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The Effect of Using Onion Skin Powder as a Source of Dietary Fiber and Antioxidants on Properties of Dried and Fried Noodles

Hala S. Sayed, Nahla M. M. Hassan and M.H. Abed El khalek

Food Technology Research Institute, Agricultural Research Center, Cairo, Egypt.

ABSTRACTS

This study aims to assessment the effect of onion skin powder (OSP) addition at 2, 4, 6% as antioxidants and dietary fiber sources on the properties of dried and fried noodles. The potential antioxidant of noodles with OSP was significantly higher than the activity noted in the control. Sensory evaluation showed that replacement of wheat flour in noodles with up to 6% OSP gave satisfactory consumer acceptability. The total phenols were significantly increased from 105.9 in the control sample to 171.76 GAE mg/100g in dry noodles and from 93.22 GAE mg/100g in the control sample to 123.18 GAE mg/100g in fried noodles. In addition to, the moisture, dietary fiber minerals and ash contents were increased in onion skin powder; however, the protein and carbohydrates content were decreased. The results recommended the possibility of producing noodles supplemented with onion skin powder as a functional food

Key words: Onion skin, onion (*Allium cepa* L.), mineral and nutrient contents, antioxidant activity, total phenols and flavonoids, cooking and sensory properties.

Introduction

Onion (*Allium cepa* L.) is a common vegetable that is largely utilized all over the world in various types of foods. Egypt is one of the top world onion producers with an annual production of more than 2.32 million Tons (FAO, 2011).The outer scales of onion, including the brown skin and the outer fleshy scales, are significant by-products of the industrial preparation of onions. These outer scales are mostly discarded. However, effective utilization of these by-products is desirable because of the high cost of their separation process (Michał *et al.,* 2013).

In recent years, the consumption of onion has increased due to its flavor and health benefits. These beneficial properties seem to strongly relate to the high content of sulfur compounds and flavonoids. Because of their activity as antioxidants and anti carcinogens, their effects on lipid metabolism and the cardiovascular system, and their antibiotic effects were put under investigation (Griffiths *et al.,* 2002). The flavonoids present in the onion consist of anthocyanins (cyanidin and peonin) and mainly flavonols (quercetin, kaempferol, isorhamnetin, and their glycosides). The onion skin has a high content of free and glycosidically bonded quercetin (2-10% w/w) and oxidized quercetin derivatives such as minor flavonols and phenolic compounds (Griffiths *et al.,* 2002 and Suh *et al.,* 1999).

In the last few decades, several epidemiological studies have shown that a dietary intake of foods rich in natural antioxidants correlates with reduced risk of a vast number of diseases. The antioxidative effects of consumption of onions have been associated with a reduced risk of many forms of cancer (Corzo-Martínez *et al*., 2007), ulcer development (Suzuki *et al*., 1998), cataract formation (Sanderson *et al*., 1999), and prevention of vascular and heart disease by inhibition of lipid peroxidation and lowering of low density lipoprotein (LDL) cholesterol levels (Kaneko and Baba, 1999; Campos *et al*., 2003). A previous study (Škerget *et al*., 2009) showed that the outer skin of onion has a much higher antioxidant activity than the onion edible parts.

Dietary fiber is a main component of plant foods and human diets that has recently gain attention for its health benefits. Dietary Fiber is defined as the remnants of the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine, with complete or partial fermentation in the large intestine. Dietary fiber includes polysaccharides, oligosaccharides, lignin, and associated plant substances (A.A.C.C., 2000). Consuming adequate amount dietary fiber is essential for proper functioning of the gut and has also been related to risk reduction for a number of chronic diseases including heart disease, diabetes, obesity and certain cancers (Kendall *et al*., 2010). It has been reported that food fiber helps to prevent over-absorption of water and the formation of hard stools which can result in constipation. Besides, fiber lowers the body cholesterol level, thus, reducing the risk of cardiovascular diseases (Rumeza *et al.,* 2006), consequently, inclusion of the outer scale of onion in soup ingredient could be of health benefit.

