ORIGINAL ARTICLE

Utilization of pumpkin powder in bakery products

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Abstract

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The objective of this study was to produce pumpkin powder and use it as an ingredient in bakery products. Pumpkin powder was produced from mature pumpkin (*Cucurbita moschat* Duch. ex. Poir.). It contained 6.01% moisture, 3.74% protein, 1.34 % fat, 7.24% ash, 2.9% fiber, 78.77% carbohydrate, 56.04% alcohol insoluble solids, 7.29 mg/100g sample of β-carotene, had color values of L*57.81, a*8.31, and b*34.39, and 0.24 water activity. It gelatinized at 90ºC. It was used as a source of β-carotene and yellow color supplement in bakery products. Wheat flour was substituted by 5 levels of pumpkin powder (10, 20, 30, 40 and 50%) in sandwich bread, sweet bread, butter cake, chiffon cake and cookies. The products were consumer-tested and their physicochemical and sensory properties analyzed. Results showed that 20% substitution was optimum for butter cake, and chiffon cake, while only 10% substitution was acceptable for sandwich bread, sweet bread and cookies. The acceptance by the consumer group was at the level of "like moderately" to "like very much". Between 90-100% of the consumers who accepted the products would buy them. Chiffon cake substituted with pumpkin powder was the most preferred, followed by butter cake, sandwich bread, cookies, and sweet bread. The pumpkin-substituted products contained 15.00-103.30 μg RE of vitamin A (3.13-12.92% of Thai RDI for vitamin A intake per day).

Key words : pumpkin powder, wheat substitution, bakery products, β-carotene

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Pumpkins (*Cucurbita moschat* Duch. ex. Poir.) are extensively grown in tropical and sub-tropical countries. In Thailand, it is one of the most widely cultivated vegetables. Pumpkins are traditionally consumed as freshly boiled and steamed or as processed food items such as soup and curry. Pumpkin is high in β-carotene, which gives it yellow or orange color. It is also high in carbohydrates and minerals. Beta-carotene in plants that have a pleasant yellow-orange color is a major source of vitamin A (Lee, 1983). Consumption of foods containing carotene helps prevent skin diseases, eye disorders and cancer (Bendich, 1989). Incorporation of β-carotene rich materials in the human diet is therefore considered a cost-effective approach to vitamin-A related health problems (Berteram and Bortkiewicz, 1995). Pongjanta *et al*. (2003) revealed that pumpkin powder produced by juice extraction and cabinet drying then ground with pin mill and sifted through an 80 mesh sieve was cheap to produce, of good quality and easy to use as a β-carotene supplement in food products. Pongjanta *et al*. (2004) indicated that the use of 10-20% pumpkin powder substituted for wheat flour in Thai desserts improved their yellow color and β-carotene content, and would be accepted by consumers. The objective of this study was to determine the appropriate substitution level of pumpkin powder for wheat flour in the formulation of bakery products. The physicochemical and sensory properties, nutritive value and consumer acceptance of the products were investigated.

Materials and Methods

Materials

Mature pumpkins and ingredients for bread, cakes and cookies were purchased from a local supermarket. Authentic β-carotene (Fluka, EC no. 2306366) was used as the standard. All chemicals used in the experiment were of analytical grade and obtained from Fluka AG (Buks, Switzerland).

Methods

Pumpkin powder production

Pumpkins were cut into 2×3 inches pieces, peeled and soaked in 0.1% citric acid solution for 15 min and drained. The pumpkin pieces were chopped and juice extracted by a crusher and hydraulic press. The pumpkin residue was transferred to a stainless steel tray and dried in a tray dryer at 65ºC for 8 h. The dried pumpkin was ground and sifted through an 80-mesh sieve by Cycrotex sample mill.

Physicochemical analysis of pumpkin powder

Pumpkin powder was analyzed for moisture, protein, fat, ash, fiber, carbohydrate, alcohol insoluble solid, gelatinization temperature and β-carotene using the methods in AOAC (1995). A GBX Fa-st/1 (France) was used for water activity determination and L*, a*, b* color values were determined with Color Meter (Model JS 555).

