COOKING QUALITY, SENSORY EVALUATION AND NUTRITIONAL VALUE OF INSTANT NOODLES FORTIFIED BY SPINACH AND ARTICHOKE

AHMED, HANAN F., HALA S. SAYED AND EMAN M. SALEM

Food Tech. Res. Ins., ARC, Giza, Egypt

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Abstract

Noodles are widely consumed throughout the world and their global consumption is second order to bread. The instant noodles market is growing fast in Egypt, and is gaining popularity in the Egyptian market. Wheat flour which is usually used to make instant noodles is not only low in fiber and protein contents but also poor in phytochemicals as mineral, total phenol, total flavonoids, carotenoids and vitamin C.

In the present study, the used wheat flour was fortified with 2.5 and 5 % spinach and artichoke. The produced noodles were tested to evaluate the physical properties, sensory and nutritional value (such as chemical composition, Fe, Ca, Zn and antioxidant).

The results revealed that no significant effect was observed on cooking quality. The fortified noodles showed improvement in nutritional value. The results showed that significant increase in protein, fiber and ash contents was noticed, compared to control. The results also showed that, the fortified noodles had significant increase in Ca, Fe and Zn contents than control. Also, overall acceptability scores demonstrate higher significant effect of spinach flour addition than artichoke. The results observed that the noodles fortified with 5 % spinach had highest amount of total phenolic, flavonoides, carotenoids and vitamin C content after cooking for 3 min. On the other hand the maximum decrease in antioxidant was observed after cooking for 9 min. Thus, the results suggest that, by incorporation of spinach and artichoke up to 5% in instant noodles, it may be possible to enhance the nutritional value of noodles without affecting its cooking and sensory properties.

INTRODUCTION

Instant noodles are widely consumed throughout the world and it is a fast growing sector of the noodle industry. This is because instant noodles are convenient, easy to cook, low cost and have a relatively long-shelf-life (Owen, 2001).

The World Health Organization (WHO) and Food and Drug Administration (FDA) consider spaghetti pasta a good vehicle for the addition of nutrients. In (1940) spaghetti pasta was one of the first foods which the (FDA) permitted vitamin and iron enrichment (Chillo *et al.*, 2008).

Other authors have studied the effect of the addition of dietary fibres, vitamins and minerals to enhance spaghetti pasta quality (Knuckles *et al.*, 1997). As there is an increasing awareness that health may be modified through diet, it has been a challenge for food scientists in finding more nutritious and healthily substitutes or alternatives to wheat flour for noodle product (Jayasena *et al.*, 2008).

The vegetables has been reported to have a high concentration of antioxidant and components. These leafy vegetables are generally cooked before being consumed. Losses of antioxidant component from vegetable during cooking have been reported by (Hunter and Fletcher, 2002).

Artichoke is not only a tasty food in the Mediterranean diet but also known since ancient times in folk medicine for its choleretic and diuretic effects. The beneficial properties have always been related to the phenolic compounds present in heads and leaves. Overwhelming scientific data, from epidemiological studies, indicate that diets rich in fruits, vegetables and grains are associated with a lower risk of several degenerative diseases, such as cancers and cardiovascular diseases. This association is often attributed to different antioxidant components, such as vitamin C, vitamin E, carotenoids, lycopenes, polyphenols and other phytochemicals (Sara *et al.*, 2010).

The aim of the present study was to investigate the effect of fortifying noodles with spinach and artichoke on cooking quality, sensory properties and nutritional value of the produced noodles.

Materials and Methods

Raw Materials

The commercially available wheat flour extract (72 %), spinach and artichoke, were bought from the local market.

Preparation of samples

Spinach and whole artichoke were cleaned under running tap water and excessive water was drained off. The spinach and artichoke were chopped into small pieces and blanched for 10 min. Blanching was done by simmering the vegetables in boiling water in the ratio of 1 to 5, draining the samples and leaving it to cool at room temperature. The samples were homogenized using a blender then dried in electric oven under vacuum at 40 °C.

