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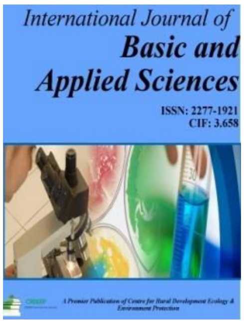

Full Length Research Paper

Rheological and Sensory Evaluation and Quality of Pasta Blender with Oats (*Vitellaria paradoxa)* flour

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ABSTRACT

The study aims of blender wheat flour with oats flour COF at 5, 10 and 15% substitution level the evaluate the effect of oats flour on farinograph parameters, color characteristics, cooking quality, consumer acceptance, texture profile and chemical composition, and the most desirable ratio of oats flour (COF) is to be determined. The results revealed phenolic compounds, flavonoids, antioxidant activity, chemical composition, farinograph parameters, color characteristics, cooking quality, and texture profile and consumer acceptance. Oats flour had adverse effects on protein, fat, ash and fiber content when compared to control. Blender pasta dough with CO Fat 5, 10 and 15% gradually increased water absorption, mixing tolerance index and dough weakening, meanwhile decreased the arrival time, dough development time and dough stability scores gradually comparing with those of pasta control sample. Pasta was darker and more brown in color (L and b* values decreased while a* values increased) with the increased addition of COF. Pasta products containing COF had an increased weight and volume than control gradually by increasing COF. Cooking loss of fortified pastas was significantly greater than the control. The untrained consumer panel significantly preferred the control pasta over that blender with COF. All pasta variations were deemed acceptable in sensory study. Hardness of pasta increased as the percentage of COF blender increased I t can be recommended that supplement with different percentages of oats flour produces high nutritional value and high protein pasta.*

Introduction

Oats cereals a member of the *Vitellaria* plant family. Oats were very popular among the Mayan tribes who helped build civilization in Central America (Pinto-Sánchez, 2017). Ground seeds with water, lemon, sugar, and Mexican tea sauce, the traditional seeds. Seeds and white as energy enhancers in the body. And Oats contain many nutrients, including fiber, omega-3 and omega-6, protein, zinc, potassium, copper, calcium and phosphorous. It also contains many vitamins, including vitamin A, B, E, and D, and minerals contain calcium, phosphorous, zinc, copper, sulfur, iron, iodine, magnesium, manganese, thiamine, and niacin, and it is also a very rich source of antioxidants (Ayankunle, 2017). Among the special properties of Oats, which is considered a unique property, is its ability to absorb more than ten times its weight in water, so Oats keep the body hydrated for a long time and help absorb the electrolytes that the body needs.

Oats cereal is rich in alpha-linolenic acid, and they help prevent metabolic diseases such as dyslipidemia, which are excess lipids in the blood and insulin resistance, which are two factors for the development of diabetes (Sanou, 2011). Oats flour can be used to make pasta, bread and biscuits. Unlike cereals, oats has a soft outer layer that does not need to be removed before milling. This allows oats to yield roughly 100% flour (Ciacci, ,*et al*., 2015).Oats is a good source of protein (16.0%), dietary fiber (35%), fat (15%), (FAO, 2014).These fats are shown to maintain their quality due to the prevalence of vitamin E, a natural antioxidant (Whitehead, 2014 and Sanou, 2011).

Oats has some functional (technological) properties like solubility, water-holding capacity (WHC), gelatin, emulsifying, and foaming that allow diversified uses (De-Risi, et al.., 2018). Oats starch has physico-chemical properties (such as viscosity, freeze stability) which give it functional properties with novel uses (Kyari,2015).There are several developments with oats flour at a smaller scale, like bread, cookies, muffins, pasta, snacks, drinks, flakes, breakfast cereals, baby foods, beer, diet supplements, and extrudates. Fernande, *et al*. (2019) used oats flour in products such as bread, pastas, biscuits and baby foods. It's small and have been used as flour, toasted, added to soups, or made into bread. Oats flour is highly nutritive and is being used to make flour, soup, breakfast and alcohol (Olaniyan and Oje, 2017). Pasta is a compound food of wheat, salt and water, and this provides the body with albumen and fatty substances, vitamins and minerals such as phosphorous, calcium and iron. Pasta is an ideal food for patients except in the case of diabetes. (Monge *et al,* 1990 and Abdel-Aal and Coulter L and Lorenz K (1991b). This provides an opportunity for the use of non-traditional raw materials to increase the nutritional quality of pasta Consequently, seeds and cereals are nutritionally complementary (Duranti 2016 and Del Nobile *et al*., 2015).The objective of this study was to evaluate the physicochemical, rheological analysis of the pasta quality by oats flour as a protein source blend in pasta production.