Use of pumpkin powder in bakery products

Five types of bakery products (sandwich bread, sweet bread, butter cake, chiffon cake, and cookies) were chosen by a group of 350 consumers in Lampang Province, Thailand. Five levels of pumpkin powder (10, 20, 30, 40 and 50%) were substituted for wheat flour in the formula of the five bakery products. The standard formulations of the products were as follows:

1. Sandwich bread: 100% wheat flour; and 0.5% bread improver, 4.45% skim milk powder, 1% dried yeast, 62.5% water, 4% sugar, 1.65% salt, and 6% shortening pumpkin powder was substituted as % of wheat flour as % of wheat flour.

2. Sweet bread: 75% wheat flour, 25% all-purpose flour; and 0.7% bread improver, 44% fresh milk, 1.6% dry yeast, 16% egg, 14.8% sugar, 1.25% salt, and 16% butter pumpkin powder was substituted as % of wheat flour as % of wheat flour.

3. Butter cake: 100% cake flour; and 5% corn flour, 0.8% baking powder, 0.8% vanilla, 112.5% sugar, 0.4% salt, and 113.5% butter pumpkin powder was substituted as % of wheat flour as % of cake flour.

4. Chiffon cake: 100% cake flour; and 8% milk powder, 4% baking powder, 0.2% vanilla,

80% sugar (1), 1% salt, 100% egg yolk, 170% egg white, 75% water, 50% rice oil, 0.5% cream of tartar and 90% sugar (2) pumpkin powder was substituted as % of wheat flour as % of cake flour.

5. Cookies: 100% all-purpose flour; and 8.9% skim milk powder, 1.4% baking powder, 0.6% salt, 61.5% margarine, 18.5% egg, 61.5% sugar and 16.6% water pumpkin powder was substituted as % of wheat flour as % of all-purpose flour.

The preparation methods for the bakery products were adopted from Pongjanta (2002). Physicochemical and sensory properties of the pumpkin-substituted samples were determined and compared to those of the control products. Moisture content, protein, fat, ash, fiber, carbohydrate, β-carotene content, colors and water activity were analyzed as above. The texture was determined with Texture analyzer (Hounsfield Test Equipment). Sensory property was evaluated by 20 trained panelists for appearance, color, odor, taste and overall acceptance on a 9-point hedonic scale (from like extremely = 9 to dislike extremely = 1) (Watts *et al*., 1989).

Statistical analysis

A one-way analysis of variance (ANOVA), with a CRD to evaluate the means of the physicochemical properties and RCBD for sensory scores. The significant differences between treatments were compared by Duncan's Multiple Range Test (DMRT) (Watts *et al*., 1989) The accepted products were selected for consumer test and their nutrition value calculated (Halen and Mary, 1995).

Consumer test

The consumer test was conducted at Big C Supermarket in Muang District, Lampang Province, Thailand. One hundred consumers were randomly selected. Questionnaires were used to collect consumer profile data. Small pieces of samples were prepared for each panelist. The 9-points hedonic scale was used for scoring the samples. The results were statistically analyzed with SPSS 10.0.