Noodles preparation

The wheat flour (72 %extraction) was fortified with 2.5 and 5% spinach and artichoke and the blends were mixed well. The samples were extruded in the form of 1.2 mm diameter noodle standards using a single screw extruder.

The noodle stands were cut into approximately 20 cm lengths and folded into block shapes. Noodles without addition of artichoke and spinach were prepared as a

control sample (Hou and Kruk, 1998). Each of the samples was prepared in triplicate. The noodles were then steamed for 15 min. at 100 °C followed by cooling to 25 °C and deep frying in vegetable oil at 140 – 150 °C for one min. (Owen, 2001). Finally, the noodles were cooled to room temperature and packed in polyethylene bags.

Determination of cooking quality

Tap water (about 1 liter) was brought to a boil in a two liter saucepan with the lid on to prevent any water loss. When the water started boiling, a 100g of noodles were added. The cooking temperature was maintained at 98 – 100 °C through out the cooking process. The cooking period began as soon as the noodles were put into the boiled water and were cooked for 3, 6 and 9 min. The noodles were then removed from the saucepan, 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 100 °C as described by the AACC method (AACC, 2000).

Chemical analysis

The moisture, protein, crude fiber and fat contents were determined by AOAC methods (AOAC, 2000). Carbohydrates were calculated by difference. Folin-Ciocalt reagent was used to determine total polyphenol in the extraction of the samples. Flavonoids and carotenoids were determined by Wettstian's method (Wettstian, 1957). Ascorbic acid was determined according to the methods of (Klein and Perry, 1982).

The minerals, Ca, Fe and Zn were digested by HNo3: $Hclo_4$ 5 : 1 (v/v) Samples were determined by Atomic Absorption Spectrophotometry Perkin Elmer 330 (Kirleis *et al.*, 1984)

Sensory evaluation of cooked noodles

The sensory evaluation was carried out in order to get consumer response for overall acceptability of the 2.5 and 5% artichoke and spinach incorporated instant noodle compared to the traditional noodle. The noodles samples were cooked as described before. Panelists from Food Technology Research Institute, Agricultural Research Center evaluated Texture, Taste, Color, and overall acceptability according to the method of (Jayasena *et al.*, 2008).

The sensory evaluation was carried out in order to get consumer response for overall acceptability of the lupin incorporated instant noodles compared to the traditional noodles. Panelists (20 in number) were given approximately 5 g of each of the 5 samples, 4 sample containing different levels of spinach and artichoke and control sample. Each of the samples was numbered using the random three-digit numbering system. Panelists were asked to indicate their preference on a 9-point Hedonic scale with degree of liking: 1 = dislike extremely, 5 = neither like nor dislike, 9 = like extremely.

Data analysis

The data collected for cooking quality, chemical analysis and sensory evaluation were analyzed using SPSS 15.0 software by applying analysis of variance **(ANOVA)** technique. The means were separated using Duncan's test at $p \leq 0.05$.

RESULTS AND DISCUSSION

Cooking quality of fortified noodles

The cooking quality of pasta and noodles is one of the most important features that encompass the following characteristics: a) the uncooked to cooked weight ratio indicating the water uptake absorption (hydration) during cooking. b) The cooking loss is considered an indicator of the overall cooking performance, as stated by, (Doxastakis *et al.*, 2007).

Table (1) represented effect of time on uncooked to cooked weight ratio. Also, Table (1) showed that, the noodles samples increased weight ratio with increasing time in case of fortification with spinach and artichoke compared with control. The fortification of noodles with spinach and artichoke had no effect on water absorption evidence by a non-significant difference ($p \leq 0.05$) in uncooked to cooked weight ratio. It revealed that water absorption phase was quite constant across the different samples. Fortified noodles sample revealed that water absorption phase was more than control. Good water absorption is a required factor in determining pasta products. Jayasena *et al.* (2008) mentioned that good quality macaroni should absorb at least twice their weight after boiling in water. Similar increase in cooked weight was found in samples containing amaranth and buck wheat spaghetti which gained about 2 to3 times their weight in water when cooked.

