NOTE

Enhancing β-Carotene Content in Asian Noodles by Adding Pumpkin Powder

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ABSTRACT

Cereal Chem. 79(4):593–595

The influence of ripened pumpkin powder on the characteristics and qualities of noodles was investigated. Varying amounts of pumpkin powder levels (0, 2.5, 5.0, and 10%) were added in making instant fried noodles. These four samples were then evaluated for β-carotene content, physical dough properties, color, cooking properties, and sensory characteristics. Adding more pumpkin powder increased the level of β-carotene in the noodles. Amylograph maximum viscosity and temperature and farinograph water absorption and stability decreased as the amount of pumpkin powder increased. Noodles made with more pumpkin powder had a more yellow color than those with less pumpkin powder. Cooked weight and volume were increased by 37 and 59%, respectively, when 5.0% pumpkin powder was added to the flour sample. Gumminess was lowest in the noodles with 5.0% pumpkin powder, while chewiness and hardness were lowest in the noodles with 10.0% pumpkin. Noodles with 5.0% pumpkin powder were the most favorable in appearance, taste, texture, and acceptability among the four samples.

Wheat is a major component of most diets of the world. Throughout the centuries, wheat has been used in a variety of human foods such as breads, cakes, crackers, pasta, and noodles. In Asian countries, almost half of the wheat flour used is consumed as noodles. Asian noodles are generally made from dough of hard or soft wheat flour that is rolled into sheets and cut into thin strips. Asian noodles can also be prepared from rice or buckwheat flour, or from starches such as rice, corn, wheat, mung beans, or tapioca (Miskelly 1993; Yeh and Shiau 1999). Asian noodles can be sold raw (uncooked), wet (precooked), dry, or instant fried. Qualities of Asian noodles such as color, cooking properties, texture, and taste are important factors affecting consumer acceptance (Moss 1971; Nagao et al 1977; Oh et al 1985; Preston et al 1986; Rho et al 1988; Toyokawa et al 1989; Crosbie 1991; Konik et al 1992). In recent years, as incomes have increased, noodle products fortified with various nutrients have become one of the important commodities in the Asian food market.

Carotenoids, including β-carotene, have been thought to act as free antioxidants or free radical traps and thus may play an important role in cancer prevention (Beecher and Khachik 1984; Ziegler 1989; Byers and Perry 1992; Woodall et al 1997). β-Carotene is an important source of vitamin A and is found in a large variety of fruits and vegetables such as apricots, broccoli, beet greens, cantaloupe, carrots, grapefruit, pumpkin, spinach, squash, and sweet potato (Bureau and Bushway 1986; Tee and Lim 1991). Wheat and other grains contain a limited amount of naturally occurring β-carotene. Thus, synthetic β-carotene has been used for providing color and vitamin A in a variety of bakery products including sweet rolls, Danish pastries, frozen waffles, bagels, soft cookies, and snack foods (Gordon et al 1985; Heinonen et al 1989). Although pumpkin is a good vegetable source of β-carotene and is served on its own, it has not yet been added to noodle products. This study assessed the effect that pumpkin powder added to noodle products had on various characteristics of noodles.

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Publication no. C-2002-0611-03R.
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MATERIALS AND METHODS

Pumpkin and Flour Samples

Ripe pumpkins (*Cucurbita moschata*) of one yellow colored cultivar (Danmhat Maettol) grown in Korea were used in this study. The pumpkin samples were harvested in 1998 from local farms. The fresh pumpkins were cleaned, peeled, cleaned of seeds, sliced into pieces 3 mm thick, and then washed in cold water. The diced flesh was deep frozen at –70°C and freeze-dried. The freeze-dried samples were ground (III Plus, Magic Mill Co., Salt Lake City, UT) and the material was passed through an 80-mesh screen and stored in air-tight polypropylene containers. A commercial noodle flour sample obtained from Daesun Flour Mills, Seoul, Korea, was used for making instant fried noodle products. The flour samples mixtures contained 0, 2.5, 5.0, and 10% pumpkin powder, respectively, on a baker's percent basis.

Moisture content was determined by Approved Method 44-15A (AACC 2000). Flour ash content was measured by the muffle furnace method (AACC Method 08-01). Flour protein content was analyzed by the Kjeldahl nitrogen procedure (AACC Method 46-10) using N × 5.7. Pasting properties of flour samples were measured by AACC Method 22-10. Water absorption, dough development time, and stability were measured with a farinograph (C.W. Brabender Instruments, South Hackensack, NJ) using AACC Method 54-21. Moisture, ash, and crude protein (N × 6.25) content of the fresh and dried pumpkin powder samples were determined using Official Methods 930.04, 930.05, and 978.04, respectively (AOAC 1995).

β-Carotene content in the freeze-dried pumpkin powder and finished noodle products were determined by AOAC Official Methods and procedures similar to that described by Rogers et al (1993) using HPLC. All analyses were done in duplicate on each extraction using HPLC-grade reagents.

