) test ($P < 0.05$) to determine significant differences between the treatment means.

3.Results and discussion

3.1 Chemical composition raw materials

The proximate analysis of Semolina, FE and FT includes moisture, ash, crude protein, lipid, crude fiber and carbohydrates. Theobtained results for the chemical composition of Semolina, FE and FT are shown in Table 1. The moisture content of FE (9.17%) had the highest content compared to all other samples followed by FT had moisture (8.78%), while the semolina had 5.41 %, respectively. The moisture content in the Semolina sample was lower than that of the raw samples.FE was characterized byhigher contents of protein and fat than FT and Semolina.FT was higher in fiber and ash contents compared with Semolina and FE. Semolina higher percentage of total carbohydrates than FE and FT. FE was the highest in the content of protein (14.90%) compared with other samples. The obtained results were in agreement with those reported by [20][21][22][23][24].

Table (1): Gross Chemical composition (%) of raw materials (on dry weight basis)

	Moisture	Ash	Fiber	Protein	Lipid	CHO
Semolina	5.41±0.28	0.90±0.03	0.86±0.02	13.16±0.48	1.08±0.07	84.00±0.75
FE	9.17±0.17	2.58±0.07	12.51±0.32	14.90±0.27	2.18±0.05	67.83±0.56
FT	8.78±0.29	2.85±0.01	22.08±0.37	11.81l±0.25	1.57±0.03	61.69±0.85

FE=*Fagopyrumesculentum*; FT=*Fagopyrumtataricum*; Cho =totalcarbohydrate

3.2 Farinograph parameters

The effect of Semolina supplementation with FE or FT at different levels (10, 20 and 30%) on farinograph parameters is presented in Table (2). The result showed that semolina with FE or FT on the farinograph parameters (absorption, arrival time, dough development time dough stability and dough weakening) at three blending levels 10, 20 and 30%. Water absorption of the control (Semolina) showed a value of 55.4%. Semolina blended with different ratios of FE showed a gradual decrease in parallel with an additional increase, while Semolina blended with different ratios of FT showed a gradual increase in parallel with an additional increase. The arrival time increased with the addition of FE and FT.Dough development time, mixing tolerance index and weakening increased compared to the control. The mixing tolerance index, which is inversely proportional to the strength of the dough increased from 20 to 120 BU with the addition of FE and FT indicating a decrease in the strength of the dough. The increased dough development time and decreased dough stability caused by added fiber were possibly associated with slowed water hydration rate and gluten development due to increased fiber content. Increased mixing tolerance and extension value may be possible, due to interactions between fibrous materials and gluten[25]. The dilution of gluten in the formulated flour decreased the interaction between starch and gluten and resulted in ahigher mixing tolerance index[26]-[27]. On the contrary, higher water absorption and gelatinization temperature have been reported for dough containing buckwheat flour. They showed that buckwheat flour incorporation may contribute to a relatively low degree of softening and extended dough stability compared with wheat flour only.Since the main dough component responsible for water absorption is gluten and as the buckwheat flour is gluten-free, the good water absorption could be due to other proteins such as albumin and globulin[28]. Rheological studies indicated that buckwheat dough possessed a more elastic character than viscous character[29].

Table (2): Effect of replacing semolina at different levels For FE and FT on farinograph parameters

Samples	Water absorption (%)	Arrival time (min)	Dough develop-ment time (min)	Dough stability (min)	Mixing tolerance index (BU)	Weakening (BU)
Control (Semolina 100%)	55.4	2.5	4.5	22	30	20
90% Semolina + 10% FE	55	3.0	5.5	12	50	40
80% Semolina + 20% FE	46.6	3.5	4.0	9.0	50	50
70% Semolina + 30% FE	45.2	3.5	4.5	6.5	60	120
90% Semolina + 10% FT	58.0	2.5	3	4	70	90
80% Semolina + 20% FT	57.6	3.0	4.0	5	80	100
70% Semolina +30 % FT	57.2	3.0	4.5	10	80	50