Table (2): showed the effect of time on cooking loss however samples containing 5 % spinach and artichoke fortification after 9 min. had high cooking loss (Jayasena *et al.*, 2008). Also, it may be noted that cooking loss increased with increasing time compared with control. This results agrees well with (Jayasena *et al.*, 2008) who stated that cooking loss was not different from control for the samples having up to the 40% replacement of wheat flour with Austratiam sweet lupin flour in noodles. Also, the same author mentioned that the solid leaching during cooking may not have an effect on nutrient quality as instant noodles are mostly eaten along with the boiling water. However, solid leaching from the noodles into the boiling water may affect on the sensory properties and texture of cooked product.

Nutrition Quality

Today, consumers have an increasing concern regarding safety and quality of foods, and as a result, many consumers look for minimally processed foods that preserve the quality of the food during processing. The chemical composition of raw materials showed this in Table (3). The chemical composition of noodles samples are shown in Table (4). From the mentioned data, it is clear that, the fortification of wheat flour with spinach and artichoke in the instant noodle formulation substantially improved its nutritional quality. There was significant increase in protein, ash and fiber contents with increasing fortification level.

Table (4) indicated that instant noodles fortified with spinach were higher in protein and ash contents than artichoke fortification, while fat contents, however were not much affected and demonstrated a non significant increase in samples. Generally, the protein content is believed to play a role in oil absorption in instant noodles. These results agreed with, (Moss *et al.*, 1987) who reported that noodles made from high – protein wheat flour absorbed less oil than that noodles made from low-protein flour .They proposed that the high oil absorption in low –protein flour noodle was due to the formation of coarse globule during steaming , allowing oil to penetrate easily through the noodle. On the other hand (Jayasena *et al.*, 2008) reported that protein content is not the sole factor influencing oil uptake, protein quality also significantly affects free oil absorption in instant noodles.

Table (4) showed also the content of Ca, Fe and Zn (mg/100g) in the fortified noodles compared to control. From the mentioned data it is clear that the highest content Ca was found in noodles with spinach, but the highest contents Fe was observed in noodles fortified with artichoke.

The results also showed that no significant differences ($p \leq 0.05$) in Zn contents for noodles with spinach and artichoke. Generally, and as compared with control, fortification with spinach and artichoke are significant in Ca, Fe and Zn contents. It is obvious that Ca content of spinach fortified noodles is as five fold higher than that of control.

Yadav and Sehgal (2003). Suggested that the cooked leaves like spinach are considered as good source of various nutrients like Ca, Fe and Zn, that should be consumed insufficient amount by various segment of population for possibly improving their health. They also reported that contribution of minerals to human nutrition which is however limited due to the presence of anti-nutritional factor that render some of the nutrients unavailable, especially Ca, Fe and Zn which leads to micronutrient deficiencies.

The effect of cooking on noodles fortified with spinach and artichoke on antioxidant contents are shown in table (5). Data in Table (5) demonstrated that total phenols, Flavonoids, Carotenoids and Vitamin C contents decreased with increasing cooking time. Also, the fortification of noodles with spinach contained higher antioxidant than artichoke. Data showed that noodles with 5 % spinach had the highest amount of phenolic, flavonoids, carotenoids and vitamin C content after cooking for 3 min. On the other hand the highest decrease in antioxidant was noticed after cooking for 9 min.

Roy *et al.*, (2007) reported that cooking samples at 100 °C for 10 or 30 min. decreased phenolic contents below up to 60 % (50 – 60 %) of the value of spinach. However, the vegetables like spinach which contain substantial amount of vitamin C, flavonids and carotenoids, have also been shown to inhibit cancer cell proliferation. There is an apparent increase of total phenolic content as a function of the common bean flour added to the pasta (Gallegos-Infante *et al.*, 2010).

In conclusion, it could be said that regarding noodles fortified with 2.5 % and 5 % spinach and artichoke cooking time 3 to 6 min. which is suitable time while cooking for 9 min. lose most antioxidant.