Materials and Methods

Materials

Oats flour (*Vitellaria paradoxa)* and semolina (*Triticum durum*) were obtained from National Research Center, Giza, Egypt.

Methods

Sample of pasta preparation

Pasta samples were produced by hand in a homemade style. The control sample was made from 100% semolina flour (SF), while three different samples were made by SF with oats flour (SF) as follow: Semolina flour by 100% C_{SFt} (a) as control, C_{SFt}5% oats flour (C_{OF1}) (b), C_{SFt}5%oats flour (C_{SF2}) (c) and C_{OF}15% oats flour (C_{OF3}) (d). Other ingredients used in this additives pasta formulation were: The dry ingredients were combined into a homogenous mixture and poured onto a clean, smooth work area. Warm water at approximately 32-49° Celsius was slowly poured into a well formed in the center of the mounded flour. The water was incorporated by pulling flour from the inside wall using a fork. Once all the water was added and mixing with a fork became difficult, the remaining flour was blended in by hand. The crumbly dough mass was then kneaded for approximately 10 minutes, forming a smooth, elastic dough. Kneading was done by the repeated action of flattening the dough with the palm of the hand, rotating the dough, and folding over. The kneaded dough was wrapped in plastic film and set to rest at room temperature for one hour. Once rested, the dough ball was divided into two pieces for processing. Each dough piece was flattened and sent through the pasta machine (Imperia Tipo Lusso SP150, Torino, Italy) starting on the thickest setting (number 1). The dough was folded into thirds and sent through again. It was then folded in half, run through, and cut into manageable lengths. Sheets of dough were fed through the pasta machine at decreasing thicknesses (numbers 2, 3, and 4, respectively). The thin, flattened sheets were laid to dry for 10 minutes before being passed through the fettuccine cutter. The cut strands were laid on wire racks and covered with a towel to dry overnight. The dried pasta was stored in bags at room temperature until further use.

Analytical Methods

Quantification of phenolic compounds, flavonoids and antioxidant activity by HPLC: The analysis of phenolic compounds was carried out using a HPLC system (Shimadzu, Japan) according to method described by Milašienė*et al.,* (2007).

Chemical composition of samples: Moisture content, total solids, crude fiber, ash, protein and crude ether extract were determined according to (AACC 2000). Total carbohydrates were calculated by the difference.

Rheological properties: Rheological properties of dough were evaluated using Farinograph according to AACC (2000).

Color measurement: Objective evaluation of color of pasta samples was measured in the National Research Center, Giza, Egypt. Hunter L*(luminosity),a*(red intensity), and b*(yellow intensity).

Cooking quality of pasta: Cooking quality of pasta were carried out by measuring the increases in weight, volume and cooking loss after cooking according the methods of AACC (2000).

Texture profile analysis of Pasta: Hardness, Deformation at hardness, Peak Stress and Fracturability with 1% of load sensitivity analysis of uncooked and cooked pasta samples was conducted using The TVT Texture Analyzer (Perten instruments) according to Tang *et al*. (1999).

Sensory evaluation: Sensory evaluation of cooked pasta was evaluated as described by Hussein *et al*. (2006).

Statistical evaluation: The obtained results were evaluated statistically using analysis of variance as reported by McClave & Benson (1991).

Results and Discussion

Total phenols, total flavonoids and antioxidant activity content of in oats flour.

Data given in Table (1) show the total phenols total flavonoids and antioxidant activity content of oats flour (COF). It is obvious that the value of total phenols and total flavonoids content of oats were 112.40 mg/g, 89.20 mg QE/g and 29.58 %, respectively. These results are in agreement with Sanou, (2011), they reported that the oats flour contains phytochemical constituents that enables it elicit medicinal properties. Oats cereal could also serve as a good source nutritional supplement in the diet of animal.