FE = *Fagopyrumesculentum*; FT =*Fagopyrumtataricum*; BU =Brabenderunit

3.3 Pasting profile (RVA)

The pasting properties of rapid viscoanalyzer (RVA) for mixtures of Semolina, FE and FT are presented in Table (3). The control sample (Semolina) had peak viscosity (4473 CP), trough (6228 CP), breakdown (537.4 CP), final (5619 CP) and setback (1146 CP) viscosities. Substitution of FE to Semolina decreased the peak viscosity, trough, breakdown, final and setback viscosities of Semolina from 4473 to 2888 CP, 6228 to 2912.2 CP, 537.4 to 736.1 CP, 5619 to 3268 CP and 1146 to 380.2 CP, respectively. Also, the addition of FT to Semolina increased the peak viscosity, trough, breakdown, final and setback viscosities of Semolina from 2292 to 3018 CP, 6012 to 6524CP, 20.07 to 42.62 CP, 4162 to 4792 CP and 1870 to 1774CP, respectively. While peak time and pasting temperature values ranged between 13.3 to 10.1 min and 53.7to 43.9ºC, respectively for both FE and FT supplementation percents.Hallen*et al*. [30]reported the decrease in the pasting parameters could be due to the decrease in the available starch for gelatinization.Symons and Brennan[31]also reported that the substitution of wheat starch with 5% barley b-glucanfiber fractions reduced peak viscosity due to the reduction in starch for gelatinization and less water available for the initial swelling of the starch granule.

According to Gómez *et al.* [32]substitution of chickpea flour in wheat decreased the peak viscosity, break down and a setback due to its decreased carbohydrate content and different protein contents affecting the viscosity parameters. The pasting temperature has been reported to be related to water-binding capacity [33]. The RVA properties of flour samples showed that flour blends had the lowest peak, trough, breakdown, final, and setback viscosities and pasting temperature[30][31][32][33][34][35].Differences in the amylose/amylopectin ratios of starches[36]and the reduction in gluten content because of the substitution of gluten-free flour [37]. In addition, the rate of gelatinization and maximum torque (viscosity) were shown to be decreased by the addition of both types of buckwheat flour. Among different flour fractions obtained by gradual milling of buckwheat, the middle fractions exhibited significantly higher peak viscosity than the other fractions[38].

Table (3): Effect of replacing semolina at different levels For FT and FT on pasting properties (RVA) of pasta

RVA Parameters / Pasta samples	Peak Vis. (CP)	Trough 1 (CP)	Break down (CP)	Final Vis. (CP)	Setback (CP)	Peak Time (Min)	Pasting Temp. (ºC)	Peak Temp. (ºC)
Control (Semolina 100%)	4473	6228	537.4	5619	1146	13.3	53.7	94.6
90% Semolina + 10% FE	2997	1288	1709	2724	273	9.93	64.3	94.7
80% Semolina + 20% FE	2855	1469.18	1490	2907	52.18	10.1	64.3	94.7
70% Semolina + 30% FE	2888	2912.2	736.1	3268	380.2	13.3	43.9	94.5
90% Semolina + 10% FT	2292	6012	20.07	4162	1870	13.1	62.7	95
80% Semolina + 20% FT	3097	6933	58.23	5044	1947	13.3	52.5	95
70% Semolina +30 % FT	3018	6524	42.62	4792	1774	13.2	59	95

FE:*Fagopyrumesculentum*; FT: *Fagopyrumtataricum*; RVA: Rapidviscoanalyzer

3.4 Proximate composition of pasta

The proximate composition of Pasta and pasta of different mixing levels with FE or FTflour(10, 20 and 30 %) were presented in Table (4).Therefore, increasing the mixing level of FE and FT flour (10 to 30%) with Semolina led to an increase in the nutritional value of pasta for moisture, protein, oil, ash and fiber while total carbohydrates decreased. Therefore, increasing the mixing level of FE (10 to 30%) with Semolina led to an increase in the nutritional value of pasta, where protein, fat, ash, fiber and carbohydrate ranged between (13.20-13.90%), (1.05-1.45%), (0.92- 1.22%), (0.83- 2.50%) and (84.00-80.93%), respectively. The present results are in agreement with those authors[16], [38][39][40][41][42][43][44]