Fiber-rich incidental products derived from the manufacturing or processing of plant based foods: cereals, fruits, vegetables, as well as algae, are sources of abundant dietary fiber. They can be used in foods to increase their dietary fiber content and result in healthy products. They may also serve as functional ingredients to improve physical and structural properties of hydration, oil holding capacity, viscosity, texture, and sensory

Corresponding Author: Nahla M. M. Hassan, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.
E-mail: Nahla_hassan40@hotmail.com

characteristics. (Elleuch *et al*., 2011). Onion skin was reported to have a potential for use, as dietary fiber-rich functional ingredients, in food applications (Benítez *et al*., 2011).

Noodles are one of the main staple foods consumed in East and Southeast Asian countries and recently other parts of the world. They are strips or strands cut from a sheet of dough that is prepared mainly from three basic ingredients; flour, water and salts, either common salt or a mixture of alkaline salts (Fu, 2008 and Kim *et al.,* 2014). Cooked instant noodles should have a relatively strong bite with a firm, smooth surface, and good mouth feel (Yousif *et al.,* 2012). Cooking quality of noodles is influenced by several factors, such as protein content, ash content, damaged starch, starch quality, thickness of noodle strands, and frying conditions. Re-hydration rate, cooking time, and cooking loss are the measure of cooking quality and ease of preparation (Purwandari *et al*., 2014).

Dried and fried noodles are the most common among different methods used in the processing of noodles. Dried noodles are produced by controlled drying of uncooked wet noodle strands until they have final moisture content less than 14%, while fried noodles are prepared by partially cooking the wet strands of raw noodles by steaming followed by dehydrating by deep frying in oil at a relatively higher temperature up to 160°C (Fu, 2008; Kim *et al*., 2013; Song *et al*., 2013).

The aim of the present work is to evaluate the use of dried onion skin powder as a source of antioxidants and dietary fiber for use in the production of both dried and fried noodles. The effect of such usage on the chemical composition including dietary fiber, antioxidant activity, cooking properties and sensory characteristics of produced noodles was studied.

Material and methods

Materials:

A red onion variety, purchased from an Egyptian local market. The outer covers were manually peeled to obtain onion skins. Wheat flour (72% extraction) was obtained from El-Safa Mills, Cairo, Egypt.

Methods:

Preparation of onion skin powder (OSP):

Onion skin powder (OSP) was prepared according to the method described by Gawlik-Dziki *et al*., (2013) as follows: the dried onion skin was separated and washed twice with deionized water and dried in an oven at 50°C. Once dried, the material was powdered using a laboratory mill and then sieved (60 mesh).

Preparation of noodles:

Dried noodles were prepared by the method described by Song *et al*., (2013) as follows: 100 g flour, 2 g salt and 40 ml water were mixed together to produce dough crumbs that were aggregated by hand kneading. The obtained stiff dough was passed through the sheeting rolls of Ampia laboratory manual machine (Tipo Lusso Model, 150, Italy) and sheeted four times. The sheeted dough was rested in a plastic bag for 30 min at room temperature and then successively sheeted using 2, 3, 4 and 5 roll gap settings. The final dough sheet was cut to obtain 2 mm-wide wet noodle strips. The wet noodles were dried in a convection oven at 40°C for 6 hr., cooled and then preserved in a polyethylene bags at room temperature.

Fried noodles were prepared according to the same method previously used in the preparation of dried noodle with the exception that the wet noodle strips were subjected to steaming for 5 min and then deep fried in fresh oil (sun flower and soybean oils mixture, 1.6 L) at 170°C for1.5 min, followed by cooling at room temperature for 1hr. and stored in polyethylene bags (Kim *et al*., 2013). For OSP noodles, 2, 4 and 6 % of wheat flour were replaced by the some amounts of OSP and were used for the preparation of noodles.

Proximate chemical composition:

Moisture, crude protein, crude fat, crude fiber and carbohydrate (by difference) were determined according to the methods described in the A.O.A.C. (2005).

Determination of mineral content:

Minerals content, magnesium (Mg), sodium (Na), zinc (Zn), manganese (Mn), iron (Fe), calcium (Ca), potassium (K) and copper (Cu) were determined by using the atomic absorption spectrophotometer (Perkin-Elmer 3300) as described by (Kirleis *et al.,* 1984).

Determination of noodle quality:

Noodles were put into boiled water and cooked for 3 min, then rinsed and cooled in running cold tap water for 1 min. Cooking loss was measured by evaporating the cooking water to dryness in oven at 100ºC as described in A.A.C.C. (2000).