Sensory Evaluation of cooked noodles

The sensory evaluation results presented in Table (6) revealed that sensory score for color of cooked noodles is improved by incorporation of spinach flour. Color of the samples containing spinach flour was preferred over the control sample that resulted in a significant score increase for spinach containing samples. It means that greenish color due to spinach flour was preferred by the judges as compared with color of the control noodles samples. Overall acceptability scores demonstrate higher significant effect of spinach flour than that of artichoke. However, overall acceptability scores decreased significantly at artichoke flour addition. Addition of 5 % spinach flour rather improved the color of the product.

In conclusion the fortification of noodles with up to 5 % spinach resulted in a functional food product endowed by overall acceptability without any deteriorating effect on its sensory quality.

Table 1. Increasing weight and uncooked to cooked weight (gm) ratio after cooking the fortified noodles with spinach and artichoke.

Treatment	Control	Spinach		Artichoke		LSD
		2.5%	5%	2.5%	5%	
Sample weight (gm)	100	100	100	100	100	
weight ratio after 3 min						
Weight (gm)	314.0	324.7	328.5	263.1	308.5	
percentage	2.14	2.24	2.28	1.63	2.08	0.66
ratio	0.318	0.307	0.304	0.304	0.324	0.03
weight ratio after 6 min						
Weight (gm)	355.5	329.8	326.9	291.0	316.9	
percentage	2.56	2.30	2.27	1.91	2.17	0.67
ratio	0.281	0.303	0.305	0.343	0.315	0.07
weight ratio after 9 min						
Weight (gm)	395.1	392.8	393.0	321.1	353.0	
percentage	2.95	2.92	2.93	2.21	2.53	0.75
ratio	0.253	0.254	0.254	0.311	0.283	0.06

Table 2. Cooking loss of noodles fortification with spinach and artichoke.

Treatment	Control	Spinach		Artichoke		LSD
		2.5%	5%	2.5%	5%	
Sample weight (gm)	100	100	100	100	100	
after 3 min						
Cooking loss %	9.88	10.33	11.84	10.23	10.64	2.00
after 6 min						
Cooking loss %	10.61	11.53	11.75	10.55	10.88	1.55
after 9 min						
Cooking loss %	11.20	13.22	15.51	11.34	13.55	3.50

Table 3. Chemical composition of the used raw material on dry basis.

Raw material / analysis	Flour 72 % ext.	Spinach	Artichoke
Protein %	10.35± 0.25	31.43 ± 0.55	15.66 ± 0.34
Fiber %	0.47 ± 0.15	9.75± 0.5	36.80 ± 1.05
Ash %	0.69 ± 0.25	12.02 ± 0.88	7.50 ± 0.91
Fat %	1.05 ± 0.4	4.21 ± 0.71	1.00 ± 0.2
Carbohydrate %	87.44 ± 3.52	42.59 ± 1.33	39.04 ± 1.59
Ca mg/100g	90.55 ± 7.82	13200 ± 25.55	3026 ± 5.36
Fe mg/100g	1.60 ± 0.61	26.54 ± 0.91	30.53 ± 1.15
Zn mg/100g	0.55 ± 0.24	4.50 ± 0.71	3.90 ± 0.2

Table 4. Chemical composition of the fortified Noodles .

Treatment / Analysis	Control	Spinach		Artichoke		LSD
		2.5%	5%	2.5%	5%	
Protein %	10.12	10.86	11.00	10.42	10.52	0.26
Fiber %	1.97	2.25	2.66	3.40	3.76	0.18
Ash %	1.77	2.00	2.22	1.82	1.92	0.06
Fat %	13.24	13.38	13.51	13.28	13.31	0.28
Carbohydrates %	72.90	71.51	70.61	71.08	70.49	0.40
Zn (mg/100g)	0.65	0.70	0.86	0.741	0.83	0.04
Ca (mg/100g)	95.31	256.75	586.26	129.05	150.61	42.8
Fe (mg/100g)	3.62	6.20	7.65	6.77	8.155	0.45

Table 5. Antioxidants content (mg/g dry weight basis) before and after Noodles cooking.