Table (4): Chemical composition of pasta supplemented with FE and FT at different levels compared to pasta control (on a dry weight basis)

Pasta samples	Moisture	Protein	Oil	Ash	Fiber	Carbohydrate
Control (Semolina 100%)	6.52^{d}±0.22	13.20^{f}±0.41	1.05^{g}±0.05	0.92^{g}±0.05	0.83^{g}±0.03	84.00^{a}±0.72
90% Semolina + 10% FE	6.92^{c}±0.09	13.50^{e}±0.25	1.17^{f}±0.02	0.98^{f}±0.03	1.55^{f}±0.05	82.80^{b}±0.55
80% Semolina + 20% FE	7.32^{b}±0.07	13.75^{c}±0.32	1.30^{d}±0.06	1.12^{d}±0.09	1.90^{d}±0.07	81.93^{bc}±0.72
70% Semolina + 30% FE	7.79^{a}±0.11	13.90^{a}±0.44	1.45^{b}±0.09	1.22^{c}±0.11	2.50^{b}±0.13	80.93^{c}±0.79
90% Semolina + 10% FT	6.92^{c}±0.05	13.60^{d}±0.27	1.22^{e}±0.05	1.05^{e}±0.13	1.60^{e}±0.11	82.53^{b}±0.85
80% Semolina + 20% FT	7.32^{b}±0.10	13.80^{b}±0.32	1.35^{c}±0.03	1.30^{b}±0.15	1.98^{c}±0.15	81.57^{bc}±0.69
70% Semolina +30 % FT	7.79^{a}±0.13	13.95^{a}±0.38	1.50^{a}±0.11	1.42^{a}±0.19	2.65^{a}±0.17	80.48^{c}±0.84

FE:*Fagopyrumesculentum*; FT: *Fagopyrumtataricum*;Results are presented as means for triplicate analyses ± standard deviation (SD). Means within column with different letters are significantly different ($P \leq 0.05$)

3.5 Cooking Quality of Pasta

Pasta quality could be estimated from cooking attributes such as weight increase, cooking loss and volume increase. The weight and volume increase of pasta supplemented with FE ranged from 220 to 265% and from 165 to 195%, respectively.

While pasta supplemented with FT ranged from 220 to 270% and from 165 to 200%, respectively. The results showed that an increase in weight and volume was observed compared to the control sample with different levels of FE or FT(Table5). This result could be due to, an increase in the protein level of FEleadingtotoan increase in the weight of cooked pasta. Similarly, Elisa *et al*.[45]reported that the addition of FE or FT increased the weight increase of the pasta. Cooking losses decreased as FE or FT levelsincreased. This result could be due to, the reinforced dough matrix of FE proteins and gluten which can entrap starch in the resultingnetwork. This value indicates the amount of dry matter lost into the cooking water[46]. Cacak-Pietrzak*et al*. [47] indicated that cooking losses of different pasta types made from semolina ranged from 6 to 11%. In the present study, cooking loss of control pasta and pasta with FE or FT was found to be 1.33, 1.36 and 1.35%, respectively. The cooking loss in all the pasta samples was below the technologically acceptable limit (≤8%) [48]. There were no significant differences in cooking loss among the groups (*P*>0.05); therefore, it can be concluded that adding SMPItothese levels did not affect the cooking loss.

Table (5): Effect of replacing semolina at different levels of FE and FT on the cooking quality of the pasta

Pasta samples	Weight increase(%)	Volume increase(%)	Cooking loss (%)
Control (Semolina 100%)	220^{f}±1.11	165^{f}±2.20	3.0±0.19
90% Semolina + 10% FE	230^{e}±1.42	170^{e}±2.75	1.35±0.25
80% Semolina + 20% FE	250^{c}±2.15	185^{c}±2.65	1.19±0.35
70% Semolina + 30% FE	265^{b}±2.25	195^{b}±2.50	1.36±0.42
90% Semolina + 10% FT	235^{d}±1.55	175^{d}±1.75	1.34±0.22
80% Semolina + 20% FT	250^{c}±2.20	185^{c}±2.25	1.35±0.30
70% Semolina +30 % FT	270^{a}±2.45	200^{a}±2.50	1.35±0.45
L.S.D at 0.05	3.503	3.702	NS

FE:*Fagopyrumesculentum*; FT: *Fagopyrumtataricum*;Results are presented as means for triplicate analyses ± standard deviation (SD). Means within the column with different letters are significantly different ($P \leq 0.05$).