Results and Discussion

Physicochemical properties of pumpkin powder

Physicochemical properties of pumpkin

Table 1. Physicochemical properties of pumpkin powder and fresh pumpkin

Physicochemical Properties[1]	Fresh Pumpkin	Pumpkin Powder
Color (L*)	32.98^{b}±1.35	57.81^{a}±4.74
(a*)	4.70^{b}±1.16	8.31^{a}±1.81
(b*)	23.26^{b}±1.03	34.39^{a}±1.90
β-carotene (mg./100 gram sample)	2.43^{b}±1.14	7.29^{a}±3.82
Moisture content (%)	84.32^{a}±3.75	6.01^{b}±1.47
Protein (%)	1.29^{b}±0.43	3.74^{a}±0.68
Fat (%)	1.45^{ns}±0.50	1.34^{ns}±0.64
Ash (%)	1.26^{b}±0.32	7.24^{a}±0.79
Crude fiber (%)	1.17^{b}±0.08	2.90^{a}±0.47
Carbohydrate (%)	10.51^{b}±1.08	78.77^{a}±5.42
Total soluble solid (ºbrix)	9.27±1.13	-
Alcohol insoluble solid (%)	5.77^{b}±1.75	56.04^{a}±5.32
Water activity (aw)	0.973^{a}±0.35	0.24^{b}±0.02
Gelatinization temperature (ºC)	-	90.00±2.20

[1]Mean (n=3).
[a,b] : Means within the same row with different superscripts are significantly different ($p<0.05$).
[ns] : No significant difference.

powder and fresh pumpkin are shown in Table 1. L*, a* and b* color values and β-carotene were significantly ($p \leq 0.05$) higher in pumpkin powder than in fresh pumpkin. L* values of pumpkin powder (57.81) were brighter than of fresh pumpkin (32.98). The average a* value of pumpkin powder

Table 2. Color values, water activity, texture and β-carotene contents of bakery products at different level of substituted wheat flour with pumpkin powder.

Bakery Product	Pumpkin Powder Substitution (%)	Color Value			a_w	Texture (kg/cm²)	β-carotene mg/100 g
		L*	a*	b*			
Sandwich - bread	(control) 0	27.65^{a}	0.73^{f}	2.64^{d}	0.954^{ns}	0.098^{a}	0.025^{d}
	10	27.54^{a}	0.87^{e}	10.61^{c}	0.950	0.039^{b}	0.415^{c}
	20	26.62^{b}	2.01^{d}	10.92^{c}	0.948	0.036^{b}	0.520^{b}
	30	26.54^{ab}	2.68^{c}	13.38^{a}	0.947	0.093^{ab}	0.592^{b}
	40	23.83^{c}	3.54^{a}	13.68^{a}	0.933	0.108^{a}	0.651^{ab}
	50	22.38^{d}	3.94^{a}	12.54^{a}	0.935	0.149^{a}	0.745^{a}
	C.V. (%)	2.81	3.16	4.39	0.70	31.91	7.188
Sweet bread	(control) 0	65.95^{a}	0.59^{c}	12.94^{d}	0.805^{ns}	0.08^{ns}	0.14d
	10	68.56^{a}	1.61^{c}	15.21^{c}	0.812	0.020	0.29^{c}
	20	65.97^{b}	2.15^{bc}	16.08^{a}	0.828	0.015	0.30^{b}
	30	66.57^{b}	2.34^{ab}	16.19^{a}	0.850	0.017	0.45^{ab}
	40	65.38^{b}	2.77^{a}	15.96^{ab}	0.853	0.011	0.50^{a}
	50	66.07^{b}	3.89^{a}	15.32^{bc}	0.843	0.014	0.64^{a}
	C.V. (%)	1.71	28.84	0.682	1.471	23.48	12.241
Butter cake	(control) 0	31.44^{a}	-0.24^{e}	12.94^{d}	0.805^{ns}	0.018^{ns}	0.20^{f}
	10	30.38^{b}	0.60^{d}	15.21^{c}	0.812	0.020	0.47^{e}
	20	28.92^{c}	0.87^{d}	16.08^{a}	0.828	0.015	0.62^{d}
	30	27.68^{d}	1.58^{c}	16.19^{a}	0.850	0.017	0.79^{c}
	40	26.32^{e}	2.12^{b}	15.96^{ab}	0.853	0.011	0.84^{b}
	50	25.12^{f}	2.60^{a}	15.32^{bc}	0.843	0.014	0.93^{a}
	C.V. (%)	1.64	12.99	0.682	1.47	23.48	1.570
Chiffon cake	(control) 0	76.12^{a}	-1.36^{e}	25.70^{c}	0.936^{ns}	0.007^{ns}	0.08^{d}
	10	72.21^{b}	0.29^{d}	35.66^{b}	0.937	0.006	0.37^{c}
	20	69.64^{c}	0.71^{d}	36.39^{b}	0.937	0.006	0.46^{c}
	30	64.52^{d}	3.02^{c}	47.08^{a}	0.943	0.008	0.56^{b}
	40	64.92^{d}	1.95^{c}	42.53^{a}	0.930	0.006	0.64^{ab}
	50	61.85^{e}	4.20^{a}	46.20^{a}	0.929	0.009	0.74^{a}
	C.V. (%)	0.92	41.29	6.505	0.374	36.721	1.387
Cookies	(control) 0	63.91^{a}	6.26^{e}	33.91^{e}	0.383^{c}	0.157^{cd}	0.06^{d}
	10	58.45^{b}	8.04^{d}	41.63^{d}	0.380^{c}	0.090^{d}	0.15^{c}
	20	54.70^{c}	9.72^{d}	43.43^{b}	0.413^{a}	0.104^{b}	0.20^{b}
	30	49.97^{d}	10.71^{b}	43.65^{b}	0.410^{ab}	0.277^{a}	0.35^{b}
	40	48.74^{d}	10.74^{c}	53.68^{a}	0.360^{d}	0.188^{bc}	0.40^{a}
	50	47.03^{e}	12.41^{a}	52.54^{a}	0.407^{b}	0.204^{ab}	0.54^{a}
	C.V. (%)	0.420	1.921	4.390	1.110	24.660	15.620