Chemical composition of samples pasta.

The chemical composition of control and blended pasta samples are shown in Table (2) a comparison between chemical composition contents of group control 100% semolina flour (C_{SFt}) and oats flour (C_{OF}). C_{SFt} group (a) recorded 10.81 ±0.70, 13.10 ±0.50, 3.36 ±0.07, 5.43 ±0.01, 6.31 ±0.15 and 67.29 ±1.25 % for moisture, crude protein, total fat, total ash, fiber, and total carbohydrates respectively. Meanwhile, sample (d) (C_{OF3}) recorded highest values was (17.41±0.14 , 4.75±0.01, 6.52±0.02 and 8.59±0.01) in protein total fat, total ash, fiber compared to all samples It could be observed from results that C_{OF} had the higher contents of protein, fat, ash and fiber as compared to those of C_{SFt}.. These results agree with Coulter and Lorenz (1991a) who reported that the content of the oats were characterized and their chemical composition determined were fairly high so some of them were not only used for food but also in medicine applications. These results were with accordance with (USDA 2013 and De-Risi, et al., , 2018) which stated that oats flour contained (13.28, 15.12,5.07, 3.38, 7.10 and 66.16 g) moisture, protein, total lipid, ash, fiber and carbohydrate respectively. While C_{SFt} contained (12.67, 12.68, 1.05, 0.77 and 72.83 g) in moisture, protein, fat, ash and carbohydrates respectively.

Rheological properties of pasta formulae from semolina *samples and their blender oats*

Farinograph parameters of four different pasta dough samples (C_{SFt}, with 5, 10 and 15%C_{OF}) were represented in Table 3. These pasta samples regarding were evaluated for water absorption, arrival time, dough development time, dough stability, mixing tolerance index and dough weakening. Data show that adding pasta dough with C_{OF}at 5, 10 and 15% caused a gradually increasing in mixing tolerance index and dough weakening comparing to pasta control. Meanwhile, the arrival time, dough development time and dough stability values were decreased gradually by the increasing of C_{OF}in pasta dough.5 and 15%C_{OF} increased water absorption compared to control pasta.

Svec *et al*. (2011) investigated dough rheological properties and dough quality from wheat oats composite flour made at rates from 0 to 15%fortified. Oats whole meal incorporation in wheat flour did not influence water absorption, but dough stability decreased dependently to basic flour quality and oats additions similarly to Jancurová *et al*. 2009 and Fernande, *et al*. 2019). During dough kneading, up to 33% shorter development time and 50% dough stability with twofold breakdown were recorded for Q30. Contrary had to independence of development time on oats level and also dough stability prolongation.

Color characteristics of pasta formulae from semolina samples and their blender oats.

Color characteristics were measured in pasta samples at four stages (the flour mixture before processing, pasta after processing before drying, dried pasta and pasta after cooking) and the obtained data were tabulated in Table 4.

Generally, the fortification of pasta with oats flour caused a significant decreasing ($p<0.05$) in brightness (L^* value) at all previous stages of pasta processing comparing with the control pasta which was significantly lighter than other samples. This decrease in brightness of pastas containing seeds flours is in accordance with many researchers who have experimented with seeds such as oats, yellow pea, split pea, faba bean, soy, and lentil, as well as pseudo-cereals like oats (Zhao *et al.,* 2005, Wood 2009, Petitot *et al.,* 2014, USDA 2013 and De-Risi, et al., 2018). Fernande, *et al*. (2019) attributed the decrease in brightness to higher ash content in seeds flour. It is known that consumers prefer bright yellow translucent pasta products, but the limit of acceptable brightness is undefined.

In Seam table 4 to lightness decreasing, redness increased (a^* value increased) as more oats flour was added. It can be concluded that the amount of oats flour added to pasta significantly affects redness of the product. The control pasta was found to be the most yellow (highest b^* value), with yellowness significantly ($p<0.05$) decreasing as more oats flour was added. This is in accordance with other researchers who have seen a decrease in yellowness of pastas containing chickpea, green pea, yellow pea, lentil, and oats flours (Wood 2009and Fernande, *et al*. 2019). This decrease in yellowness may be due to the leaching and/or degradation of color pigments, such as carotenoids and xanthophyll (De-Risi, et al., 2018).

