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SUPPLEMENTATION OF INSTANT NOODLES BY COLLAGEN HYDROLYSATE AS A FUNCTIONAL FOOD

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ABSTRACT

Collagen is responsible for the elasticity and freshness of the skin giving it the necessary softness and wrinkles fighting and preventing the early appearance of its marks on the skin. It also prevents the occurrence of arthritis and bone pain and strengthens muscles. The progress in age causes low natural collagen production by the body. Therefore it is useful to compensate this decrease from another sources, preferably a natural source. In this study, instant noodles were produced from hard wheat or corn flour containing collagen hydrolysate extracted from chicken feet as a functional food by three levels of pH (4.0, 6.5 and 9.0). The best protein content of collagen hydrolysate was obtained from treatment by pH 4.0, thus this treatment was used in supplementation of instant noodles at levels of 10, 20 and 30%. Chemical composition , amino acids content, sensory evaluation, shear force and cooking quality of instant noodle blends were improved. The blends of instant noodles supplemented with collagen hydrolysate had a high protein content which ranged from 20.13 to 34.95 % for hard wheat blends and from 25.54 to 33.30 % for yellow corn blends. Regarding amino acids content, chicken feet collagen had the highest value of threonine, alanine, glycine, proline, hydroxylysine and hydroxyproline compared to hard wheat and yellow corn flour. Regarding the percentages of the recommended dietary allowances (RDA %) provided from 100g of different instant noodles for age of 31 -50 years old, the results showed that all values of RDA % for protein was high in instant noodles produced from hard wheat flour which ranged from 35.95 to 62.41 % for males and ranged from 43.76 to 75.98% for females compared to the control sample which showed RDA % value of 22.61 and 27.52% for males and females, respectively. Also, the results showed that all values of RDA % for protein was high in instant noodles produced from yellow corn flour which ranged from 32.02 to 59.46% for males and ranged from 38.98 to 72.39% for females compared to the control sample which showed RDA % value of 18.43 and 22.43 % for males and females, respectively. The results showed that the product of yellow corn flour instant noodles can be used as a functional food for patients suffering from celiac disease.

***Key words**: instant noodles, chicken feet, collagen hydrolysate, amino acids and celiac disease.*

1. INTRODUCTION

Instant noodles gain popularity due to their ready-to-eat convenience, cost competitiveness, availability of various products with different taste and texture, beneficial nutrition, and long shelf life. Globally, the consumption of wheat instant noodles is second to bread (Shin and Kim, 2003). With nearly 40% of wheat being processed into instant noodles in Asia (Hou, 2001). Recently, the consumption of instant noodles has been increasing in the fastest pace in cereal foods (Choy *et al.*, 2010).

Chicken feet contain a large amount of protein, essential minerals and collagen which is the major component of protein (Polian, 2012). Chicken feet utilization can be further enhanced by processing it into useful products like ready-to-use chicken soup mixes, gelatin (Taha *et al.*, 2015 and Jayathilakan *et al.*, 2010)). Chicken feet collagen is extracted for various applications in food and pharmaceutical industries using acidic, alkaline, thermal and enzymatic hydrolysis methods (Wei *et al.*, 2013 and Delgado *et al*., 2017)). Study of the isolation and characteristic of collagen from chicken feet can increase the value-added potential of this byproduct and its utilization in medical, cosmetic as well as in food application (Hashim *et al.*, 2014). The collagen protein substance is naturally occurring in the human body, but the

problem occurs with age progress, the body's ability to produce collagen, which leads to changes in flexibility and increases in the inflammatory pain and arthritis, so it is recommended to take collagen from another sources. The most popular and used is the gelatin of mammals (pigs and cattle) that are subjected to greater restrictions and skepticism among consumers, by socio-cultural and health concerns (Karim and Bhat, 2009). Collagen hydrolysate (CH) has long been used in pharmaceuticals and foods in many countries and regions, such as United States, Europe, China and Japan. Approved as Generally Recognized As Safe (GRAS), the safety of CH has been affirmed by the Food and Drug Administration (FDA) Center for Food Safety and Nutrition. The bioavailability and absorption of CH have also been widely studied. It has been reported that CH is more easily absorbed and has higher bioavailability than gelatin (Oesser *et al.*, 1999 and Song *et al.*, 2017). Ohara *et al.*, (2010), Hatanaka *et al.*, 2014 and Hongdong and Bo, 2017) reported that Collagen hydrolysate (CH) has many beneficial effects include antioxidant, anti aging, anti osteoporotic , anti osteoarthritis, anti-inflammatory, anti tumor, anti hypertensive, anti atherosclerotic, anti obesity and hypoglycemic effects.

The development of new food products has been explored, through the discovery of new sources of food or the reuse of by-products or wastes. For this, nutritional and sensory aspects should be taken into account, so they could supply some vitamin or minerals without rejecting the product by the consumers. In this context, there are the so-called functional foods (Rodrigues *et al*., 2011).

Celiac disease is a chronic disease of the gastrointestinal system, in which characteristics atrophy of the small intestinal mucosa occurs in genetically predisposed people in response to the presence of gluten in food. It is a continuous intolerance of gluten, gliadin and responsive prolamins that are present in wheat, rye and barley (Amin *et al.*, 2002). Functional food is food similar in appearance to conventional food, which is consumed as a part of the usual diet and has demonstrated physiological benefit and/or reduces the risk of chronic disease beyond basic nutritional functions (Mohamed *et al.*, 2004).

Chicken feet can be used as an alternative source of collagen for the development of new products. In this sense, the aim of this study was the production of noodles using hard wheat flour or yellow corn flour supplemented with collagen hydrolysate extracted from chicken feet for fortification of noodles by protein and calcium, also to produce free gluten noodles by using yellow corn flour as a functional food.

2. MATERIALS AND METHODS

2.1.Materials

Hard wheat flour (72% ext.) was obtained from South Cairo Mills Company, Giza, Egypt.

