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Full Length Research Paper

The effect of apricot kernel flour incorporation on the physicochemical and sensory properties of noodle

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This study considers the application of apricot kernel (AK), a by-product of apricot processing plants containing wide range of nutrients, in enrichment of noodle. The alterations in chemical (moisture, oil, protein and ash content), physical (colour), cooking (optimum cooking time, cooking loss, volume and weight increase), and sensory properties (odour, appearance, mouthfeel, taste, total acceptability) of noodles were examined by adding apricot kernel flour (AKF) to the noodle formulation at the level of 5, 10, 15, 20% flour weight basis. The results of the study indicated that samples of AKF added noodles, for all addition levels, contained more protein, lipid and ash as compared to control sample. Colour and cooking properties were altered by the addition of AKF. In the sensory analysis, the control noodle had the highest score and 20% AKF added noodle had statistically significant ($p<0.05$) lowest score as compared with other samples. The results obtained in this study suggest that acceptable noodles in terms of physicochemical and sensory properties could be produced by incorporating AKF into wheat flour up to the level of 15% flour weight basis. Therefore, AKF could successfully be used to enrich noodles, giving alternative utilization opportunity to producers and healthy choice option to the consumers.

Key words: Noodle; apricot kernel, flour, cooking, sensory properties.

INTRODUCTION

The consumption of foods enriched with proteins from plant sources has been increasing among vegetarian and health conscious people (Wu et al., 2001). However, efforts needs to ensure that enrichment should not cause any important alteration in sensory and functional attributes of final product (Topgül 1996, Morad et al., 1980). In addition, enriched product should be economically affordable, nutritive and satisfactory in terms of consumer expectations (Ugarcic-Hardi et al., 2003). In this context, popularity of noodles has been increasing as a result of their simple preparation requirement, desirable sensory attributes, long shelf-life (Bergman et al., 1994, Lee et al., 1998), together with diversity and nutritive values. Therefore, noodle could serve as a suitable food for fortification and/or enrichment purposes. As the world food market is being diversified, studying for the development and improvement of new and acceptable noodles satisfying consumer demands are imminent (Ge et al., 2001).

Noodles and other pasta types are rich in carbohydrate but they are deficient in terms of protein quantity and amino acid balance. Therefore the deficiency problem could be solved by consuming noodles together with foods that are rich in protein or by enrichment of noodle. In recent years, enriched noodles with different compounds have become available especially in Asia food market (Lee et al., 2002).

Many studies have been performed on the noodle enrichment and the effect of added compounds on final product quality has been reported. Garbonzo bean flour (Lee et al., 1998), defatted peanut flour (Chompreeda et al., 1987), soy flour (Singh et al., 1989), pumpkin powder (Lee et al., 2002), raw and cooked pea flour or pea protein concentrate (Nielsen et al., 1980), sweet potato flour (Collins and Pangloli, 1997), defatted wheat germ (Ge et al., 2001), rye flour (Kruger et al., 1998), raw and cooked yellow and green pea and defatted soy flour (Jeffers et al., 1979), soy milk powder (Kim and Park, 1992), and

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laver powder (Lee et al., 2000) are among the enrichment materials used.

AK constitutes 15-16% of apricot fruit (Arı, 1999; El-Adawy et al., 1994), and 31-38% of whole stone (Rahma et al., 1994). AK is used by many industries including oil/fat, cosmetic, medicine and bakery (Açkurt, 1998). Protein and oil content of AK has aproximately been reported between 20-25% and 45-55%, respectively (Beyer and Melton, 1990; Hallabo et al., 1975; Özcan, 2000; Femenia et al., 1995; Salem and Salem, 1973; Abd El-Aal et al., 1986; Aydemir et al., 1993). AKF mainly contains amino acids methionine, phenylalanine, valine, threonine, arginine, aspartic acid and glutamic acid (Kamel and Kakuda, 1992). AKF contains high level of potassium and magnesium minerals, B group vitamins, its oil is rich in unsaturated fatty acids, especially oleic (31-80%) and linoleic (6.3-51%) acids and is also good source of tocopherol (Lazos, 1991).

The objective of this study was to examine the effect of added AKF, a by-product obtained in excess amounts in apricot processing plants and rich source of nutrients (Alpaslan and Hayta, 2006), on physico-chemical (colour, moisture, oil, protein, and ash), cooking (optimum cooking time, cooking loss, weight and volume increase) and sensory (odour, appearance, mouthfeel, taste and total acceptability) properties of dried salted noodles.