^{a,b} : Means within columns followed by a different letter are significantly different ($p \leq 0.05$)
^{ns} : No significant difference ($p > 0.05$)

was higher (8.31) than that of fresh pumpkin (4.70), indicating more redness in pumpkin powder. An average b* value of pumpkin powder (34.39) was also higher than of fresh pumpkin (23.26), indicating more yellow. The pumpkin powder had a higher β-carotene content (7.29 mg/100 g samples)

Table 3. Sensory attributes of bakery products at different levels of wheat flour substituted with pumpkin powder.

Bakery Product	% Pumpkin Powder	Sensory Attributes					
		Appearance	Color	Odor	Taste	Texture	Total Acceptance
Sandwich - bread	(control) 0	6.80^{a}	6.83^{a}	6.86^{a}	7.03^{a}	7.03^{a}	7.00^{a}
	10	7.10^{a}	7.26^{a}	6.83^{a}	6.96^{a}	7.06^{a}	7.06^{a}
	20	5.33^{b}	5.53^{b}	5.20^{b}	4.90^{b}	5.03^{b}	5.13^{b}
	30	5.56^{b}	4.80^{c}	4.20^{c}	3.60^{c}	4.06^{c}	4.06^{c}
	40	3.86^{c}	3.66^{d}	3.26^{d}	2.96^{cd}	2.86^{d}	3.00^{d}
	50	3.26^{c}	3.13^{d}	2.73^{d}	2.53^{d}	2.53^{d}	2.33^{d}
	C.V. (%)	20.60	18.52	21.33	19.93	21.55	20.80
Sweet bread	(control) 0	6.78^{a}	6.60^{a}	6.66^{a}	7.28^{a}	7.00^{ab}	7.13^{a}
	5	6.91^{a}	6.59^{a}	6.56^{a}	7.20^{a}	8.20^{a}	7.16^{a}
	10	6.71^{a}	6.90^{a}	6.00^{b}	6.73^{b}	6.53^{b}	6.43^{b}
	15	6.30^{b}	6.66^{a}	5.90^{b}	6.56^{b}	6.35^{b}	6.36^{b}
	20	5.80^{c}	5.71^{b}	4.88^{c}	5.96^{c}	5.75^{b}	5.63^{c}
	25	5.85^{c}	5.61^{b}	4.78^{c}	6.00^{c}	5.71^{b}	5.66^{c}
	C.V. (%)	12.18	14.28	17.95	13.49	44.06	12.48
Butter cake	(control) 0	6.13^{ns}	5.93^{ab}	5.53^{ns}	6.43^{b}	6.13^{b}	5.93^{b}
	10	6.60	6.86^{a}	6.53	7.06^{ab}	7.06^{a}	6.67^{a}
	20	6.50	6.80^{a}	6.66	7.26^{a}	7.20^{a}	6.90^{a}
	30	5.50	5.60^{b}	5.43	6.20^{b}	6.03^{b}	5.56^{b}
	40	5.36	5.83^{b}	5.73	6.26^{b}	6.36^{b}	6.16^{ab}
	50	5.50	5.30^{c}	5.66	5.90^{b}	6.10^{b}	5.93^{ab}
	C.V. (%)	27.25	27.45	25.93	20.85	21.43	25.25
Chiffon cake	(control) 0	7.16^{a}	6.80^{a}	5.53^{ab}	7.23^{a}	7.13^{a}	7.16^{a}
	10	6.86^{a}	7.13^{a}	6.43^{a}	6.96^{a}	6.66^{ab}	6.93^{a}
	20	6.73^{a}	7.06^{a}	6.30^{a}	6.80^{ab}	6.43^{abc}	6.63^{ab}
	30	5.23^{b}	5.70^{b}	5.56^{ab}	5.83^{cd}	5.66^{cd}	5.60^{b}