Preparation of Noodles

A pilot-scale laboratory noodle machine (Seoju Engineering Co., Seoul, Korea) was used to prepare the noodles. The instant fried noodles were made in the laboratory using 100 parts flour, 36 parts distilled water, 1.9 parts sodium chloride, 0.1 part sodium carbonate, and 0.1 part potassium carbonate. Pumpkin powder was added to each flour sample at 0, 2.5, 5.0, and 10% and then mixed in a mixer. A brine solution was added over 30 sec on low speed mixing to achieve the final optimum water absorption. Mixing continued for 4.5 min at low speed, 8 min at high speed, and an additional 2 min at low speed. The dough was then allowed to rest in a polypropylene bag at room temperature for 15 min to distribute the water uniformly throughout the flour particles. The dough was passed through two rollers in five successive steps with decreasing roll gaps of 10.0, 6.0, 4.0, 2.0, and 1.2 mm in the same direction. The final sheeted noodle dough was cut into strips 1.5 mm wide and waved while passing through two pairs of slotted brass rolls. The noodles were steamed for 170 sec in a stainless steel steamer at pressure of 1.0 kg/cm^2. The steamed noodles (140 g) were folded in two layers and immersed in palm oil for 100 sec at 140°C. The fried noodles were then removed from the fryer and excess oil was allowed to drain for 30 sec. The noodles were cooled for 30 min at room temperature and stored in polypropylene bags until further analysis.

The noodle samples were uniformly ground using a mortar and pestle and placed in a granular material attachment (Minolta CR-A50, Osaka, Japan). Colors were measured with a Chroma Meter 300 (Minolta) using the CIE 1976 chromameter *L*, *a*, and *b* color scale equipped with a standard C illuminant. The color of each ground noodle sample was measured five times.

The cooking properties of noodles were evaluated by a method similar to that described by Park et al (1997). These evaluations of cooking properties were all done in duplicate. Texture profile analysis (TPA) parameters of cooked instant fried noodles were made on a texture analyzer (TA-XT2, Stable Microsystems, England) with fixtures and procedures similar to those described by Baik et al (1994). The measurements for each sample were done in triplicate within 5 min after cooking.

Sensory Evaluation

Ten highly trained panelists from the Department of Food Science and Technology at Konkuk University in Seoul, Korea, evaluated the cooked noodles for appearance, flavor, taste, texture, and overall acceptability. Noodle samples for the sensory test were prepared as for the texture measurement. Preference scores of each noodle sample were rated on a scale from 1 (very poor) to 5 (very good).

Statistical Analysis

The general linear model (GLM) procedure of the SAS program (SAS Institute, Cary NC) was used to perform analyses of variance (ANOVA) to assess data variability. The least significant difference (LSD) test was performed to determine statistical differences between means when the analysis of variance indicated significant differences in means ($P < 0.05$).

TABLE I
Means of Proximate Composition, Pasting Properties and Farinograph Measurements

	% Pumpkin Power Added			
Quality Parameter[a]	**0**	**2.5**	**5.0**	**10**
Proximate composition				
Protein (%)	8.79	8.85	8.63	8.03
Oil (%)	22.9	20.1	19.4	18.9
Ash (%)	0.50	0.59	0.61	0.68
Pasting properties				
Initial pasting temperature (°C)	52.0	53.5	53.5	53.5
Peak viscosity (BU)	820	636	462	462
Pasting temperature (°C)	86	86	85.6	82.9
Farinograph measurements				
Water absorption (%)	58.5	58.0	57.3	57.0
Development time (min)	1.9	2.5	2.8	3.3
Stability (min)	8.5	6.8	6.2	5.4
Weakness (BU)	60	90	110	130

[a] Expressed on a 14% moisture basis.

RESULTS AND DISCUSSION

The mean values of crude protein and ash contents for the fresh pumpkin samples were 0.93 and 0.57%, respectively. The freeze-dried pumpkin samples had crude protein and ash concentrations of 0.91 and 0.65%, respectively, moisture content was 1.61%. The mean value of β-carotene content was 58.2 mg/100 g of freeze-dried pumpkin power sample on a dry basis. Protein and ash contents of the flour samples were 9.33 and 0.41%, respectively, on a 14% moisture basis.

A summary of pasting properties and mixing characteristics for flour samples with added pumpkin powder is presented in Table I. Peak viscosity was 462–820 BU; flour samples with 5.0 and 10% added pumpkin powder had the lowest pasting properties. The same initial pasting temperature (53.5°C) was found in all flour samples with added pumpkin powder, which was higher than the sample with no added pumpkin powder (100% flour sample). As the amount of pumpkin powder increased in the flour, water absorption and stability decreased; dough development time and weakness increased. These farinograph measurements seem to indicate that the pumpkin powder influenced the dough mixing characteristics.