Yellow corn flour was obtained from Food Technology Research Institute, Agricultural Research Center, Giza, Egypt.

Chicken feet were obtained from the local market at Giza, Egypt. Immediately after slaughtering, the samples were transported using an ice box to the laboratory of Meat and Fish Technology, Food Technology Research Institute Salt was obtained from local market of Giza, Egypt.

2.2. Methods

2.2.1. Preparation of chicken feet collagen hydrolysate

1- Chicken feet were cleaned, washed thoroughly and soaked in boiling water for 3 minutes and the surface yellow membranes on the feet were peeled according to the method of Yang *et al*. (2009) with some modifications by Wei *et al.* (2013). Chicken feet were immersed in a mixture of 0.25 mol/l NaOH and 1% hydrogen peroxide (v/v) by ratio of 1:7 (w/v) and held at room temperature for 40 minutes. The chicken feet samples were drained, and squeezed by hand. The alkali pre-treated chicken feet samples were then washed under running tap water for 40 min and drained, and subsequently soaked in 0.2% sulphuric acid (1:7, w/v) for 40 minutes. The liquid was drained and the samples were flushed with tap water. Finally, the chicken feet samples were soaked in 0.3 mol/L acetic acid (1:7, w/v) for 40 min and flushed with tap water to remove the remaining acid. The chicken feet samples were then drained and weighed.

2–The chicken feet were cooked at three deferent degrees of pH (4.0, 6.5 and 9.0) under pressure in an autoclave at 121°C for 3 hours.

3–Cooked chicken feet were separated and the remained liquid was concentrated

4 –The bones were removed from cooked mass to obtain the deboned feet meat

5 –The deboned meat of chicken feet was minced and added to the concentrated liquid.

The mixture was blended to obtain slurry.

6 – The obtained ground slurry was dried at 50 °C for 24 hour

7– The chicken feet collagen hydrolysate was grinded and dried, then the product was stored at –20°C until use .

The yield (%) was calculated as (dried collagen hydrolysate (g)/ Chicken feet (g)) × 100, according to the method described by Wei *et al.* (2013).

2.2.2. Preparation of instant noodles

Instant noodles was prepared in laboratory using hard wheat flour 72% ext. or yellow corn flour with different levels of chicken feet collagen hydrolysate (10, 20 and 30%) according to the method described by Park *et al.* (2004).

The formulas are shown in Table (1). One kilogram of each dough blends of the tested combinations of raw materials was mixed with the required amount of water. After the complete addition of water, mixing was continued for 8 min. The premixed dough was placed in the vacuum mixer of the Demaco molder (Demaco, De francis machine corporation Germany) under condition of 21 rpm, 25 °C. An extension tube was added to ensure uniform hydration of the instant noodles dough prior to extrusion. The instant noodles was steamed for 3 to 4 min.

2.2.4. Minerals analysis

Calcium (Ca) magnesium (Mg) and iron (Fe), were determined using a Pye Unicom SP 19000 atomic absorption spectroscopy technology as described by A.O.A.C. (2005).

Determination of total amino acids was carried out as described in the A.O.A.C. (2005).

Tryptophan was analyzed in triplicate by HPLC, according to the method of Slump *et al.* (1991).

Total volatile nitrogen (TVN) was determined according to the method published by Winton and Winton (1958).

The pH value was determined according to Aitken *et al*. (1962).

Thiobarbituric acid (TBA) value was determined as described by Egan *et al.* (1981).

Water activity value of the dried samples mixtures was measured using Rotronic Hygrolab 3CH-8303, Switzerland as mentioned by Cadden (1988).

Rehydration ratio was performed according to the methods of Krokida and Marinos-Kouris (2003).

2.2.5. Cooking quality of instant noodles

Weight increase % and volume increase % of instant noodles were determined according to the method described by Dexter *et al.* (1990) by cooking 25 g of each sample in one litter of boiling water for 5 min., the samples were washed and allowed to drain for 2 min.

Weight increase% = [(Weight of cooked sample- weight of uncooked sample) / (weight of uncooked sample)] X100.

Volume increase % = [(volume of cooked sample-volume of uncooked sample) / (volume of uncooked sample)] X100.

Total soluble solids of cooking liquid were determined as cooking loss% according to the

Table (1): Formula of instant noodles blends.

Ingredients	**Instant noodles(g)**				
	Control 1	**Blend 1**	**Blend 2**	**Blend 3**	**Blend 4**
Hard wheat flour (HWF)	1000	900	800	700	600
Chicken feet collagen hydrolysate (CFCH)	-	100	200	300	400
	Control 2	**Blend 5**	**Blend 6**	**Blend 7**	**Blend 8**
Yellow corn flour(YCF)	1000	900	800	700	600
Chicken feet collagen hydrolysate (CFCH)	-	100	200	300	400
Salt (gm)	All 10				
Water (ml)	330-360				

Control (1) =100% HWF
Control (2) =100% YCF.
Blend (1) = 90% HWF + 10% CFCH.
Blend (2) = 80% HWF +20% CFCH
Blend (3) = 70% HWF + 30% CFCH
Blend (4) = 60% HWF + 40% CFCH
Blend (5) = 90% YCF +10% CFCH
Blend (6) = 80% YCF + 20% CFCH
Blend (7) = 70% YCF + 30% CFCH.
Blend (8) = 60% YCF + 40% CFCH.

2.2.3.Chemical analysis

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

Total calories was calculated according to FAO/ WHO (1973) as follows:

E = 4X (nitrogen free extract %+ protein %) + 9X (fat %) Where: E = Energy as kcal per 100gm.

method of Walash and Cilles (1971). The residue weight was calculated as a percentage based on the uncooked product weight as follows:

Cooking loss% = (weight of residues in cooking water/weight of uncooked sample) X100.