Petitot *et al.,*(2014) they found that pasta fortified with faba bean flour saw a significant increase in redness. Also noted that yellowness (b^* values) was not affected in this change. This is important to note because according to Ugarcic-Hardi *et al.,*(2003), bright yellow pasta is achieved by having both high b^* values and low a^* values.

In the table 4 show that the effect of C_{OF}blender of pasta weight increase was volume increase and cooking loss percentage, A significant increase were observed in weight and volume increase values gradually by increasing C_{OF} percentage in pasta. Weight increase percentage recorded 235±3.00, 255±4.32 and 275±5.33% for pasta with 5, 10 and 15%C_{OF}, respectively. While volume increase percentage recorded 180±3.20, 195±5.60 and 210±3.55 for pasta with 5, 10 and 15%C_{OF} respectively meanwhile control pasta made with 100% C_{SFt} recorded 220±2.80 and 165±4.42 for weight and volume increase percentage, respectively. Cooking loss was significantly affected by the addition of C_{OF}. The control pasta made with 100% SF recorded significant less cooking loss (3.5±0.14) comparing with pasta containing C_{OF}. It could be noticed that the cooking loss values increase gradually by the increasing of C_{OF} percentage as recorded 5.00±0.21, 6.5±0.28 and 7.5±0.42 for pasta samples with 5, 10 and 15%C_{OF}.The pasta blender with seeds flour increases cooking loss (Zhao *et al.,*2005 and Petitot *et al.,*2014).Also, Lorenz et al. (1993) also found that adding oats flour to pasta resulted in a higher cooking loss than the control made from wheat flour. De-Risi, et al.., (2018), found that cooking loss increased as the level of fortification increased. The observed higher water absorption and cooking loss in spaghetti blended with seeds flour and concentrates. Legume and seeds supplementation of pasta resulted in greater cooking loss when compared to control (Bahnassey and Khan, 1986)

The texture profile of dried and cooked pasta formula from semolina samples and their blender oats.

Table 6show that the texture profile of dried and cooked pasta was represented in hardness of the pastas was affected by the fortification of pasta with oats flour. Hardness is the height of the force peak of the first compression cycle (Bourne 2002). In this study, it is the maximum force required to compress the dried pasta samples recorded (17.55, 32.30, 34.32 and 48.32N) for control sample, 5, 10 and 15%C_{OF}pasta, respectively. Meanwhile, the maximum force required to compress the cooked pasta samples recorded (3.02, 3.47, 3.86 and 4.09) for control sample5, 10 and 15% C_{OF} pasta, respectively.

The control pasta (dried or cooked) was found to be less hard than the fortified pasta products. Pasta formula blander with 15%C_{OF} was harder than pastas with 5 and 10%C_{OF}. The addition of C_{OF} has a greater effect on cooked and dried pasta hardness. Petitot *et al.,* (2014) fount that pasta fortified with 35% seeds flours (oats) significantly increased the hardness of pasta, which they attributed to increased protein content and decreased water uptake. The adding 10, 30, and 50% oats flour to wheat pasta. The addition of oats required more water for mixing, made the pasta darker in color, and increased cooking loss. Pasta made with 50% oats flour was shown to be poor in flavor and texture and was deemed unacceptable (Lorenz *et al*., 1993 and De-Risi, et al., , 2018).

The sensory analysis of pasta formulae from semolina samples and their blender oats

The blender of *COF* significantly affected consumer acceptance of the pasta products. The average scores given by panelists in color, flavor, mouth feel, elasticity and overall acceptability can be seen in Table 7. The control pasta was significantly ($p<0.05$) more liked than pastas containing oats flour. The least favored pasta was 15% C_{OF} pasta. This may be due to the poor textural properties of the samples. Of the fortified pastas, 5%oats flour pasta was found to be the most favored. These results are in accordance with other researchers who found that pasta control 100% C_{SFt} received the highest overall acceptability when compared to pastas supplemented with legume, seeds and pseudo-cereal flours (Zhao *et al*., 2005; Mastromatteo *et al*., 2011 and De-Risi, et al., 2018).Oats has been incorporated into wheat noodles (Lorenz *et al*., 1993). Non-significant difference was found between noodles made with 5% and 15%C_{OF}pasta. White noodles with 50% oats content were ranked least acceptable. C_{OF} was extruded with corn grits to produce expanded snack products. Addition of oats produced a darker, less yellow extruded product. The products were rated as moderately acceptable (Coulter & Lorenz, 1993; Lorenz *et al*., 1995).It could be noticed that the pasta sample with 15%C_{OF} caused an obvious increasing in protein, ash, fat and fiber contents comparing with other pasta samples. Therefore, we recommend the importance of using oats flour for pasta dough to reduce the consumption of semolina flour from the economic cost and as a foodstuff because of its many benefits that have made it receive great attention in recent times for its high nutritional value, effective compounds, and antioxidants, rheological and organoleptic properties.