3.6 Color parameters

Color is one of the crucial parameters used for the acceptability of food. Thus, it directly impacts consumers' impressions because of its association with anticipations for product freshness and flavor. Adding FE and FT to pasta produced a pleasing white tone, per the panelists' assessments and color examinations. Table 6 displays the color alterations of enriched pasta at various FE and FT concentrations 10, 20, and 30%). As anticipated, a rise in darkness (L*) was noticed in the color of the enriched pasta products. Since FE and FT contains a large amount of white pigment, the control group possessed the lowest b*value (14.73). After preparation, color losses were observed due to the pasta's brighter and yellow colors. Table 6 and photos (1, 2) shows that the pasta color significantly reduced when the FE and FT mixing level was increased. This finding is supported by the preceding color parameters (L, a, and b), where the darkness increases as the FE and FT replacement level increases. Nevertheless, a minor visible indication of the pigments' diffusion into the cooking water existed. After cooking, colour losses were detected because effect on consumers' perceptions. Because of the positive impact on consumers, coloured pasta products have gained attention in recent years.

According to colour measurements and evaluations of the panellists, adding FE or FT in pasta provided an appealing white tone. The colour changes of enrichedof the brighter and yellow colours of the enriched pasta. Data in the table (6) revealed that pasta colour significantly decreased in pasta of different FE or FT mixing levels, this result is confirmed with the previous colour parameter (L, a and b) where darkness was increased with increasing replacement of FE or FT. This is characterized as having lower lightness, less green tint, and more intensive yellowness than semolina pasta (Table 6). These results can be related to the darker colour and the presence of carotenoid pigments in buckwheat flour.

Table (6): Effect of replacing semolina with FE andFTon colour quality of uncooked and cooked pasta at different levels

Pasta samples from	Uncooked Pasta Sample			Cooked Pasta Sample		
	L*	**a***	**b***	**L***	**a***	**b***
Control (Semolina 100%)	72.92^{a}±2.12	4.10^{a}±0.03	14.73^{g}±0.28	77.41^{a}±0.97	2.23^{e}±0.11	19.46^{a}±0.34
90% Semolina + 10% FE	70.11^{b}±0.22	3.12^{c}±0.05	17.22^{f}±0.12	69.15^{b}±0.30	2.90^{a}±0.09	19.07^{b}±0.25
80% Semolina + 20% FE	67.25^{c}±0.14	3.07^{e}±0.12	22.97^{d}±0.56	66.12^{c}±0.22	2.65^{c}±0.07	18.25^{d}±0.17
70% Semolina + 30% FE	64.15^{d}±0.30	2.89^{f}±0.124	23.57^{b}±0.03	62.17^{d}±0.23	1.62^{g}±0.02	16.51^{f}±0.13
90% Semolina + 10% FT	69.55^{b}±0.53	3.45^{b}±0.07	18.09^{e}±0.07	67.38^{c}±0.35	2.71^{b}±0.02	18.66^{c}±0.22
80% Semolina + 20% FT	66.19^{cd}±0.25	3.09^{d}±0.05	23.25^{c}±0.05	62.35^{d}±0.35	2.35^{d}±0.35	16.92^{e}±0.19
70% Semolina +30 % FT	63.68^{e}±0.45	2.82^{g}±0.05	25.19^{a}±0.15	59.52^{e}±0.35	1.69^{e}±0.35	15.85^{g}±0.15
L.S.D at 0.05	1.513	0.0175	0.0358	1.751	0.0173	0.0959

FE: *Fagopyrumesculentum*; FT: *Fagopyrumtataricum*;Results are presented as means for triplicate analyses ± standard deviation (SD). Means within column withdifferent letters are significantly different ($P \leq 0.05$).