2.2.6. Sensory evaluation of instant noodles

The cooked instant noodles were evaluated for their sensory characteristics by ten panelists from the staff of bread and pastry, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt, according to the method of Abd El-Salam (2005).

2.2.7. Statistical analysis:

Statistically analyzed using analysis of variance and least significant differences (L.S.D) according to method of Snedecor and Cochran (1980).

3. RESULTS AND DISCUSSION

3.1. Effect of different pH degrees on the chemical composition of extracted collagen hydrolysate:

Collagen hydrolysate was extracted from chicken feet using cooking at three deferent degrees of pH (4.0, 6.5 and 9.0) in an autoclave at 121°C for 3 hours and the chemical composition of the tested samples is shown in Table (2).

The obtained results pointed that significant differences were found between all treatments (pH 4.0, 6.5 and 9.0) for moisture ,protein and ash contents, while no-significant differences were observed for content of lipid and minerals (calcium, magnesium and iron), where extracted collagen hydrolysate at pH 4.0 showed the highest content of protein and the lowest content for moisture, ash, lipid and minerals except iron content when compared with extracted collagen hydrolysate at pH 6.5 and 9.0. These results agree with earlier studies by Wei *et al.,* (2013) and Yang *et al.,* (2009). They found that extracted collagen hydrolysate from Tilapia skin fish at pH 4.0 showed higher content of protein than at pH 6.5 and 9.0.

3.2. Effect of different pH degrees on amino acid contents of collagen hydrolysate

The effect of different pH degrees on amino acid contents of collagen hydrolysate was studied and the obtained results are shown in Table (3).

The results presented in Table (3), indicated that the collagen hydrolysate produced at pH degree of 4.0 was high in proline and hydroxyproline contents, which known to be very important for producing glucosamine in the human body in the presence of ascorbic acid (Morimura *et al.,* 2002). On the other hand, the same results showed that values of hydroxyproline, proline, glycine, aspartic, serine, valine, lysine, hydroxylysine, arginine, and methionine contents were higher at pH 4.0 compared with pH 6.5 and 9.0. This may be due to acid condition of pH 4.0 which influenced positively on the hydrolyzation degree (Morimura *et al.,* 2002).

3.3. Effect of different pH degrees on chemical quality attributes of collagen hydrolysate

The effect of different pH degrees on chemical quality attributes of collagen hydrolysate was studied and the obtained results are shown in Table (4).

The presented data in Table (4) showed that the collagen hydrolysate produced at pH 4.0 contained significantly the highest level of TVN (8.75 mg/100mg) followed by the collagen hydrolysate produced at pH 9.0 and 6.5 which scored 6.80 and 4.35 mg/100mg, respectively. This may be due to protein content was higher in the hydrolysed collagen produced at pH 4.0 compared with the hydrolysed collagen produced at pH 9.0 and 6.5, respectively, as previously indicated in Table (2), and may be due also to the direct relationship between protein content and TVN, during drying period, since microbial and enzyme activities led to disintegration of protein components, so with increasing protein content in sample the level of TVN increased (Sanchez- Alouso *et al*., 2008).

From the same Table (4), the data showed also that there was no-significant difference of TBA for collagen hydrolysate produced at deferent degree of pH (4.0, 6.5 and 9.0), although TBA level was the highest in collagen hydrolysate produced at pH 9.0 followed by pH 6.4 and 4.0, respectively.

The data in Table (4) showed also that the collagen hydrolysate produced at pH 4.0 recorded the highest value of pH followed by the collagen hydrolysate produced at pH 9.0 and 6.5. These results confirmed the higher TVN content of the collagen hydrolysate produced at pH 4.0 than the collagen hydrolysate produced at pH 9.0 and 6.5 as there is a direct relationship between TVN content and pH value (Sanchez-Alouso *et al*., 2008).

Table (2): Effect of different pH degrees on the chemical composition of extracted collagen hydrolysate from chicken feet (on dry weight basis).

Component	Different degree of pH			LSD
	PH 4.00	pH 6.50	pH 9.00	
Moisture (%)	$7.13^{c}\pm0.9$	$8.19^{a}\pm0.85$	$7.97^{b}\pm0.95$	1.280
Protien (%)	$86.96^{a}\pm1.12$	$83.20^{c}\pm1.06$	$84.40^{b}\pm0.98$	1.416
Lipd (%)	$0.93^{a}\pm0.20$	$1.39^{a}\pm0.20$	$1.24^{a}\pm0.10$	0.137
Ash (%)	$5.08^{c}\pm0.53$	$7.23^{a}\pm0.65$	$6.12^{b}\pm0.81$	0.913
Calcium (Ca)(mg/100g)	$88.00^{a}\pm0.95$	$91.30^{a}\pm1.13$	$90.80^{a}\pm0.90$	0.365
Magnesium(Mg)(mg/100g)	$5.0^{a}\pm0.01$	$5.13^{a}\pm0.01$	$5.09^{a}\pm0.02$	0.038
Iron (Fe)(mg/100g)	$0.91^{a}\pm0.05$	$0.89^{a}\pm0.02$	$0.90^{a}\pm0.03$	0.008

Means in the same row with different letter are significantly different ($P \leq 0.05$).

Table (3): Effect of pH degrees on amino acids contents of collagen hydrolysate extraction.

Amino acids gm/100g	Different degree of pH		
	PH 4.00	pH 6.50	pH 9.00
Hydroxyproline	76.35	54.78	48.91
Aspartic	58.11	53.56	45.63
Therionine	53.02	55.21	57.03
Serine	26.31	22.31	18.92
Glutamic	91.20	95.14	98.05
Glycine	311.90	306.23	295.43
Alanine	141.21	168.11	185.90
Valine	19.30	18.73	18.25
Isoleucine	10.33	11.12	11.95
Leucine	20.84	26.24	35.91
Tyrosine	1.16	1.47	1.86
Phenyl alanine	12.16	15.21	18.93
Histidine	9.71	10.36	13.10
Lysine	28.30	26.71	25.83
Arginine	5.36	5.25	5.11
Proline	118.16	113.38	104.30
Hydroxylysine	5.45	5.32	5.20
Methionine	11.13	10.87	9.69

Table (4): Effect of different pH degrees on the chemical quality attributes of the extracted collagen hydrolysate from chicken feet.