Table (1): Total phenols, total flavonoids and antioxidant activity content of oats flour extracts

Samples	Total phenol (mg GAE /100g DW)	Total Flavonoids (mg QE./100g DW)	Antioxidant activity %
oats flour	112.40	89.20	29.58

Table (2): Chemical composition of samples pasta %

Pasta samples	Moisture	Protein	Fat	Ash	Fiber	Carbohydrate
C_{SFt}	10.81± 0.70	13.10± 0.50	3.36± 0.07	5.43± 0.01	6.31± 0.15	67.29± 1.25
C_{OF1}	10.78± 0.07	13.99± 0.14	3.87± 0.01	6.08± 0.02	7.04± 0.08	65.44± 0.39
C_{OF2}	9.54± 0.06	15.73± 0.24	4.49± 0.03	5.75± 0.02	8.24± 0.08	65.79± 0.39
C_{OF3}	9.50± 0.06	17.41± 0.14	4.75± 0.01	6.52± 0.02	8.59± 0.08	62.70± 0.39

Values are the means of 3 independent determinations.100%CSFt: Semolina flour, COF: Oats flour pasta

Table (3): Effect of adding oats flour to semolina flour in different substitutes on farinograph parameters of pasta dough.

Samples	Water absorption (%)	Arrival time (min)	Dough development time (min)	Dough stability (min)	Mixing tolerance index (BU)	Dough weakening (BU)
100%C_{SFt}	57.6	7.0	11.5	11.5	20	60
5%C_{OF1}	57.5	4.5	8.5	10.0	25	70
10%C_{OF2}	61.5	5.5	7.0	9.5	35	80
15%C_{OF3}	62.5	5.2	7.5	7.5	50	90

100%$C_{SFt:}$ Semolina flour, C_{OF}: Oats flour pasta

Table (4): Effect of adding oats flour to semolina flour in different on color characteristics of pasta.

Samples	Color parameters of flour mixture		
	L*	**a***	**b***
100%C_{SFt}	85.40±0.21a	2.25±0.03a	20.85±0.10a
5%C_{OF1}	83.81±0.11b	1.95±0.05b	19.15±0.07b
10%C_{OF2}	82.47±0.07b	1.70±0.03c	17.88±0.09c
15%C_{OF3}	81.55±0.04c	1.41±0.04d	16.80±0.09d
	Color parameters of processed pasta before drying		
Samples	**L***	**a***	**b***
100%C_{SFt}	77.61±0.28a	1.89±0.035c	20.05±0.05b
5%C_{OF1}	73.22±0.45b	1.80±0.02c	19.26±0.02c
10%C_{OF2}	62.49±0.09c	2.43±0.06b	20.83±0.07a
15%C_{OF3}	62.02±0.07c	2.57±0.07a	21.35±0.07a
	Color parameters of Processed pasta after drying		
Samples	**L***	**a***	**b***
100%C_{SFt}	77.01±0.381a	2.16±0.07c	19.55±0.14c
5%C_{OF1}	70.11±0.139b	3.07±0.120b	22.97±0.56b
10%C_{OF2}	66.15±0.302c	3.42±0.124a	23.57±0.03b
15%C_{OF3}	63.55±1.53d	3.45±0.07a	24.09±0.07a
	Color parameters of cooked pasta		
Samples	**L***	**a***	**b***
100%C_{SFt}	71.17±0.55a	0.66±0.01d	17.19±0.07c
5%C_{OF1}	62.17±0.23b	1.62±0.02c	18.40±0.07a
10%C_{OF2}	59.38±0.35c	2.31±0.02b	17.66±0.05b
15%C_{OF3}	53.67±0.32d	2.53±0.04a	17.16±0.07c