Determination of total phenolic content, total flavonoid and DPPH:

Total phenols were estimated by the Folin-Ciocalteu method reported by El-Falleh *et al.,* (2009) and the amount of total flavonoids was measured spectrophotometrically according to the method of Nasri *et al.,* (2011). The DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity of methanolic extracts was determined by using the method reported by Okonogi *et al.,* (2007).

Determination and identification of flavonoid fraction of onion skin powder by HPLC

The fractionation of total flavonoids content of onion skin powder were measured by the method described by (Schieber *et al.,* 2001). A high performance liquid chromatography system equipped with a variable wave length detector (Agilant, Germany) 1100, auto sampler, quaternary pump degasser and column compartment. Analysis were performed with a C_{18} reverse phase packed stainless- steel column (Zorbax ODS 5µm 4.6x250 mm). HPLC method started with linear gradient at a flow rate of 1.0 ml/ min with mobile phase of water/ acetic acid (98:2 v/v, solvent A) and methanol/ aceto-nitril (50:50, v/v, solvent B), starting with 5% B and increasing B to levels of 30% at 25 min, 40% at 35 min, 52% at 40 min, 70% at 50 min, 100% at 55 min. The initial conditions were re-established by 5 min wash in both solvents. All chromatograms were plotted at 330 nm flavonoids. All components were identified and quantified by comparison of peak areas with external standard.

Sensory evaluation of fortified Noodles:

Sensory evaluation of cooked noodles was evaluated for various quality attributes such as color, taste, texture and overall acceptability on 1 to 10 hedonic scale as described by (Jayasena *et al.,* 2008). The obtained data for sensory evaluations were statistically analyzed by the least significant differences value (L.S.D.) of 0.05 levels probability procedure of Snedecor and Cochran (1980).

Results and Discussion

Chemical composition of wheat flour,onion skin powder and produced noodles

The data in Table (1) showed that, the protein, crude fat, dietary fiber, ash and total carbohydrates on dry weight basis, for wheat flour(72% ext.), onion skin powder (OSP) and supplemented noodles with (OSP) at level 2%, 4%, and 6%. Data showed that the onion skin powder (OSP) contained considerable amount of dietary fiber (7.78%) and ash content (5.93%). Also it has lower protein content (3.06%). While, Wheat flour showed high protein content and total carbohydrate (10.32% and 84.71% respectively), and it has lower dietary fiber and ash content (3.75% and 0.51%% respectively) than (OSP).

Table 1: Chemical composition (% on dry weight basis) of wheat flour, onion skin, dried and fried noodles supplemented with onion skin at different levels.

Treatment	Moisture	Protein	Crude fat	Dietary fiber	Ash	Total Carbohydrates
Wheat flour (72% ext.)	11.90	10.32	0.71	3.75	0.51	84.71
Onion skin	8.08	3.06	1.08	7.78	5.93	82.15
Dried noodles						
Control	8.97	9.86	0.74	3.70	1.50	84.2
Wheat flour +2% OSP	9.29	9.50	0.79	4.25	1.69	83.77
Wheat flour +4% OSP	9.00	9.44	0.82	6.66	1.81	81.27
Wheat flour +6% OSP	9.61	9.30	0.89	7.98	1.91	79.92
Fried noodles						
Control	5.87	9.24	12.03	3.64	1.31	73.78
Wheat flour +2% OSP	5.71	9.11	12.58	4.23	1.52	72.56
Wheat flour +4% OSP	5.95	9.01	12.69	6.51	1.60	70.19
Wheat flour +6% OSP	5.71	8.89	12.91	8.08	1.77	68.35

OSP = Onion Skin Powder

Also, the supplemented noodles with (OSP) at 2%, 4%, 6% levels showed increase in the dietary fiber and ash content. The dietary fiber and ash content was increased in the 6% OSP supplementation of wheat flour up to 7.98% and 1.91% in the dry noodles and 8.08% and 1.77% in fried noodles respectively. The crude protein of the onion skin was 3.06 and after 6% fortification, it was increased to 9.30% in dried noodles and 8.89 in fried noodles. This might be due to the high dietary fiber and ash contents of (OSP) than wheat flour. Also, crude fat increased of its blends compared to control noodles at all levels of supplement. While carbohydrate contents were decreased for all supplementation.