	40	5.40^{b}	5.73^{b}	5.30^{b}	6.20^{bc}	6.03^{bc}	5.60^{b}
	50	4.23^{b}	5.90^{b}	4.20^{c}	5.13^{d}	4.86^{d}	4.60^{c}
	C.V. (%)	25.97	20.77	24.05	15.18	18.37	18.85
Cookies	(control) 0	6.81^{a}	6.56^{ab}	6.88^{a}	7.08^{a}	7.16^{a}	7.11^{a}
	10	7.03^{a}	7.16^{a}	6.46^{ab}	6.80^{a}	6.51^{ab}	6.75^{a}
	20	6.78^{a}	6.91^{ab}	5.75^{bc}	6.03^{b}	5.15^{b}	5.80^{b}
	30	6.23^{ab}	6.13^{b}	5.16^{cd}	5.83^{b}	4.58^{bc}	5.10^{bc}
	40	5.43^{b}	5.26^{c}	4.63^{de}	5.33^{b}	5.41^{b}	4.93^{c}
	50	5.45^{b}	4.96^{c}	4.00^{e}	4.43^{c}	4.11^{c}	4.13^{d}
	C.V. (%)	18.47	18.78	19.26	17.14	12.77	18.34

^{a,b} : Means within columns followed by a different letter are significantly different ($p \leq 0.05$)
^{ns} : No significant difference ($p > 0.05$)

than fresh pumpkin. It contained 6.01% moisture, 3.74% protein, 1.34% fat, 7.24% ash, 2.9% fiber, 78.77% carbohydrate, 56.04% alcohol insoluble solids, with gelatinization temperature of 90ºC and 0.24 water activity. Fresh pumpkin consisted of 84.32% moisture, 1.29% protein, 1.45% fat, 1.26% ash, 1.17% fiber, 10.51% carbohydrate, 9.27ºbrix of total soluble solids, 5.77% alcohol insoluble solid, and 0.973 water activity.

Physicochemical properties of bakery products with substituted pumpkin powder

Color, water activity, texture characteristic and β-carotene content of bakery products at different levels of pumpkin powder substitution of wheat flour are shown in Table 2. Pumpkin powder substitution at 10 to 50% in the formulations significantly ($p \leq 0.05$) increased the β-carotene content in the samples, by 2.35-4.65 times in butter cake, and 4.60-9.25 times in chiffon cake. With 5-25 % substitution, the β-carotene contents increased 2.18-8.0 times in sweet bread, 16.60-29.80 times in sandwich bread and 2.44-5.29 times in cookies. The average b* values of all pumpkin powder-substituted samples were higher than of the control. However, water activity and texture were not significantly different ($p>0.05$) for all levels of pumpkin powder substitution in butter cake, chiffon cake and sweet bread. The 20% substitution in sandwich bread and cookies gave lower texture values than the control.