3.7Sensory properties

The organoleptic properties of cocked pasta from semolina and semolina supplemented with FE or FT at different levels (10, 20 and 30%) were evaluated for colour, flavour, mouth feel, elasticity, and overall acceptability in Table (7) and illustrated in pic. (2). The table revealed that pasta colour significantly decreased in pasta of different FE or FT mixing levels, this result is confirmed with the previous colour parameter (L, a, and b) where darkness was increased with increasing replacement of FE or FT. But elasticity of control pasta did not significantly affectby increasing replacing levels of FE or FT up to 30%. Mouth feel is one of the most important characteristics of pasta quality. The obtained sensorial results indicated that the mouth feels, and overall acceptability of pasta fortified with 10 and 20% FE or FT did not significantly affect compared to the control sample, while flavour didn't significantly affect pasta with 10% FE or FT. From the presented results in Table (7) it could be noticed that the sensory characteristics were decreased with increasing the level addition of FE or FT. Pasta may be enriched with FE or FT at levels 10 or 20% without any reverse effect on sensory acceptance of the product[49].

Table (7): Sensory characteristics of cooked pasta supplemented with different levels of FE or FT

Sensory characteristics / Pasta samples from	Colour (10)	Flavour (10)	Appearance (10)	Tenderness (10)	Stickiness (10)	overall acceptability (50)
Control (Semolina 100%)	$9.85^{a}\pm0.56$	$9.79^{a}\pm0.31$	$9.50^{a}\pm0.45$	$9.65^{a}\pm0.45$	$9.82^{a}\pm0.62$	$48.61^{a}\pm1.19$
90% Semolina + 10% FE	$9.05^{b}\pm0.40$	$9.29^{c}\pm0.42$	$8.61^{b}\pm0.50$	$9.00^{c}\pm0.59$	$9.50^{c}\pm0.53$	$45.45^{b}\pm1.28$
80% Semolina + 20% FE	$8.15^{c}\pm0.46$	$8.39^{e}\pm0.39$	$7.33^{c}\pm0.41$	$8.70^{d}\pm0.65$	$9.33^{d}\pm0.45$	$41.90^{d}\pm1.51$
70% Semolina + 30% FE	$7.31^{d}\pm0.72$	$8.10^{f}\pm0.51$	$6.65^{d}\pm0.62$	$7.50^{f}\pm0.69$	$9.17^{e}\pm0.68$	$38.73^{f}\pm1.32$
90% Semolina + 10% FT	$9.01^{b}\pm0.46$	$9.35^{b}\pm0.45$	$8.30^{b}\pm0.59$	$9.05^{b}\pm0.42$	$9.62^{b}\pm0.66$	$45.33^{c}\pm1.12$
80% Semolina + 20% FT	$8.07^{c}\pm0.54$	$8.42^{d}\pm0.52$	$7.25^{cd}\pm0.44$	$8.60^{e}\pm0.50$	$9.15^{f}\pm0.52$	$41.49^{e}\pm1.22$
70% Semolina +30 % FT	$6.65^{e}\pm0.62$	$7.30^{g}\pm0.45$	$6.30^{d}\pm0.65$	$7.35^{g}\pm0.63$	$8.83^{g}\pm0.61$	$36.43^{g}\pm1.19$
L.S.D at 0.05	0.316	1.715	0.631	0.018	0.0172	0.0414

FE: *Fagopyrum esculentum*; FT: *Fagopyrumtataricum*;Results are presented as means for triplicate analyses ± standard deviation (SD). Means within column with different letters are significantly different ($P \leq 0.05$).