Item	Different degree of pH			LSD
	PH 4.00	pH 6.50	pH 9.00	
TVN (mg/100mg)	$8.75^{a}\pm0.35$	$4.35^{c}\pm0.20$	$6.80^{b}\pm0.50$	1.301
TBA (mg malonaldehyde/kg)	$0.196^{a}\pm0.03$	$0.217^{a}\pm0.06$	$0.250^{a}\pm0.07$	0.318
pH	$6.63^{a}\pm0.13$	$6.31^{c}\pm0.16$	$6.54^{b}\pm0.11$	0.073

Means in the same row with different letter are significantly different ($P \leq 0.05$).
TVN= Total volatile nitrogen. TBA=Thiobarbituric acid.

3.4. Effect of different pH degrees on yield, rehydration ratio and water activity of collagen hydrolysate

The effect of different pH degrees on yield, rehydration ratio and water activity of collagen hydrolysate was studied and the obtained results are shown in Table (5).

The obtained results in Table (5) indicated that no-significant differences were noticed for yield of collagen hydrolysate produced at different degrees of pH (4.0, 6.5 and 9.0). However, the highest value of yield was produced at pH 9.0 followed by that produced at pH 4.0 then that produced at pH 6.5, respectively. These results agreed with these of Wei *et al.* (2013), who found that yield of extracted collagen hydrolysate from tilapia skin fish at pH 4.0, pH 6.5 and 9.0 was 13, 11 and 14%, respectively.

Rehydration ratio is very important to a dried product and is an indicator of quality criterion in most dried foods. It is an indicator of cellular and structural disintegration that occurs during dehydration. The rehydration rate are important characteristics of many products, related to their later preparation for consumption (Jokić *et al*., 2009). The obtained results pointed that the collagen hydrolysate produced at pH 4.0 had the highest value of rehydration ratio when compared with the collagen hydrolysate produced at pH 9.0 and 6.5. This may be due to the collagen hydrolysate produced at pH 4.0 had the highest content of protein and the lowest content of moisture compared with the collagen hydrolysate produced at pH 9.0 and 6.5 (Table 2).

It is known that water affect the activity of the enzymes and microorganisms. The water activity required for growth of most bacteria, fungi and yeasts ranged from 0.61 to 0.97 (Anthony and Fontana, 2008). So, water activity is consided one of the most important tests for dried foods due to its relation to it's shelf life. The results presented in Table (5) showed that water activity values of the collagen hydrolysate produced at different degrees of pH (4.0, 6.5 and 9.0). These results indicated the water activity values of the collagen hydrolysate produced at pH degrees of 4.0, 6.5 and 9.0 were 0.421,0.438 and 0.429, respectevily, it is clear that different treatments of dried collagen hydrolysate is sufficient to minimize microbial growth.

3.5. Chemical compositions of the raw materials

The chemical compositions of raw materials under investigation are presented in Table (6). It could be noticed that the hard wheat flour (72% ext.) and yellow corn flour contained the highest value of nitrogen free extract (84.07 and 83.99% respectively). However ash contents were 1.70 and 1.59 %, respectively, crude fiber contents were 0.7 and 1.0%, respectively and fat contents were 0.87 and 3.11% , respectively. Meanwhile, the chicken feet collagen hydrolysate contained the highest values of protein (86.96%) but had the lowest value of nitrogen free extract (7.03%), moreover, chicken feet collagen hydrolysate contained , 0.93%fat and 5.08% ash. These results confirmed those obtained by Hashim *et al.*, (2014).

The minerals content of hard wheat flour (72% ext.), yellow corn flour and chicken feet collagen hydrolysate are shown in Table (6). Calcium contents were found to be 30.10,21.10 and 88.00 mg/100 gm, magnesium contents were 159.22, 98.71 and 5.00mg/100gm and iron contents were 2.05, 4.65 and 0.91 mg/100 gm for hard wheat flour (72% ext.), yellow corn flour and chicken feet collagen hydrolysate, respectively.

3.6. Sensory evaluation of the produced instant noodles

From the presented results in Tables (7) it could be noticed that the sensory characteristics values were decreased with increasing the level of chicken feet collagen hydrolysate supplementation. Also, it could be noticed that instant noodles produced from hard wheat flour or yellow corn flour supplemented with chicken feet collagen hydrolysate until level 30%, still have good overall acceptability. Moreover, data revealed that no significant differences were found between 10 and 20% levels of chicken feet collagen hydrolysate, which were 90.00 and 89.00% for blends 1, 2 , respectively, and 93.00 and 91.67% for blends 5, 6, respectively. So, supplementation levels of 10, 20 and 30% were selected to study their chemical composition, amino acids and cooking quality parameters.

3.7. Amino acids content of the raw materials and instant noodles

Amino acids of raw materials are presented in Table (8A). The results showed that hard wheat flour contained the highest value of isoleucine,

lysine, methionine, valine, tryptophan, cystine, arginine and aspartic compared with yellow corn flour and chicken feet collagen hydrolysate. These results agreed with those reported by Abd El-salam *et al.* (2017). However, yellow corn flour had the highest value of leucine, phenylalanine, glutamic, serine and tyrosine compared to other raw materials while, chicken feet collagen hydrolysate contained the highest value of threonine, alanine, glysine and proline compared with other raw materials. These results agree with those reported by lim *et al.* (2013). On the other hand chicken feet collagen hydrolysate had only hydroxylysine and hydroxyproline due to the thermal treatment through cooking of chicken feet (Morimura *et al.*, 2002).