Sensory evaluation

The mean scores of different sensory parameters of pumpkin powder-substituted sandwich bread, sweet bread, butter cake, chiffon cake, and cookies are shown in Table 3. The appearance, color, odor, taste, texture and overall acceptance scores of 10% substitution in sandwich bread, sweet bread and cookies were not significantly

Table 4. Nutritive value of bread and cookies at 10% substitution and butter cake and chiffon cake at 20% substitution.

Nutritive Value	Pumpkin-substituted Products (100 g sample)					Thai RDI[/1] per day (g)
	Sandwich Bread	Sweet Bread	Butter Cake	Chiffon Cake	Cookies	
Moisture	13.82	26.29	40.85	34.02	1.48	
Protein	7.08	8.05	12.20	8.47	6.77	
- % Thai RDI/each[/2]	(14.16)	(16.10)	(24.40)	(16.94)	(13.54)	50
Ash	1.65	2.90	2.85	2.25	1.78	
Fat	4.43	11.20	29.70	17.77	22.68	
- % Thai RDI/each	(6.81)	(17.22)	(45.69)	(27.34)	(34.89)	65
Fiber	0.42	0.63	0.86	0.56	0.89	
- % Thai RDI/each	(0.17)	(0.25)	(0.34)	(0.22)	(0.35)	25
Carbohydrate	47.64	51.49	39.62	37.43	67.20	
- % Thai RDI/each	(13.20)	(17.16)	(15.88)	(12.47)	(22.39)	300
Total energy (kcal)	247.22	338.94	486.22	343.58	479.98	
β-carotene (mg)	0.41	0.09	0.62	0.46	0.15	
Vitamin A (µg. RE)[/3]	68.33	15.00	103.33	76.67	25.00	
- % Thai RDI/each	(8.54)	(1.88)	(12.92)	(9.58)	(3.13)	800

[/1] Adapted value from Ratanapanon and Ratanapanon (1997)
[/2] % Thai RDI = Percent of Thai recommended daily intake for over 6 years old based on a 2,000 calories diet that was calculated by each of consume at 30 g of sandwich bread, 30 g of sweet bread, 40 g of butter cake, 20 g of chiffon and 30 g of cookies.
[/3] Vitamin A (µg RE) = µg.β-carotene/6 (Olson,1989)

different (p>0.05) from the control, ranging from "like slightly" to "like moderately". The mean scores for all quality attributes of 20% substitution in butter cake and chiffon cake were higher than of the control, but not significantly different (p>0.05).

Substituting a portion of wheat flour with pumpkin powder in sandwich bread, sweet bread, and cookies were acceptable at 10% level and 20% in butter cakes and chiffon cake. Further increase in the substitution level would affect color, volume and overall acceptability of the products. Thus, for sandwich bread, sweet bread and cookies 10% pumpkin powder substitution in the formulation was optimum, while 20% substitution in butter cake and chiffon cake was acceptable.

Nutritive value of the bakery products substituted with pumpkin powder

Nutritive value of sandwich bread, sweet bread, butter cake, chiffon cake, and cookies at 10-20% substitution levels are shown in Table 4. The products were composed of 6.77-12.20% protein, 4.43-29.70% crude fat, 0.42-0.89% crude fiber, and 37.43-67.20% carbohydrate, depending on the type of the products. The caloric value of the bakery products ranged from 247.22 to 486.22 kcal/100 g samples. The products were generally high in fat and carbohydrate and lower in fiber. According to the Thai RDI, the products are high in fat and low in fiber content. Especially, butter cake (40 g) contained more than 45.69% of fat