MATERIALS AND METHODS

Materials

AKF was obtained from Kanat Agricultural Products Co., Malatya, Turkey and sieved (1 mm) to have uniform particle size. Special-purpose wheat flour (Selva Food Industry Co., Konya) and table salt was purchased from local markets. AKF and wheat flour were stored at refrigerator until used.

Proximate analysis of flour and AKF and noodle

Moisture and protein content (N%x5.7) of wheat flour was determined according to AOAC (1984); ash content was determined according to ICC. Moisture, ash, oil and protein content of AKF was determined according to AOAC (1984). A protein conversion factor 6.25 was used (El-Adawy et al., 1994; Lazos, 1991). Noodle samples were prepared according to AOAC (1984) for chemical analyses. Moisture and protein contents of noodle samples were determined according to AOAC (1984) using protein changing factor was 5.7 for control noodle. Protein conversion factors of AKF added noodles were calculated on the basis of relative proportions (Bejosano and Corke, 1998). Ash contents of noodle samples were determined according to ICC. For oil content of noodle, 10 g sample was placed in Soxhlet cartridge and subjected to extraction for 6 h by using hexane as solvent. Then solvent was evaporated in a rotary evaporator (ST 150SA, Staffordshire, UK) and percent fat contents of noodle samples were calculated on a weight basis.

Noodle preparation

Methods of Oh et al. (1983) and Collins and Pangloli (1997) were used with some modification for noodle preparation. The amount of water to obtain uniform dough for control (100% wheat flour noodle) and AKF added noodles were evaluated with preliminary experiments (Singh et al., 1989; Oh et al., 1983; Manthey et al., 2004). As a result, a level of 45%, flour weight basis, was required to obtain uniform dough for noodle. Insufficient water caused non-uniform dough, while excess water made the dough very extensible. AKF substituted with wheat flour at the level 0, 5, 10, 15 and 20%, on flour weight basis, and the levels of water used were 40, 38, 36, and 34%, respectively. Salt (2%, on flour weight basis), was resolved in water beforehand. For noodle production, flour was placed in kneader (Kitchen Aid Artisan Mixer, Model 5KSM150PS, St. Joseph, MI, USA), mixed 1 min at speed 1 using flat kneading attachment. After adding dissolved salt, mixing is continued 1 min at speed 1 and 4 min at speed 2. The dough was kneaded by hand for 1 min and divided 100 g portions and rested at room temperature 30 min in the plastic bags. Rested dough was sheeted to about 4 mm thickness by wood rolling pin and finally to 1.3 mm thickness at five stepwise reductions (4, 3.3, 2.5, 1.9 and 1.3 mm) by using a noodle machine (Marcato, Model Atlas 150 mm-Deluxe, Italy). The sheeted dough was cut by being passed between cutter rollers of noodle machine. Noodles were dried in laboratory conditions for 18 h by spreading the noodle strips on metal rock having 2 mm holes. Dried noodles were stored in refrigerator at in glass jars until they were analyzed. The dried noodles had 1.5 mm thickness, 6 mm width and 12 cm length.

Colour analysis

Colour values of raw, dried and cooked noodles were measured with colorimeter (Minolta CR 10 Series, Osaka, Japan) using Hunter colour scale; L: brightness (white: 100, black: 0), a: redness (+ red, - green), b: yellowness (+ yellow, - blue). Colour measurement of raw noodle samples were performed according to modified method of Cho et al. (2001). Methods of Lee et al. (2002) and Bergman et al (1994) were used in colour analysis of dried noodles. The dried noodle (25 g) was cooked in boiling water (250 mL) until optimum cooking time was reached. After cooked noodles were drained by being rinsed in tap water, remaining water on the surface was sponged by a clean paper towel. Colour analysis was done in duplicate and the values for each parameter were recorded from 3 different points of noodles.

Optimum cooking time

Optimum cooking time of noodles was evaluated according to method of Singh et al. (1989). The noodle sample (5 g) was inserted in a beaker containing 75 mL distilled water and one strip was crushed between two glasses in every 30 s. The cooking was continued until white fraction in central core of crushed noodles was disappeared and time that passed was recorded as optimum cooking time.