Table (5): Effect of different pH degree on yield, rehydration ratio and water activity of extracted collagen hydrolysate from chicken feet.

Item	Different degree of pH			LSD
	PH 4.00	pH 6.50	pH 9.00	
Yield (%)	13.85a±1.13	12.30a±1.0	14.20a±1.20	1.932
Rehydration ratio	4.81a±0.25	4.58c±0.10	4.68b±0.15	0.087
Water activity	0.421c±0.01	0.438a±0.01	0.429b±0.01	0.006

Means in the same row with different letter are significantly different ($P \leq 0.05$).

Table (6): Chemical composition of raw materials (on dry weight basis).

Component	Hard wheat flour(72%ext.)	Yellow corn flour	Chicken feet collagen hydrolysate
Moisture(%)	9.11	12.64	7.13
Protein (%)	12.66	10.31	86.96
Ash (%)	1.70	1.59	5.08
Crude Fiber (%)	0.70	1.00	----
Crude fat (%)	0.87	3.11	0.93
Nitrogin free extract (%)	84.07	83.99	7.03
Calcium(Ca) (mg/100g)	30.10	21.10	88.00
Magnesium (Mg)(mg/100g)	159.22	98.71	5.00
Iron (Fe)(mg/100g)	2.05	4.65	0.91

Table (7): Sensory evaluation of instant hard wheat flour and yellow corn flour noodles supplemented with chicken feet collagen hydrolysate.

Sample	Appearance (20)	Colour (20)	Tenderness (20)	Flavour (20)	Stickiness (20)	Overall acceptability(100)	Acceptance
	Hard wheat flour instant noodles						
Control	18.00 ^{a}	19.00 ^{a}	15.00 ^{b}	15.00 ^{b}	16.00 ^{b}	83.00 ^{c}	G
Blend (1)	19.00^{a}	19.00 ^{a}	18.00 ^{a}	17.00 $^{a\,b}$	17.00 ^{ab}	90.00 ^{a}	V
Blend (2)	18.00^{a}	18.00 ^{a}	17.00 ^{ab}	18.00 ^{a}	18.00 ^{a}	89.00 ^{ab}	V
Blend (3)	16.00^{b}	16.00 ^{b}	17.00 $^{a\,b}$	18.00 ^{a}	18.00 ^{a}	85.00 ^{bc}	G
Blend (4)	13.00^{c}	13.00 ^{c}	14.00 ^{b}	13.00 ^{c}	16.00 ^{b}	69.67 ^{d}	Un s
LSD 0.5	1.82	1.82	2.30	2.20	1.63	4.41	------
Yellow corn flour instant noodles							
Control 2	17.00 ^{ab}	17.33 ^{a}	16.67 ^{b}	17.33 ^{bc}	18.00 ^{b}	83.00 ^{b}	G
Blend (5)	18.67 ^{a}	17.67 ^{a}	18.67 ^{a}	18.67 ^{a}	19.33 ^{ab}	93.00 ^{a}	V
Blend (6)	17.00 ^{ab}	16.67 ^{a}	18.67^{a}	18.33 ^{ab}	19.67 ^{a}	91.67 ^{a}	V
Blend (7)	16.00 ^{b}	14.67 ^{b}	16.33 ^{b}	16.67 ^{c}	19.33 ^{ab}	84.00 ^{b}	G
Blend (8)	13.00 ^{c}	12.33 ^{c}	12.33 ^{c}	12.67 ^{d}	14.00 ^{c}	64.33 ^{c}	Un s
LSD 0.5	1.96	1.33	1.56	1.33	1.57	4.84	-----

Means in the same column with different letter or letters for wheat or yellow corn noodles are significantly different ($P \leq 0.05$).
90-100 Very Good (V). 80-89 Good (G). 70-79 Satisfactory (S). Less Than 70 Unsatisfactory (Un s).

Control(1) =100% HWF **Control (2)**=100% YCF. **Blend(1)**= 90% HWF + 10% CFCH.
Blend(2) = 80% HWF +20% CFCH **Blend(3)** = 70% HWF + 30% CFCH
Blend(4) = 60% HWF + 40% CFCH **Blend(5)** = 90% YCF +10% CFCH
Blend(6) = 80% YCF + 20% CFCH **Blend(7)** = 70% YCF + 30% CFCH.
Blend(8) = 60% YCF + 40% CFCH.

Table (8A): Amino acids content of hard wheat flour (72%ext.), yellow corn flour and chicken feet collagen hydrolysate (gm / 100 gm protein).

Amino acids	Hard wheat flour (72%ext.)	Yellow corn flour	chicken feet collagen hydrolysate
Isoleucine	6.48	4.45	1.03
Leucine	8.52	11.78	2. 08
Lysine	7.10	2.82	2. 83
Methionine	2.20	1.87	1. 11
Phenylalanine	4.20	4.52	1. 22
Threonine	4.72	3.90	5. 31
Valine	6.09	5.00	1. 93
Tryptophan	1.20	0.68	ND
Cystine	1.90	1.28	ND
Alanine	7.19	6.96	14. 12
Arginine	7.30	5.25	0. 54
Aspartic	11.03	6.41	5. 81
Glutamic	13.00	18.50	9. 12
Glycine	5.11	3.32	31. 19
Histidine	2.58	2.97	0. 97
Proline	3.95	9.60	11.82
Serine	4.14	4.65	2. 63
Tyrosin	3.29	6.04	0. 13
Hydroxylysine	ND	ND	0. 55
Hydroxyproline	ND	ND	7. 61

Results in Table (8B) showed amino acid contents for blends of instant noodles produced from hard wheat and yellow corn flour supplemented with chicken feet collagen hydrolysate. From these results, it could be noticed that hard wheat flour instant noodles or yellow corn flour instant noodles with 30% of chicken feet collagen hydrolysate showed the highest value of threonine, alanine, glysine, proline, hydroxylysine and hydroxyproline compared to other blends.