In many countries, wheat flour is the staple food product, thus attempts at enriching them with materials rich in bioactive ingredients seem well targeted (Gawlik-Dziki *et al.,* 2009; Han and Koh, 2011a; Han and Koh, 2011b; Peng *et al.,* 2010). Onion skin powder (OSP) contains significantly high level of flavonoids, especially quercetin aglycone, proximate compositions and mineral elements.

Mineral contents in the tested materials and products noodles

Data presented in Table (2) showed the composition of elements: calcium (Ca), iron (Fe), zinc (Zn), magnesium (Mg), sodium (Na), potassium (K), manganese (Mn), and copper (Cu) for wheat flour(72% ext.), onion skin powder (OSP) and supplemented noodles with (OSP) at level 2%, 4%, and 6%. Data showed that the onion skin powder (OSP) appear to be a good source of calcium (39.251mg/g),and potassium (4.365mg/g). Also it contain considerable amount of magnesium (1.495 mg/g), manganese (1.077 mg/g) and iron (0.818 mg/g), whereas wheat flour showed mineral contents lower than (OSP). Substitution of wheat flour with 2%, 4% and 6% of OSP for making dried and fried noodles resulted increase, in Ca, K, Mg, K and Fe content

Revealed that, calcium amounts were 0.243, 0.360, 0.206 and 0.300 mg/g in the control of dried noodle, dry noodle fortified with 6% OSP, control of fried noodle and fried noodle fortified with 6% OSP, respectively. While, potassium content was 4.365 mg/g of (OSP). Potassium is an essential nutrient and has an important role in the synthesis of amino acids and proteins which helps to repair worn out tissues (Malik and Srivastava 1982,; Hershko and Nussinovitch 1998) and calcium is the major component of bone and helps in teeth development (Brody 1994).

The onion wastes contain some transition metals which are essentially known for catalytic activities (Mn, Fe), and thus could be explored as food ingredient to improve digestion processes if added to food there by aid and or increase metabolic activity in the body. The level of iron is higher in the onion skin; Fe is the constituents of hemoglobin which is used in respiratory processes; incorporation of this part in food ingredients could assist in prevention of iron deficiency anemia.

A great variation exists in mineral content of onions among cultivars (Bibak *et al.,* 1998; Ariyama *et al.,* 2007). The mineral distribution in onion wastes depend on the type of mineral found in the soil; the highest concentration of iron and zinc was found in top-bottom waste probably because this part comprise the plant roots in which the nutrient uptake occurs.

Table 2: Mineral contents (mg/g on dry weight basis) in wheat flour, onion skin, dried and fried noodles supplemented with onion skin at different levels.

Treatment	Ca	Fe	Zn	Mg	Na	K	Mn	Cu
Wheat flour	0.268	0.158	0.015	0.250	0.206	0.385	0.010	0.031
Onion skin	39.251	0.818	0.039	1.495	0.340	4.365	1.077	0.050
Dried noodles								
Control	0.243	0.163	0.015	0.209	0.476	0.357	0.010	0.028
Wheat flour +2% OSP	0.255	0.169	0.017	0.221	0.450	0.364	0.012	0.031
Wheat flour +4% OSP	0.350	0.236	0.019	0.303	0.502	0.398	0.015	0.034
Wheat flour +6% OSP	0.360	0.340	0.020	0.316	0.544	0.481	0.017	0.045
Fried noodles								
Control	0.206	0.205	0.017	0.151	0.540	0.373	0.011	0.033
Wheat flour +2% OSP	0.254	0.224	0.018	0.256	0.568	0.388	0.012	0.034
Wheat flour +4% OSP	0.276	0.248	0.018	0.264	0.595	0.450	0.015	0.035
Wheat flour +6% OSP	0.300	0.286	0.020	0.270	0.632	0.469	0.018	0.043

OSP = Onion Skin Powder

Cooking qualities of noodles

The cooking time and cooking loss of dried and fried noodles supplemented with onion skin powder (OSP) are shown in Table (3). In the present study, the optimum cooking times of all dry noodle samples ranged from 6.57 to 6.41 min., and 5.23 to 4.59 min. for dried and fried noodles, respectively. The cooking loss is the amount of dry matter in the cooking water of optimally cooked noodles. The increase in the cooking loss of noodles containing onion skin powder may be due to weakening of the protein network by the presence of onion skin. This may allow more solids to be leached out from the noodles into the cooking water (Rayas-Duarte *et al.,* 1996).