Cooking loss

Cooking loss was evaluated according to method of Ozkaya and Kahveci (1990). 25 g noodle was cooked in boiling water (250 mL) on the basis of their optimum cooking time. The cooked noodles were drained from buhner funnel and placed cooking beaker again. Cooked and drained noodle washed by adding 90 mL water and drained again. The cooking water was fulfilled with fresh water (350 mL) and mixed completely. Then 50 mL of cooking water was transferred into another beaker and dried in an oven at 98°C. The cooking loss was calculated according to following formula:

$$\% \text{ Cooking Loss} = \frac{G \times 28}{100 - W} \times 100$$

G is the weight (g) difference between beakers before and after the drying; and W is noodle moisture.

Volume increase

Volume increase was evaluated according to method of Ozkaya and Kahveci (1990). 25 g noodle was cooked in boiling water (250 mL) on the basis of their optimum cooking time, rested for 5 min and transferred to a beker fullfilled with 250 mL water. Tthe volume of water overlowed from beaker was recorded. The same procedure was repeated for uncooked noodle as well. The percent volume increase was calculated on the basis of difference between the volume of overflowed water for cooked and uncooked noodles.

Weight increase

Weight increase was evaluated according to Ozkaya and Kahveci (1990). After cooked and drained noodles were rested for 5 min, the weight was recorded and percent weight increase was calculated on the basis of difference between the weight of cooked and uncooked noodles.

Sensory evaluation

Sensory evaluation of noodle samples was performed by 5 semi-trained panellists, who are regularly consuming noodles. They were assessed noodles in terms of odour, appearance, mouthfeel (firmness) and taste properties. Total acceptability score was calculated by averaging of whole sensory parameters. Sensory firmness (mouthfeel) was described as required force to bite a noodle strip. High points represent high firmness. In other parameters, 10 points represents the most liking. Noodle samples were offered in white plastic dishes coded with random 3 digit numbers. The panellists were used drinking water before evaluating each sample. Sensory evaluation was repeated in two different days.

Statistical analysis

Data obtained were evaluated statistically with SPSS package program (SPSS 9.00 software for Windows) by variance analysis. When variance analysis showed significant difference ($p<0.05$) among the means, the least difference test was used to evaluate means.

RESULTS AND DISCUSSION

Chemical properties of wheat flour, AKF and noodles

Special-purpose wheat flour consists of 11.1% moisture, 11.8% protein and 0.52% ash on dry matter basis. The proximate composition of AKF is given in Table 1. Protein (26.9%) and oil content (52%) values of AKF used in study are identical to the values reported by other reserchers (Beyer and Melton, 1990; Hallabo et al., 1975; Özcan, 2000; Femenia et al., 1995; Salem and Salem, 1973; Abd El-Aal et al., 1986; Aydemir et al., 1993). The ash content (2.9%) for AKF reported by Beyer and Melton (1990) well agrees with the value of present study as well.

Table 2 shows the effect of AKF on some chemical properties of noodles. Moisture content was the highest in control noodle. The increase in AKF level led to decrease in the moisture contents of noodles. But the difference was not significant ($p>0.05$) among 10, 15 and 20% AKF added noodles. This might be resulted from the differences in the level of water added to dough containing various level of AKF flour before mixing. Similar result was reported by garbanzo bean flour addition to obtain uniform noodle dough (Lee et al., 1998). It is also possible that the lipid content of wheat flour increases as AKF level increased resulting decreased water absorption. Ingredients having high level of lipid contain relatively low level of hydrophilic compounds (Manthey et al., 2004). Ash content of noodles varied from 0.69 to 1.00%. The ash content was the lowest in control and 5% AKF added noodle samples but the difference was not statistically important ($p>0.05$). AKF addition increased ash content. The AKF added (20%) noodle had the highest ash content. Lipid content values of noodles varied from 0.4 to 10.6%. While control noodle had the lowest value, 20% AKF added noodle had the highest lipid content. When AKF addition level was increased, lipid content of noodles significantly ($p<0.05$) increased.

Protein content of noodles changed from 11.5 to 14.5%. As expected, AKF addition at highest level resulted in the noodle containing the highest protein content. It has been reported that defatted AKF in pasta resulted in highest protein and ash values as compared to control sample (Shams et al., 1997). In the present study, ash, moisture and protein content of control and whole AKF added noodles was in accordance with Turkish noodle standard (2003).

Table 1. The proximate composition of AKF.