3.8. Chemical composition of the produced instant noodles

The data in Table (9) showed the chemical composition of the produced instant noodles from hard wheat or yellow corn flour supplemented with chicken feet collagen hydrolysate. All blends showed high values of protein and ash and low value of crude fiber and nitrogen free extract compared with the control sample (instant noodles without chicken feet collagen hydrolysate). All blends of hard wheat flour instant noodles contained protein varied from 20.13 to 34.95%, ash from 1.94 to 2.72 %, crude fiber from 0.64 to 0.51 %, crude fat from 0.87 to 0.89% and available nitrogen free extract from 76.42 to 60.93 % while the control sample contained 12.66 % protein, 1.70% ash, 0.70 % crude fiber, 0.87 % crude fat and 84.07% nitrogen free extract Also yellow corn flour instant noodles with chicken feet collagen hydrolysate contained protein varied from 25.54 to 33.30 %, ash varied from 2.27 to 2.63 %, crude fiber varied from 0.80 to 0.70 % and fat varied from 2.76 to 2.46% and nitrogen free extract varied from 68.72 to 60.91 % while the control sample contained 12.66 % protein, 1.70 % ash, 0.70 % crude fiber, 0.87 % fat and 84.07 %.nitrogen free extract. These results are in agreement with those found by Gomez-Guillen *et al*., (2011).

The data presented in the same Table showed also the mineral contents of instant noodles of all blends which contained chicken feet collagen hydrolysate. Such blends showed high values for calcium content, compared to the control sample. Hence, instant noodles blends containing chicken feet collagen hydrolysate are favorable because of their high content of important mineral which depend upon the substitution levels by the chicken feet collagen hydrolysate.

3.9. Cooking quality of the produced instant noodles

The cooking quality of instant noodles produced from hard wheat flour or corn flour supplemented with 10, 20 and 30 % of natural collagen hydrolysate extracted from chicken feet were evaluated and the obtained data are presented in Table (10). The cooked weight gain% and cooked volume gain% of instant noodles of all blends were higher than the control sample and the highest gain for weight and volume was noticed with supplementation

Table (8B): Amino acids content of hard wheat flour and yellow corn flour instant noodles supplemented with chicken feet collagen hydrolysate. (gm / 100 gm protein).

Amino acids	hard wheat flour Instant noodles supplemented with chicken feet collagen hydrolysate.			yellow corn flour Instant noodles supplemented with chicken feet collagen hydrolysate		
	Blend(1)	Blend(2)	Blend(3)	Blend(4)	Blend (5)	Blend (6)
Isoleucine	5.94	5.39	4.85	4.11	3.77	3.42
Leucine	7.88	7.23	6.59	10.81	9.84	8.87
Lysine	6.67	6.25	5.82	2.82	2.82	2.82
Methionine	2.09	1.98	1.87	1.79	1.72	1.64
Phenylalanine	3.90	3.60	3.27	4.19	3.86	3.53
Threonine	4.78	4.84	4.90	4.04	4.18	4.32
Valine	5.67	5.26	4.84	4.69	4.39	4.08
Tryptophan	1.08	0.96	0.84	061	0.54	0.48
Cystine	1.71	1.52	1.33	1.15	1.02	0.90
Alanine	7.88	8.58	9.27	7.68	8.39	9.11
Arginine	6.62	5.95	5.27	4.78	4.31	3.84
Aspartic	10.51	9.98	9.46	6.35	6.29	6.23
Glutamic	12.61	12.22	11.84	17.56	16.63	15.69
Glycine	7.72	10.33	12.93	6.11	8.89	11.68
Histidine	2.42	2.26	2.10	2.77	2.57	2.37
Proline	4.74	5.52	6.31	9.82	10.04	10.27
Serine	3.99	3.84	3.69	4.47	4.25	4.04
Tyrosin	2.97	2.66	2.34	5.45	4.86	4.27
Hydroxylysine	0.06	0.11	0.17	0.06	0.11	0.17
Hydroxyproline	0.76	1.52	2.28	0.76	1.52	2.28

Blend(1)= 90% HWF + 10% CFCH. **Blend(2)** = 80% HWF +20% CFCH
Blend(3) = 70% HWF + 30% CFCH **Blend(4)** = 90% YCF +10% CFCH
Blend(5) = 80% YCF +20% CFCH **Blend(6)** = 70% YCF + 30% CFCH

Table (9): Chemical composition of hard wheat flour and yellow corn flour instant noodles supplemented with chicken feet collagen hydrolysate. (on dry weight basis).

Sample	Protein %	Ash %	Crude fiber%	Crude fat%	Nitrogen free extract%	Calories %	Calcium(mg/100g)	Magnesium (mg/100g)	Iron(mg/100g)
	Hard wheat flour instant noodles								
Control 1	12.66^{d}	1.70^{d}	0.70^{a}	0.87^{a}	84.07^{a}	394.75^{a}	30.10^{d}	159.22^{a}	2.05^{a}
Blend 1	20.13^{c}	1.94^{c}	0.64^{ab}	0.87^{a}	76.42^{b}	394.03^{b}	35.89^{c}	143.80^{b}	1.94^{b}
Blend 2	27.52^{b}	2.39^{b}	0.56^{bc}	0.88^{a}	68.65^{c}	392.60^{c}	41.68^{b}	128.38^{c}	1.82^{c}
Blend 3	34.95^{a}	2.72^{a}	0.51^{c}	0.89^{a}	60.93^{d}	391.53^{d}	47.47^{a}	112.95^{d}	1.71^{c}
LSD	0.19	0.15	0.10	0.11	0.52	0.58	0.47	1.24	0.07
	Yellow corn flour instant noodles								
Control 2	10.32^{d}	1.59^{d}	1.03^{a}	3.11^{a}	83.95^{a}	405.07^{a}	21.10^{d}	98.71^{a}	4.65^{a}
Blend 4	17.93^{c}	1.94^{c}	0.91^{ab}	2.89^{b}	76.33^{b}	403.05^{b}	27.79^{c}	89.34^{b}	4.28^{a}
Blend 5	25.54^{b}	2.27^{b}	0.80^{bc}	2.67^{c}	68.72^{c}	401.07^{c}	34.48^{b}	79.97^{c}	3.90^{b}
Blend 6	33.30^{a}	2.63^{a}	0.70^{c}	2.46^{d}	60.91^{d}	398.98^{d}	41.17^{a}	70.60^{d}	3.53^{b}
LSD	0.13	0.06	0.15	0.05	0.23	0.84	0.50	0.45	0.50