These results are in agreement with Ovando-Martinez *et al.,* (2009) who reported that partial or complete substitution of durum wheat semolina with fiber material can result in negative changes to pasta quality, including increased cooking loss. In the same way, our results indicated that, the addition of 6% OSP as natural ingredient reduce cooking time in both types of noodles and increase the volume expansion and water absorption. On other words the addition of OSP improve the quality of the produced noodles and this results were in agreement with the results of Lee *et al.* (2008) who reported that, the addition of alginate is effect on physicochemical, rheological, and noodle properties, and the noodles exhibited an increase in cooked weight, cutting and tensile forces, and yellowness while there was a decrease in cooking loss.

Table 3: Cooking properties of dried and fried noodles supplemented with onion skin powder at different levels.

	Volume expansion (cm3/g)	Water absorption (g/g)	Cooking time (min.)	Cooking loss (%)
Dried noodles				
Control	0.89	1.20	7.13	11.58
Wheat flour +2% OSP	0.91	1.25	6.57	11.58
Wheat flour +4% OSP	0.92	1.33	6.40	11.90
Wheat flour +6% OSP	0.98	1.46	6.41	12.48
Fried noodles				
Control	0.85	1.16	5.23	12.37
Wheat flour +2% OSP	0.89	1.20	5.32	12.69
Wheat flour +4% OSP	0.89	1.28	5.38	13.73
Wheat flour +6% OSP	0.92	1.30	4.59	14.55

OSP = Onion Skin Powder.

Flavonoids compounds of onion skin powder

The present study decided to evaluate the dry onion skin as a functional supplement for noodles as indicated in Table (4).

Results in Table (4) indicated that, the flavonoids compounds of onion skin powder. Pyrogallol is considered the highest amount of flavones. The amount of Benzoic is 464.22 ppm meanwhile, the concentration of cinnamic, Narengin, Querceterrin and Quercetin is 359.36, 358.24, 271.0 and 238.81 ppm, respectively. The obtained results are in good agreement with (Leighton *et al.,* 1992, Wiczkowski *et al.,* 2008 , Gareth *et al.,* 2002 ,Takahama and Hirota, 2000 and Wiczkowski *et al.,* 2003).

Table 4: Flavonoids fractions of onion skin powder (OSP) using HPLC

Flavonoids compounds	(ppm)	Flavonoids compounds	(ppm)
Pyrogallol	673.60	Ellagic	148.51
Gallic	20.43	Coumrin	59.68
Protocatechuic acid	124.09	Cinnamic	359.36
Catechol	35.22	Narengin	358.24
Catechin	53.37	Hisperdin	61.485
Chlorogenic	56.48	Rosmarinic	56.87
P-OH Benzoic	170.27	Rutin	187.24
Epicatechin	135.66	Querceterrin	271
Caffeic acid	24.31	Narenginin	37.378
Vanillic	23.79	Quercetin	238.81
Caffein	42.88	Hispertin	149.53
Ferulic acid	14.89	Kampferol	32.949
Benzoic	464.22	Apignen	0.0002
Salycilic	190.08	7-hydroxyflavon	117.54

OSP = Onion Skin Powder

By comparison with other fruit and vegetables, onion has 300 mg/kg of quercetin, broccoli100 mg/kg, apples 50 mg/kg black currants 40 mg/kg and tea 30 mg/kg (Hollman and Arts, 2000).The concentration of these compounds usually increases in the outer scales.

Total Phenolic Contents, Total Flavonoids and DPPH

Total phenolic contents, total flavonoids and DPPH radical scavenging activity of dried and fried noodles were presented in Table (5). Total phenols and flavonoids were expressed as (mg gallic acid/g dry weight and mg quercetin/g dry weight) respectively, while DPPH was expressed as inhibition percent.

From the data presented in Table (5) it could be noticed that, the onion skin powder is a good source of total phenolic content 882.35, total flavonoids 1875 and had a great free radical scavenging activity (DPPH) 88.47%. Substitution of wheat flour with 2%, 4% and 6% of OSP for making dried and fried noodles resulted in significant increases in total phenolics, flavonoids and DPPH respectively. OSP (6%) substituted dried and fried noodles characterized with the highest values of total phenolic contents 171.76 and 123.18 mg GAE/g DW, total flavonoids, 237.25 and 196.66 mg Que/g DW and DPPH 76.01 and 87.04% respectively compared with control noodle (100% wheat flour).