Parameter	Amount
Moisture (%)	6.9
Protein (%, N x 6.25)[1]	26.9
Ash (%)[1]	2.39
Oil (%)	52.0

[1]On dry matter basis.

Colour values of noodles

Colour is one of significant factors which affect acceptability of food products by consumer (Lee et al., 2002; Hou and Kruk, 1998). It is desired that white salted Japanese noodles should have white colour. Moreover, non or the minimum level of spots should occur on the Srface of noodle (Nagao, 1996). According to Turkish noodle standard (2003), salted noodles must have white or creamy-white colour. The effect of AKF addition on colour attributes of raw, dried and cooked noodles is shown in Table 3.

AKF addition had a statistically significant ($p<0.05$)

Table 2. Effect of AKF addition on some chemical properties of noodles*.

AKF (%)	Moisture (%)	Ash (%)[1]	Lipid (%)	Protein (%)[1]
0 (control)	12.3 a	0.69 b	0.4 d	11.5 c
5	11.3 ab	0.76 b	2.8 c	12.0 c
10	10.7 b	0.93 a	5.5 c	12.9 b
15	10.4 b	0.97 a	8.0 b	13.5 b
20	10.3 b	1.00 a	10.6 a	14.5 a
LSD[2] (0.05)	1.00	0.081	0.47	0.72

*Different letters on same column represent statistically significant ($p<0.05$) difference between means.
[1]On dry matter; [2]LSD: Least significant difference.

Table 3. Effect of AKF addition levels on colour attributes of noodles*.

AKF (%)	Raw			Dried			Cooked		
	L	a	b	L	a	b	L	a	b
0 (control)	81.58 a	-0.82	21.90 d	88.96 a	-1.77	15.66	74.55 c	-2.43 a	16.62
5	80.74 ab	-0.61	25.24 c	88.26 a	-2.20	15.27	77.37 b	-2.84 ab	16.66
10	79.82 bc	-0.59	26.52 bc	88.77 a	-2.19	15.40	78.04 ab	-3.19 bc	17.70
15	78.45 cd	-0.43	28.08 ab	88.36 a	-2.10	16.36	78.26 ab	-3.43 c	17.18
20	77.65 d	-0.43	29.05 a	86.61 b	-1.93	18.16	78.78 a	-2.45 a	17.76
LSD[2] (0.05)	1.588		1.664	1.072			1.184	0.504	

[1]L: brightness, a: redness, b: yellowness; [2] LSD: Least significant difference; *Different letters on same column represent statistically significant ($p<0.05$) difference between means.

effect on L value of raw noodle at 5% level and on b (yellowness) value at 1% level whereas AKF addition showed no significant effect on a (redness) value of raw noodle. L value was the highest in raw control noodle and when AKF addition increased, L value declined gradually (Table 3). The b value was the lowest in row control noodle and as the level of AKF addition increased, b value also increased ($p<0.05$). AKF addition had statistically significant effect ($p<0.05$) on L values of dried noodles and did not have a significant effect on the values of “a” and “b” ($p>0.05$). Dried control noodle, and AKF incorporated noodles at the level of 5, 10 and 15% had the highest L values (Table 3). While 20% AKF added dried noodle had the lowest L value. AKF addition had statistically significant effect on L values of cooked noodles at 1%, whereas on a value of cooked noodles at 5%. The effect of AKF addition on b values of cooked noodles was not statistically significant ($p>0.05$). The cooked control noodle had the lowest L value and when AKF addition level increased, L values of cooked noodles also increased. No significant difference was determined between L values of 10 and 15% AKF added noodles ($p>0.05$). It is likely that water-soluble matters (water-soluble protein fraction and minerals present) in AKF Champreeda et al. (1987) used defatted peanut flour (DPF) in Chinese noodle production and they observed that the colour of cooked noodle darkened gradually when DPF level increased and brightness value of control sample was higher than L values of DPF added noodles.