Means in the same column with different letter or letters for wheat or yellow corn noodles are significantly different ($P \leq 0.05$).

Control 1 =100% HWF **Control 2**=100%YCF.
Blend 1= 90% HWF + 10% CFCH. **Blend 2** = 80% HWF +20% CFCH
Blend 3 = 70% HWF + 30% CFCH **Blend 4** = 90% YCF +10% CFCH
Blend 5 = 80% YCF +20% CFCH **Blend 6** = 70% YCF + 30% CFCH

Table (10): Cooking quality properties of hard wheat flour and yellow corn flour instant noodles supplemented with chicken feet collagen hydrolysate.

Sample	Cooking time (min)	weight gain(%)	volume gain(%)	Cooking lose (T.S.S%)
Hard wheat flour instant noodles				
Control (1)	7.50 [a]	230 [c]	205 [d]	6.00 [a]
Blend (1)	7.00 [ab]	250 [b]	215 [c]	5.90 [a]
Blend (2)	6.50 [bc]	270 [a]	235 [b]	5.30 [ab]
Blend (3)	6.00 [C]	285 [a]	250 [a]	5.00 [b]
LSD 0.5	0.55	0.25	28.1	0.70
Yellow corn flour instant noodles				
Contro (2)	4.80 [a]	180 [c]	195 [c]	7.00 [a]
Blend (4)	4.50 [ab]	190 [bc]	210 [bc]	6.50 [a]
Blend (5)	4.20 [b]	220 [ab]	230 [ab]	5.80 [b]
Blend (6)	4.00 [b]	250 [a]	240 [a]	5.20 [b]
LSD 0.5	0.94	9.40	19.97	0.87

Means in the same column with different letter or letters for wheat or yellow corn noodles are significantly different ($P \leq 0.05$).

Control 1 =100% HWF **Control 2**=100%YCF.
Blend 1= 90% HWF + 10% CFCH. **Blend 2** = 80% HWF +20% CFCH
Blend 3 = 70% HWF + 30% CFCH **Blend 4** = 90% YCF +10% CFCH
Blend 5 = 80% YCF +20% CFCH **Blend 6** = 70% YCF + 30% CFCH

level of 30% of natural collagen for both hard wheat and yellow corn flour instant noodles. Meanwhile, cooking loss % was decreased with increasing the natural collagen percentage for both hard wheat and yellow corn flour instant noodles. So, the addition of collagen hydrolysate improved the cooking quality of instant noodles.

3.10. Firmness of instant noodles

The data presented in Table (11) showed the firmness values of instant noodles produced from hard wheat or yellow corn flour supplemented with 10, 20 and 30 % of natural collagen extracted from chicken feet, compared to the control sample. The firmness values were increased with increasing of natural collagen percentage for both hard wheat and yellow corn flour instant noodles. The increase of instant noodles firmness values may be related to the addition of components rich in protein that, probably have a significant influence in the reinforcement of the gluten network as reported by Abd El-Salam (2005).

3.11. Recommended dietary allowances (RDA%) of the produced instant noodles

The percentages of the recommended dietary allowances (RDA%) which provided from 100g of instant noodles for age of 31 -50 years old are shown in Table (12). It could be observed that all values of RDA % for protein was high in instant noodles produced from hard wheat flour, since it ranged from 35.95 to 62.41 % for males and ranged from 43.76 to 75.98 % for females compared to control sample which showed RDA % of 22.61 and 27.52% for males and females, respectively , moreover, calcium showed RDA% ranged from 3.59 to 4.75% for both males and females, respectively, compared to the control

Table (11): Effect of the steaming process on firmness of hard wheat and yellow corn flour instant noodles supplemented with chicken feet collagen hydrolysate.

Sample	Steaming time (min)	Firmness (shear force) Kg / cm^2
Hard wheat flour instant noodles		
Contro(1)	**3.00**	**0.23**
Blend (1)	**3.00**	**0.25**
Blend (2)	**3.00**	**0.32**
Blend (3)	**3.00**	**0.43**
Yellow corn flour instant noodles		
Contro(2)	**4.00**	**0.25**
Blend (4)	**4.00**	**0.30**
Blend (5)	**4.00**	**0.37**
Blend (6)	**4.00**	**0.40**

Control 1 =100% HWF **Control 2**=100%YCF.
Blend 1= 90% HWF + 10% CFCH. **Blend 2** = 80% HWF +20% CFCH
Blend 3 = 70% HWF + 30% CFCH **Blend 4** = 90% YCF +10% CFCH
Blend 5 = 80% YCF +20% CFCH **Blend 6** = 70% YCF + 30% CFCH

Table (12): Percentages of the recommended dietary allowances (RDA%) which provided from 100 gm hard wheat flour and yellow corn flour instant noodles supplemented with chicken feet collagen hydrolysate for some nutrients for adults (31-50 years).