Treatment / Analysis	Formula fortified with spinach								Formula fortified with artichoke							
	2.5%				5%				2.5%				5%			
	Before cooking	After cooking			Before cooking	After cooking			Before cooking	After cooking			Before cooking	After cooking		
		3min	6min	9min		3min	6min	9min		3min	6min	9min		3min	6min	9min
Total phenol	27.24	22.51	17.32	11.06	55.32	47.25	42.63	35.11	11.75	8.32	5.42	2.58	21.32	18.50	13.23	8.86
Total Flavonoids	4.21	4.02	3.13	1.98	6.62	5.65	3.21	2.05	0.83	0.74	0.51	0.28	1.75	1.20	0.92	0.66
Carotenoids	13.52	11.10	8.32	5.42	23.17	17.32	12.22	8.45	9.54	8.04	6.25	3.22	18.32	17.37	14.22	9.30
Vitamin C	31.4	23.2	11.3	8.4	53.2	47.1	35.2	10.8	19.2	13.50	6.3	2.6	39.2	28.9	18.4	10.1

Table 6. Sensory evaluation after Noodles cooking fortification with spinach and artichoke.

Treatments / Sensory	Control	Spinach		Artichoke		F value
		2.5%	5%	2.5%	5%	
Texture	8.0± 0.13	8.2±0.19	8.0±0.15	7.4±0.20	7.4±0.17	0.62
Taste	8.64±0.15	8.53±0.49	8.5±0.28	8.2±0.33	7.96±0.28	0.56
Color	7.54±0.23	8.2±0.28	8.4±0.43	6.8±0.14	6.2±0.13	0.76
Overall Acceptability	24.18±0.82	24.94±1.09	23.80±0.14	22.55±0.40	21.36±0.45	1.44

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تقيم جودة الطهى والخواص الحسية والقيمة الغذائية للشعرية سريعة التحضير المدعمة بالسبانخ والخرشوف

حنان فوزى أحمد ، هالة سعد سيد ، أيمان محمد سالم

معهد بحوث تكنولوجيا الاغذية – مركز البحوث الزراعية – جيزة

تعتبر الشعرية ثانى استهلاك بعد الخبزو يوجد الآن نمو سريع فى استهلاك الشعرية سريعة التحضير فى الأسواق المصرية ويستخدم عادة الدقيق المعتاد من القمح لعمل الشعرية والفقير فى محتوى الآلياف والبروتين والرماد والمعادن والفينولات والكاروتينات وفيتامين- ج.

اجريت هذة الدراسة بغرض تدعيم دقيق الشعرية المعتاد استخدامة بـ ٢,٥ % و ٥ % من السبانخ والخرشوف ، حيث تم تقيم الصفات الفيزيقية والحسية والقيمة الغذائية (مثل التحليل الكيميائى والبروتين والالياف والحديد والكالسيوم والزنك وأيضا مضادات الآكسدة) ووجد عدم وجود تأثير معنوى فى الصفات الفيزيقية للشعرية المدعمة بالسبانخ والخرشوف.

وقد أظهرت النتائج زيادة معنوية فى محتوى البروتين والالياف والرماد مقارنة بالكنترول. كما أوضحت النتائج وجود زيادة معنوية فى محتوى الكالسيوم والحديد والزنك . ووجد أيضا أعلى قيمة لمحتوى الفينولات الكلية والفلافونويدات والكاروتين وفيتامين ج بعد الطبخ لمدة ٣ دقائق للشعرية المدعمة بالسبانخ أكثر من الخرشوف. وأظهرت النتائج للشعرية المدعمة بالسبانخ انها حازت قبول أكثر فى التقيم الحسى عن المدعمة بالخرشوف أوالكنترول. وبناءا على هذة النتائج يمكن الحصول على قيمة غذائية اعلى عند تدعيم الشعرية سريعة التحضير بنسبة ٥ % من السبانخ او الخرشوف بدون تاثير على الصفات الفيزيقية .