TABLE II
Measurements of β-Carotene Content, Color, Cooking Characteristics, Texture Profile Analysis, and Sensory Evaluation for Instant Fried Noodles

	% Pumpkin Powder Added			
Variable[a]	**0**	**2.5**	**5.0**	**10**
β-Carotene (mg/100 g)[b]	nd[c]	0.72	2.35	5.52
Chromameter value				
L	84.9a	83.1b	83.2b	78.3c
a	–1.9b	–2.3c	–2.4d	0.6a
b	14.5d	20.5c	22.1b	24.5a
Cooking quality characteristics				
Weight gain (%)	101c	118b	147a	115c
Volume gain (%)	120c	151b	168a	148b
Cooking loss (%)	5.0a	5.2a	3.2b	5.2a
Texture profile analysis				
Springiness (mm)	0.04a	0.05a	0.05a	0.05a
Gumminess (N)	1570a	1760a	1367b	1439b
Cohesiveness ratio	0.7a	0.7a	0.6a	0.7a
Hardness (N)	2407a	2670a	2273b	2091b
Chewiness (N × mm)	67.4a	86.3a	61.7a	70.1a
Sensory evaluation score				
Appearance	2.8b	3.3b	4.3a	3.5b
Flavor	3.2b	3.6a	3.9a	3.8a
Taste	2.7c	3.3b	4.2a	3.3b
Texture	3.1b	3.5b	4.2a	3.7b
Acceptability	3.0b	3.6b	4.6a	3.7b

[a] Values followed by the same letter in the same row are not significantly different ($P < 0.05$).
[b] Expressed on a dry basis.
[c] Not detectable.

No detectable amount of β-carotene was found in the noodles prepared with 0% pumpkin powder. The amount of β-carotene in the noodles with pumpkin powder added at 2.5, 5.0 and 10% was 0.72, 2.35, and 5.52 mg/100 g , respectively (approximately one serving size) (Table II). Ranhotra et al (1995) reported that β-carotene stability of bread and cracker products was slightly reduced during processing, and this loss of stability was higher in crackers than in breads, which may be related to product characteristics such as surface area and final moisture content. In this study, minimal loss in β-carotene content may have occurred during the noodle processing (mixing, sheeting, slitting, steaming, or frying). β-Carotene content of 2.35 mg of noodles with 5% added pumpkin powder was comparable to another study (Rogers et al 1993) that showed β-carotene contents of 2.31 (cakes), 3.65 (cookies), and 2.69 mg (bagels) per 100 g of each product, when a known value of synthetic β-carotene was added. That study also showed that single serving of these products would enable a person to obtain the desired amount of 5–6 mg of β-carotene in the daily diet if the person also consumes a normal diet. Consequently, this research showed that consumption of noodles supplemented with pumpkin powder would have a nutritional benefit as a natural source of β-carotene in the diet.

Mean values of noodle colors with added pumpkin powder are presented in Table II. There were apparent differences in chromameter values among the noodle samples. *L* values of noodle color decreased as pumpkin powder level increased, which indicated a decrease in noodle brightness. Chromameter *b* value of noodles with 10% added pumpkin powder was highest among the noodle samples. Noodle color became greener as more pumpkin powder was added, with the exception of the sample with 10% added pumpkin powder; this sample exhibited redness in noodle color.

Generally speaking, high weight and volume gains and low cooking loss would be desirable characteristics for high quality Asian noodles. Flour noodles with added pumpkin powder had higher weight and volume gains than the flour noodle samples with no added pumpkin (Table II). Mean cooking loss for flour with 5% pumpkin powder added was less than the means for the samples with 0, 2.5, and 10% pumpkin powder added. TPA parameters of cooked noodles varied considerably for gumminess and hardness. However, springiness, cohesiveness, and chewiness were not different among the samples, indicating the pumpkin powder did not affect such parameters.

The sensory evaluation scores for each parameter showed significant differences among the noodle samples (Table II). Noodle appearance, flavor, taste, texture, and overall acceptability for the noodles with 5% added pumpkin powder had higher scores than those with 0, 2.5, and 10% added pumpkin powder. This result implied that the noodles with 5% added pumpkin powder were preferred by the panelists.

CONCLUSIONS

This study demonstrated the effect of ripened pumpkin powder on qualities and characteristics of wheat flour noodles. Higher amounts of pumpkin powder added to noodles could provide more β-carotene in those noodle products with improved color, cooking, and sensory characteristics. This supplement could allow the labeling of the product as a good source of β-carotene. Noodle products fortified with naturally occurring β-carotene may be of interest to consumers because of the health benefit of the antioxidant effect, as compared with the nonfortified products. Furthermore, the use of pumpkin powder in noodle products may result in an economical use of surplus pumpkin products in Asia. Therefore, this research showed that noodles supplemented with pumpkin powder could be a nutritional benefit in the daily diet.

ACKNOWLEDGMENTS

Financial support from Konkuk University is gratefully acknowledged.

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[Received October 3, 2001. Accepted February 13, 2002.]