Cooking properties of noodles

Noodle quality could be estimated from cooking attributes such as cooking loss, volume and weight increase (Özkaya et al., 1984). The effect of AKF addition on the cooking properties of noodles is presented in Table 4. The control noodle had highest whereas the 20% AKF added noodle lowest optimum cooking time (Table 4). As AKF addition level increased, optimum cooking time gradually decreased. No statistically significant difference was observed between optimum cooking times of control and 5% AKF added noodles ($p>0.05$). Ingredients other than wheat flour such as AKF may cause discontinuity in gluten network (Manthey et al., 2004; Izydorczyk et al., 2004) resulting in faster moisture penetration and therefore leading to optimum cooking time. The high pasta (Hou and Kruk, 1998). The weight increase varied from 131.5 to 183.5%. The value was the highest in control noodle. AKF addition led to reduction in the weight of cooked noodles. Other studies showed that cooked weights of noodles increase when cooking time increased (Izydorczyk et al., 2004; Duszkiewicz-Reinhard et al., 1988). Volume increase values of cooked noodles varied from 150 to 240%. The AKF addition at the level of 5% resulted in the highest volume increase which is statistically significant ($p<0.05$). As the cooking loss is an indicator of noodle’s resistance to cooking (Nagao, 1996), low levels are preferable. The cooking loss was the highest in 10% AKF added noodle, the lowest in control

Table 4. Effect of AKF addition levels on cooking attributes of noodles*.

AKF (%)	Optimum cooking time (min)	Weight increase (%)	Volume increase (%)	Cooking loss (%, on dry matter)
0 (control)	12.25 a	183.47 a	220 b	6.54 d
5	12.00 a	174.60 b	240 a	7.13 b
10	10.00 b	171.54 b	210 b	7.37 a
15	8.25 c	137.50 c	170 c	6.78 c
20	7.00 d	131.52 d	150 d	7.24 b
LSD[1] (0.05)	0.252	5.095	17.56	0.124

*Different letters on same column represent statistically significant ($p<0.05$) difference between means.
[1]LSD: Least significant difference.

Table 5. Effect of AKF addition on sensory properties of noodles*.

AKF (%)	Odour	Appearance	Firmness (mouthfeel)	Taste	Total acceptability
0 (control)	9.20 a	7.45 a	6.30 a	8.85 a	7.95 a
5	7.70 b	7.10 a	5.05 b	7.40 b	6.81 b
10	5.90 c	6.05 b	4.20 c	7.00 c	5.78 c
15	4.70 d	5.80 b	4.10 c	5.45 d	5.01 d
20	4.00 e	5.85 b	3.45 d	4.35 e	4.39 e
LSD[1] (0.05)	0.621	0.575	0.430	0.372	0.277

*Different letters on same column represent statistically significant ($p<0.05$) difference between means.
[1]LSD: Least significant difference.

noodle and the values were higher in all of AKF added noodles than control noodle. However the difference between cooking loss values of 5 and 20% added noodles was insignificant ($p>0.05$). Izydorczyk et al. (2004) stated that cooking loss could be attributed to weak protein-starch interaction and/or destroyed protein matrix. AKF addition would have been resulted in similar effect. Moreover high cooking loss of AKF added noodles compared to control may result from the presence of high water-soluble protein fraction and minerals in AKF (Shams et al., 1997). The results of present study for cooking loss levels agree with Turkish noodle standard which states that cooking loss should not exceed the level of 10% on dry matter basis.

Sensory attributes of noodles

Ingredients added during enrichment should not cause any undesirable change in sensory properties of food (Kruger, 1996). The effect of AKF addition on sensory properties of noodles is shown in Table 5. Noodles had lower sensory scores when AKF addition level was increased. It is desired that white salted noodles are soft (not very soft) in terms of mouthfeel (firmness) property (Kim, 1996). Control and 5% AKF added noodle had the highest score for appearance score whereas the difference was not significant ($p>0.05$). The appearance score values of AKF added noodles at the level of 10, 15 and 20% were higher than control and 5% AKF added noodles. Control noodle had the highest score. A reduction in sensory firmness value was obtained by increasing level of AKF in noodle. However the difference between 10 and 15% AKF added noodles were not statistically significant ($p>0.05$). Gluten has been reported to be responsible for firmness of noodle (Chompreeda et al., 1987). Increase in softness of AKF added noodles might result from the relative reduction of gluten as a result of AKF addition. AKF added noodles had lower taste scores. The calculated total acceptability values varied from 4.39 to 7.95 and control noodle had the highest total score. The total acceptability value decreased as AKF increased and the lowest value was obtained for 20% AKF added noodle. It has been reported that the increase in defatted peanut flour level in Chinese type noodles resulted in lower sensory scores (Chompreeda et al., 1987).