3.8 Texture parameters of pasta

Texture parameters of pasta prepared from semolina and semolina supplemented with FE or FT at different levels (10, 20 and 30%) are given in Table (8). Texture parameters, mainly, Hardness (N), Deformation at hardness (mm), Deformation at hardness (%),Hardness work (mJ), load at target (N), Peak Stress (N/m^2), strain at peak load, Fracturability (N)and Fracturability with 1% of load sensitivity (N). These texture parameters of the pasta and pasta supplemented with FE or FT were determined as the maximum force offered by the sample during shearing in a texture-testing machine (Instron). Results demonstrated that the Hardness (N)for all samples of different pasta ranged between 106.08to 52.06 N. On the other hand, the higher hardness for pasta without FE or FTis related to low moisture and increase hardness, on the other side increased work done. The hardness of pasta is perceptible to consumers and may be correlated with the expansion and cell structure of the product, independent of the feed moisture content. Dry rice-buckwheat pasta showed significantly lower hardness (4.05 N) than rice pasta (12.12 N). This effect could be related to the lower diameter of semolina-buckwheat pasta, compared to semolina pasta, and the presence of fiber fractions from buckwheat flour. These fiber fractions could weaken pasta structure by the formation of discontinuities or cracks inside the pasta strand[50]. From the obtained data of texture profile analysis, it could be concluded that mixing with FE or FT at different levels (10,20 and 30%) was able to decrease Hardness (N), Deformation at hardness (mm), Deformation at hardness (%), Hardness work (mJ) and Fracturability with 1% of load sensitivity (N) of Pasta. On the other hand, the hardness value decreased when FE or FT level in the Pasta formulations was increased. On the contrary supplementation of WF with FE or FTincreasedthehardness value of Pasta.

Table (8): Texture profile analysis of cooked pasta supplemented with different levels of FE or FT

Pasta samples from / **Texture profile analysis**	Control (Semolina 100%)	90% Semolina + 10% FE	80% Semolina + 20% FE	70% Semolina + 30% FE	90% Semolina + 10% FT	80% Semolina + 20% FT	70% Semolina +30 % FT
Hardness (N)	0.91	0.62	1.35	1.45	1.01	0.94	0.97
Deformation at hardness (mm)	4.30	4.68	6.97	4.96	4.57	3.55	5.48
% Deformation at hardness (%)	14.30	15.60	23.20	16.50	15.20	11.80	18.30
Hardness work (mJ)	47.00	27.00	60.00	67.00	50.00	47.00	43.00
Load at Target (N)	0.90	0.17	1.35	0.76	0.77	0.58	0.58
Peak Stress (N/m2)	51611	34962.3	76584.1	82133.7	57160.6	53275.9	54940.8
Strain at Peak Load	0.14	0.16	0.23	0.17	0.15	0.12	0.18
Fracturability (N)	0.09	0.09	0.76	1.27	0.96	0.09	0.24
Fracture Load Drop Off (N)	0.02	0.01	0.02	0.02	0.02	0.01	0.01
Cohesiveness	0.37	0.22	0.46	0.44	0.45	0.52	0.37
Springiness	6.19	4.50	5.77	6.07	6.01	5.79	5.08
Gumminess	0.34	0.14	0.63	0.64	0.45	0.49	0.36
Chewiness	21.00	6.00	37.00	40.00	28.00	29.00	19.00
Adhesiveness	1.00	0.00	1.00	3.00	4.00	2.00	1.00
Resilience	0.18	0.05	0.35	0.12	0.10	0.10	0.14

FE: *Fagopyrumesculentum*; FT: *Fagopyrumtataricum*

Control (100%Semolina)

90% Semolina + 10% FE

80% Semolina + 20% FE

70% Semolina + 30% FE

90% Semolina + 10% FT

80% Semolina + 20% FT

70% Semolina +30 % FT

Pic (1): photo of uncooked pasta supplemented with FF or FT at different level

Control (100%Semolina)

90% Semolina + 10% FE

80% Semolina + 20% FE

70% Semolina + 30% FE

90% Semolina + 10% FT

80% Semolina + 20% FT

70% Semolina +30 % FT

Pic (2):cooked pasta supplemented with FF or FT at different levels

4.Conclusion

The addition of buckwheat flour in the formulation ofpasta had significant effects on colour value, cookingquality, and sensory and rheological properties of pasta.As the supplementation ratio of buckwheat flourincreased in pasta, the weight, ash, fiber, fats andprotein content also increased. The buckwheatflour negatively affected the cooking and colour scoreof pasta. As a result of the sensory evaluation, theoverall acceptance of pasta was found best in pastasupplemented with 30% buckwheat flour. It can be included that buckwheat flour addition improvedthe nutritional quality of pasta but 40 and 50% BWFaddition levels adversely affected the colour and sensoryproperties.

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