Our results indicated that total phenolic, total flavonoids and DPPH increased of substituted noodles by increasing of substitution levels. This could be due to onion skin powder contains phenols and flavonoids more than wheat flour, subsequently increase DPPH of substituted noodles formulas. These results in the line of (Gawlik-Dziki *et al.,* 2013) who found that the antioxidant potential of bread with OS was significantly higher than the activity noted in the control. The 2–3% OSP addition caused significant improvement of antioxidant abilities.

Table 5: Total phenol, Total flavoniods and Radical scavenging activity of wheat flour, onion skin, dried and fried noodles supplemented with onion skin at different levels.

	Total phenol (mg GAE*/100g)	Total flavoniods (mg /100g)	Radical scavenging activity (%RSA) DPPH
Wheat flour	47.30	128.75	34.60
Onion skin	882.35	1875	88.47
Dried noodles			
Control	105.90	141.66	48.61
Wheat flour +2% OSP	119.45	173.79	68.47
Wheat flour +4% OSP	141.58	204.54	73.60
Wheat flour +6% OSP	171.76	237.25	76.01
Fried noodles			
Control	93.22	132.96	62.69
Wheat flour +2% OSP	101.86	168.39	74.05
Wheat flour +4% OSP	119.45	181.33	81.39
Wheat flour +6% OSP	123.18	196.66	87.04

OSP = Onion Skin Powder. **GAE= Gallic acid Equivalent*

Many studies have been carried out to find potential sources of bioactive compounds for wheat flour. Based on the fact that onion skin contains significantly higher levels of flavonoids than the edible portion of the vegetable (about 2–10 g/kg) (Leighton *et al.,* 1992).

Sensory evaluation of the tested noodles

In the present study, the sensory evaluation of cooked dried and fried noodles prepared from wheat flour as control and of the noodles prepared from wheat flour containing different levels of OSP are given in Table (6). From data presented in Table (6) it could be observed that supplemented of noodles with OSP led to significant increase the color, texture and overall acceptability at all supplementation levels relative to noodles control. The taste significant increase at all supplemented with onion skin powder. The noodles were accepted until supplementation level 6% (OSP) to wheat flour. These results are in good agreement with that found by (Neelam *et al.,* 2014).

Table 6: Sensory characteristics of dried and fried noodles supplemented with onion skin at different levels of fortification.

	Texture	Color	Taste	Overall acceptability
Dried noodles				
Control	8.6^{abc}	7.8^{ed}	8.2^{c}	24.6^{c}
Wheat flour +2% OSP	8.9^{a}	8.4^{bcd}	8.8^{ab}	26.1^{b}
Wheat flour +4% OSP	8.2^{bc}	7.9^{ed}	7.4^{d}	23.5^{d}
Wheat flour +6% OSP	9.0^{a}	9.4^{a}	9.2^{a}	27.6^{a}
Fried noodles				
Control	8.2^{bc}	7.4^{e}	8.4^{bc}	24.0^{cd}
Wheat flour +2% OSP	8.5^{abc}	8.6^{bc}	8.8^{ab}	25.9^{b}
Wheat flour +4% OSP	8.0^{c}	8.1^{cd}	8.2^{c}	24.3^{cd}
Wheat flour +6% OSP	8.8^{ab}	9.0^{ab}	8.9^{a}	26.7^{ab}

OSP = Onion Skin Powder.
Means within the same columns with the same letters are not significantly ($p<0.05$) different.

This would definitely encourage the utilization of OSP to be incorporated in noodles to improve its color and nutritional value and also to provide decorated food to the consumer. These results are in good agreement with that found by (Neelam *et al.,* 2014).

Conclusion

The current study concluded that onion skin constitutes are valuable supplements for developing the noodles with enhanced the functional properties. In the light of the present data it can be, also, concluded that the 6% OSP supplementation was the optimal for improving the antioxidant potential as well as dietary fiber of noodles. Therefore, consumption of the parts that are discarded as waste as food ingredient will not only prevent environmental pollution but will increase appreciably the amount of nutrients available for body building.

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