Conclusion

The results of present study suggest that AKF incorporation into wheat noodle up to a level of 15%, flour weight basis, seems suitable in terms of physicochemical and sensory properties. An alternative utilization of AK as flour substitute in noodle preparation is important for producer and processors. It is quite possible to evaluate undersize or broken kernels to obtain flour. It is also advantages for consumers seeking alternative products containing healthy ingredients. The use of defatted AKF and or AK isolates in bakery products require further investigation.

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REFERENCES

Abd El-Aal MH, Hamza MM, Rahma EH (1986). *In-vitro* digestibility, physicochemical and functional properties of apricot kernel proteins. Food Chem. 19: 197-211.

Açkurt F (1998). Importance of Apricot in Healthy Nutrition and New Apricot Products, I. Apricot Council Result Report, Malatya, pp. 21-29.

Alpaslan M, Hayta M (2006). Apricot kernel: physical and chemical properties. J. Am. Oil Chem. Soc. 82: 469-471.

AOAC (1984). Official Methods of Analysis of the Association of Official Analytical Chemists, 14th ed. Virginia, USA.

Arı N (1999). Usage and Effective Components of Apricot Kernel Oil. Term Project. Ankara University, Ankara, Turkey.

Aydemir A, Yılmaz İ, Özdemir İ, Arıkan N (1993). Kayısı çekirdeği yağının fiziksel ve kimyasal özelliklerinin incelenmesi. Doğa-Türk Kimya Dergisi. 17: 56-61.

Bejosano FP, Corke H (1998). Effect of amaranthus and buckweat proteins on wheat dough properties and noodle quality. Cereal Chem. 75: 171-176.

Bergman CJ, Gualberto DG, Weber CW (1994). Development of a high temperature dried soft wheat pasta supplemented with cowpea (*Vigna unguiculata* (l.) walp) cooking quality, color and sensory evaluation. Cereal Chem. 71: 523-527.

Beyer R, Melton LD (1990). Composition of New Zealand Apricot Kernels, New Zealand J. Corp. Hort. Sci. 18: 39-42.

Cho SY, Tak SH, Rhee C (2001). Effect of extraction rate of Korean flour on rheological and raw noodle-making properties. Food Sci. Biotechnol. 10: 246-250.

Chompreeda P, Resurreccion AVA, Hung YC Beuchat LR (1987). Quality evaluation of peanut-supplemented Chinese type noodles. J. Food Sci. 52: 1740-1741.

Collins JL, Pangloli P (1997). Chemical, physical and sensory attributes of noodles with added sweetpotato and soy flour. J. Food Sci. 62: 622-625.

Duszkiewicz-Reinhard W, Khan K, Dick JW, Holm Y (1988). Self-life stability of spaghetti fortified with legume flours and protein concentrates. Cereal Chem. 65: 278-281.

El-Adawy TA, Rahma H, El-Badawey AA, Gomaa MA, Lasztity R, Sarkadi L (1994). Biochemical studies of some non-conventional sources of proteins part 7. Effect of detoxification treatments on the nutritional quality of apricot kernels. Die Nahrung. 38: 12-20.

Femenia A, Rossello C, Mulet A, Canellas J (1995). Chemical composition of bitter and sweet apricot kernels. J. Agric. Food Chem. 43: 356-361.

Ge Y, Sun A, Ni Y, Cai T (2001). Study and development of a defatted wheat germ nutritive noodle. Eur. Food Res. Technol. 212: 344-348.

Hallabo SAS, El-Wakeil FA, Morsi MKS (1975). Chemical and physical properties of apricot kernel, apricot kernel oil and almond kernel oil. Egypt. J Food Sci. 3: 1-6.

Hou G, Kruk M (1998). Asian Noodle Technology, AIB Research Department, Technical Bulletin. Vol: XX. Issue 12.

ICC Standards (1981). International Associstion for Cereal Chemistry, Vienna, Austria.

Izydorczyk MS, Lagasse SL, Hatcher DW, Dexter JE, Rossnagel BG (2004). The enrichment of Asian noodles with fiber-rich fractions derived from roller milling of hull-less barley. J. Sci. Food Agric. 85: 2094-2104.

Jeffers HC, Noguchi G, Rubenthaler GL (1979). Effects of legume fortifiers on the quality of udon noodles. Cereal Chem. 56: 573-576.

Kamel BS, Kakuda Y (1992). Characterization of the seed oil and meal from apricot, cherry, nectarine, peach and plum, J. Am. Oil Chem. Soc. 69: 493-494.