Sample	RDA** Protein (56g)	RDA** Energy (2700kcal)	RDA** Ca (1000mg)	RDA** Fe (8mg)	RDA** Protein (46g)	RDA** Energy (2000kcal)	RDA** Ca (1000mg)	RDA** Fe (18mg)
	Hard wheat flour instant noodles							
	RDA %* Males				**RDA %* Females**			
Control (1)	22.61	14.62	3.01	25.63	27.52	19.74	3.01	11.39
Blend (1)	35.95	14.59	3.59	24.25	43.76	19.70	3.59	10.78
Blend (2)	49.14	14.54	4.17	22.75	59.83	19.63	4.17	10.11
Blend (3)	62.41	14.50	4.75	21.38	75.98	19.58	4.75	9.50
	Yellow corn flour instant noodles							
	RDA %* Males				**RDA %* Females**			
Sample	RDA** **Protein (56g)**	RDA** **Energy (27000kcal)**	RDA** **Ca (1000mg)**	RDA** **Fe (8mg)**	RDA** **Protein (46g)**	RDA** **Energy (2000kcal)**	RDA** **Ca (1000mg)**	RDA** **Fe (18mg)**
Control (2)	18.43	15.00	2.11	58.13	22.43	20.25	2.11	25.83
Blend (4)	32.02	14.93	2.78	53.50	38.98	20.15	2.78	23.78
Blend (5)	45.61	14.85	3.45	48.75	55.52	20.05	3.45	21.67
Blend (6)	59.46	14.78	4.12	44.13	72.39	19.95	4.12	19.61

RDA%*= value of nutrient in sample x 100 / RDA for the same nutrient in reference.
RDA**= value of nutrient in reference.

Control(1) =100% HWF
Control (2)=100% YCF.
Blend(1)= 90% HWF + 10% CFCH.
Blend(2) = 80% HWF +20% CFCH
Blend(3) = 70% HWF + 30% CFCH
Blend(4) = 60% HWF + 40% CFCH
Blend(5) = 90% YCF +10% CFCH
Blend(6) = 80% YCF + 20% CFCH
Blend(7) = 70% YCF + 30% CFCH.
Blend(8) = 60% YCF + 40% CFCH.

sample which showed RDA % of 3.01% for both males and females. Moreover, the same results showed also that all values of RDA % for protein was high in instant noodles produced from yellow corn flour and ranged from 32.02 to 59.46 % for males and ranged from 38.98 to 72.39 % for females compared to the control sample which showed RDA % of 18.43 and 22.43 % for males and females, respectively , concerning calcium it showed RDA% ranged from 2.78 to 4.12% for both males and females, respectively, compared to control sample which showed RDA % of 2.11 % for both males and females. The obtained results also indicated that energy values of all blends were found to be approximately the same. However, the control 1 and 2 showed higher values of iron content than all the studied blends.

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تدعيم النودلز بالكولاجين المتحلل كغذاء وظيفى

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ملخص

يعتبرالكولاجين هو المسؤل عن مرونة الجلد ونضارتة وإعطائة النعومة اللازمة، وكذلك مكافحة التجاعيد ومنع ظهور علاماتها مبكرا على الجلد ومنع حدوث التهاب المفاصل وألام العظام وتقوية العضلات . ومن المعروف أن التقدم فى العمر يسبب إنخفاض الكولاجين الطبيعى الناتج من الجسم. لذلك من المفيد تعويض هذا الإنخفاض من مصدر أخر ويفضل أن يكون طبيعيا. تم فى هذة الدراسة إنتاج نودلز بإستخدام دقيق قمح أو دقيق ذرة يحتوى على الكولاجين المتحلل المستخلص من أرجل الدجاج كغذاء وظيفى بإستخدام ثلاث درجات pH مختلفة وهى 4و6.5و9 . أظهرت النتائج أن المعاملة على درجة pH 4 احتوت على أعلى نسبة من البروتين. ولذلك فقد تم إستخدام هذه المعاملة فى تدعيم النودلز بنسب مختلفة (10-20- 30 %). كما تم تقدير التركيب الكميائى والأحماض الأمينة وخصائص الجودة الطبيعية والحسية للنودلز المنتج المحتوى على الكولاجين المتحلل. وأظهرت النتائج تحسن واضح فى الخواص الطبيعية والحسية للنودلز المدعم بالكولاجين المتحلل, وكذلك حدث إرتفاع فى نسبة البروتين والتى تراوحت بين 20.13 إلى34.95 % و25.54 إلى 33.30% وذلك بإستخدام دقيق القمح ودقيق الذرة على التوالى. كما إرتفعت نسبة الاحماض الامينية مقارنة بالكنترول وذلك فى نوعى الدقيق المستخدمين. كما تم تقدير الاحتياجات اليومية من النسب الموصى بها لكل 100 جرام من معاملات النودلز الناتجة لعمر 31 – 50 سنة للإناث والذكور. وأوضحت النتائج أن كل قيم الإحتياجات الموصى بها للبروتين كانت مرتفعة وذلك للنودلزالمدعمة بالكولاجين المتحلل المصنعة من دقيق القمح، حيث تراوحت النسبة من 35.95 الى 62.41 % للذكور و 43.76 الى 75.76% فى الاناث مقارنة بالكنترول 22.61% و 27.52 فى الذكور والاناث، على التوالى. كما أوضحت النتائج أن كل قيم الإحتياجات الموصى بها للبروتين كانت مرتفعة، وذلك للنودلزالمدعمة بالكولاجين المتحلل المصنعة من دقيق الذرة حيث تراوحت النسبة من 32.02 الى 59.46 % للذكور و 38.98 الى 72.39% فى الإناث مقارنة بالكنترول 18.43% و 22.43 فى الذكور والاناث، على التوالى. كما أظهرت النتائج أن النودلز المصنعة من دقيق الذرة يمكن أن تستخدم كغذاء وظيفى لمرضى حساسية الجلوتين.