100%C_{SFt} : Semolina flour C_{OF}: Oats flour pasta, L: luminosity, a*: red intensity, and b*: yellow intensity*

Table (5): Effect of adding oats flour to semolina flour in different on cooking quality of pasta

Samples	Weight increase (%)	Volume increase (%)	Cooking loss (%)
100%C_{SFt}	220±2.82d	165±4.42d	3.5±0.14d
5%C_{OF1}	235±3.00c	180±3.20c	5.00±0.21c
10%C_{OF2}	255±4.32b	195±5.60b	6.5±0.28b
15%C_{OF3}	275±5.33a	210±3.55a	7.5±0.42a
LSD at 0.05	12.801	12.453	0.791

100%C_{SFt}: Semolina flour C_{OF}: Oats flour pasta

Table (6): Effect of adding oats flour to semolina flour in different on texture profile of dried and cooked pasta

Samples	Hardness (N)	Deformation at hardness (mm)	Hardness work (mJ)	Peak Stress Dyn/cm^2	Fracturability with 1% of load sensitivity (N)
Dried pasta					
100%C_{SFt}	17.55	0.23	0.80	55904152	17.55
5%C_{OF1}	32.30	2.15	3.20	102876128	1.93
10%C_{OF2}	34.32	1.87	4.70	109309792	1.13
15%C_{OF3}	48.32	0.49	3.00	153876960	48.32
Cooked pasta					
100%C_{SFt}	3.02	1.61	3.40	9619262	3.02
5%C_{OF1}	3.47	1.62	1.10	11055905	3.47
10%C_{OF2}	3.86	1.98	1.30	12305160	0.07
15%C_{OF3}	4.09	1.73	1.30	13023481	4.09

100%C_{SFt}: Semolina flour C_{OF}: Oats flour pasta, Hardness = The maximum force of the 1st compression

Table (7): Effect of adding oats flour to semolina flour in different on sensory analysis of pasta

Samples	Color (10)	Flavor (10)	Mouth feel (10)	Elasticity (10)	Overall acceptability (10)	Total (50)
100%C_{SFt}	9.75±0.35a	9.83 ±0.28a	9.70 ±0.23a	9.81± 0.25a	9.55± 0.52a	47.81 ± 1.02a
5%C_{OF1}	8.9 ± 0.42a	9.33 ± 0.57a	9.01 ± 0.42a	8.50 ± 0.35a	8.95 ± 0.46a	44.18± 1.25b
10%C_{OF2}	7.65 ±0.35b	9.11 ±0.28a	8.10 ±0.35a	7.13± 0.41c	7.13± 0.37b	42.25± 0.88c
15%C_{OF3}	7.20 ±1.41b	8.26 ±0.64b	6.70 ±0.32c	6.50± 0.62d	6.04 ± 0.35c	38.66 ±1.52d
LSD at 0.05	0.9311	0.8996	0.9211	0.9621	0.8621	2.207

100%C_{SFt} : Semolina flour C_{OF}: Oats flour pasta

Conclusion

The results revealed phenolic compounds, flavonoids, antioxidant activity, chemical composition, farinograph parameters, color characteristics, cooking quality, and texture profile and consumer acceptance. Oats flour had adverse effects on protein, fat, ash and fiber content when compared to control. Blender pasta dough with CO Fat 5, 10 and 15% gradually increased water absorption, mixing tolerance index and dough weakening, meanwhile decreased the arrival time, dough development time and dough stability scores gradually comparing with those of pasta control sample. Pasta was darker and more brown in color (L* and b* values decreased while a* values increased) with the increased addition of COF. Pasta products containing COF had an increased weight and volume than control gradually by increasing COF. Cooking loss of fortified pastas was significantly greater than the control. The untrained consumer panel significantly preferred the control pasta over that blender with COF. All pasta variations were deemed acceptable in sensory study. Hardness of pasta increased as the percentage of COF blender increased I t can be recommended that supplement with different percentages of oats flour produces high nutritional value and high protein pasta.

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