Kim SK (1996). Instant Noodles in Pasta and Noodle Technology. Am. Assoc. Cereal Chem. St. Paul, MN, USA. pp. 195-226.

Kim ZU, Park WP (1992) Manufacture of extruded noodles mixed with soymilk residue, J. Korean Agric. Chem. Soc. 33: 216-222.

Kruger JE (1996). Noodle Quality-What Can We Learn from the Chemistry of Breadmaking? in Pasta and Noodle Technology. Am. Assoc. Cereal Chem. St. Paul, MN, USA, pp. 157-168.

Kruger JE, Hatcher DW, Anderson MJ (1998). The effect of incorporation of rye flour on the quality of oriental noodles. Food Res. Int. 31: 27-35.

Lazos ES (1991). Composition and oil characteristics of apricot, peach and cherry kernel. Grasas y Aceites. 42: 127-131.

Lee CH, Cho JK, Lee SJ, Koh W, Park W, Kim CH (2002). Ehancing β-carotene content in asian noodles by adding pumpkin powder. Cereal Chem. 79: 593-595.

Lee JW, Kee HJ, Park YK, Rhim JW, Jung ST, Ham KS, Kim IC, Kang SG (2000). Preparation of noodle with laver powder and its charactersitics. Korean J. Food Sci. Technol. 32: 298-305.

Lee L, Baik BK, Czuchajowska Z (1998). Garbanzo bean flour usage in Cantonese noodles. J. Food Sci. 63: 552-558.

Manthey FA, Yalla SR, Dick TJ, Badaruddin M (2004). Extrusion properties and cooking quality of spaghetti containing buckwheat bran flour, Cereal Chem. 81: 232-236.

Morad MM, El-Magoli SB, Afifi SA (1980). Macaroni supplemented with lupin and defatted soybean flours. J. Food Sci. 45: 404-405.

Nagao S (1996). Processing Technology of Noodle Products in Japan, in Pasta and Noodle Technology. Am. Assoc. Cereal Chem. St. Paul, MN, USA, pp. 169-194.

Nielsen MA, Sumner AK, Whalley LL (1980). Fortification of pasta with pea flour and a ir-classified pea protein concentrate. Cereal Chem. 57: 203-206.

Oh NH, Seib PA, Deyoe CW. Ward AB (1983). Noodles. I. Measuring the textural characteristics of cooked noodles. Cereal Chem. 60: 433-438.

Özcan M (2000). Composition of some apricot (*prunus armeniaca l.*) kernels grown in Turkey. Acta Aliment. 29: 289-293.

Özkaya H, Kahveci B (1990). Tahıl ve Ürünleri Analiz Yöntemleri. Gıda Teknol. Derneği Yayınları No: 14, Ankara, pp. 146-148.

Özkaya H, Seçkin R, Ercan R (1984). Bazı makarna çeşitlerinin kimyasal bileşimi ve pişme kalitesi üzerine araştırma. Gıda. 9:133-161.

Rahma EH, El-Adawy TA, Lasztity R, Gomaa MA, El-Badawey AA, Gaugecz J (1994). Biochemical studies of some non-conventional sources of proteins part 6. Physicochemical properties of apricot kernel proteins and their changes during detoxification. Die Nahrung. 38: 3-11.

Salem SA, Salem FMA (1973). Egyptian apricot kernels seeds. Dtsch. Lebensm. Rundsch. 69: 322-324.

Shams El-Din MHA, Faheid SMM, Abd El-Kader MM (1997). Quality of spaghetti supplemented with apricot kernel flour. Egypt. J. Food Sci. 25: 21-38.

Singh N, Chauhan GS, Bains GS (1989). Effect of soyflour supplementation on the quality of cooked noodles. Int. J. Food Sci. Technol. 24: 111-114.

Topgül LM (1996). Effect of different drying conditions and cooking in pasta quality and some nutrients. MSc Thesis, Ege University, Izmir, Turkey,

Turkish Noodle Standard 12950 (2003). Türk Standartlar Enstitüsü (TSE), Ankara.

Ugarcic-Hardi Z, Hackenberger D, Subaric D, Hardi J (2003). Effect of soy, maize and extruded maize flour addition on physical and sensory characteristics of pasta. Ital. J. Food Sci. 15: 277-286.

Wu YV, Hareland GA, Warner K (2001). Protein-enriched spaghetti fortified with corn gluten meal. J. Agric. Food Chem. 49: 3906-3910.