Table 5. Characteristics of the respondents

Characteristics	Bakery Products / Frequency (%)				
	Sandwich	Sweet Bread	Butter Cake	Chiffon Cake	Cookies
1. Sex - Female	63.0	72.0	69.0	66.1	71.0
- Male	37.0	28.0	31.0	34.0	29.0
2. Age - 20 or less	27.0	32.0	17.0	10.0	30.0
- 21-30	40.0	33.0	42.0	31.0	39.0
- 31-40	17.0	16.0	20.0	28.0	12.0
- 41 or over	16.0	19.0	21.0	26.0	17.0
3. Education - Diploma	51.0	58.0	55.0	41.0	51.0
- Bachelor	46.0	38.0	37.0	48.0	41.0
- Master	3.0	4.0	8.0	11.0	8.0
4. Occupation - Student	48.0	49.0	34.0	28.0	54.0
- Government employee	7.0	3.0	15.0	9.0	2.0
- Private employee	43.0	48.0	51.0	63.0	44.0
5. Monthly income (Bath.)					
- 5,000 or less	33.0	37.0	35.0	20.0	42.0
- 5,001-10,000	40.0	33.0	36.0	44.0	30.0
- 10,001-15,000	17.0	17.0	13.0	11.0	12.0
- 15,001 or over	10.0	13.0	16.0	25.0	16.0
6. Frequency of eating					
- every days	19.0	19.0	17.0	23.0	14.0
- 3-5 times / week	44.0	45.0	53.0	53.0	41.0
- depend on occasion	37.0	46.0	30.0	24.0	33.0
7. Place for buying					
- Fresh market	11.0	10.0	10.0	12.0	12.0
- Grocery	39.0	39.0	53.0	37.0	44.0
- Supermarket	43.0	40.00	29.0	42.0	30.0
- Others	7.0	11.00	8.0	9.0	14.0

recommended daily intake, while butter cake contained only 0.34% of fiber recommended daily intake. The use of pumpkin powder to substitute wheat flour in the baked products would increase the level of vitamin A recommended daily intake in the products, ranging from 1.88 to 12.92% (Table 4).

Consumer test of the bakery products substituted with pumpkin powder

The characteristics of the respondents are shown in Table 5. The questionnaires for five types of bakery products were collected and processed. More than 63% of the consumers were ladies with average age between 21-30 years. Between 41-58% of them had diplomas and bachelor degrees. Among them, 43-63% were students and private employees. Between 30-44% of the consumers had average monthly income of 5,001 to 10,000 baht. All (100%) of the consumers had been eating bakery products, with 53% of them consuming bakery products, mainly obtained from the grocery and supermarket, at 3-5 times a week.

The mean scores of different sensory parameters of pumpkin-substituted sandwich bread, sweet bread, butter cake, chiffon and cookies by the consumers are shown in Table 6. The mean scores were significantly different ($p \leq 0.05$) between products. The color, appearance, odor and taste scores were highest in pumpkin cookies, while the mean score for texture (7.64) was highest in pumpkin chiffon cake. The overall acceptability

Table 6. Mean scores of pumpkin sandwich, pumpkin sweet bread, pumpkin butter cake, pumpkin chiffon and pumpkin cookies from consumer test.

Characteristic score[/1]	Products				
	Sandwich Bread	Sweet Bread	Butter Cake	Chiffon Cake	Cookies
Color and Appearance	7.08 [c/2]	7.03 [c]	7.01 [c]	7.35 [b]	7.74 [a]
Odor	6.38 [c]	7.13 [b]	7.29 [b]	7.43 [a]	7.41 [a]
Taste	6.01 [c]	7.08 [b]	7.40 [a]	7.59 [a]	7.49 [a]
Texture	6.89 [c]	7.44 [b]	7.30 [b]	7.64 [a]	7.30 [b]
Total acceptance	6.59 [c]	7.16 [b]	7.16 [b]	7.55 [a]	7.51 [a]

[/1] **Mean of value, score 1 indicates dislike extremely and 9 like extremely**
[/2 a,b] **: Means within rows followed by a different letter are significantly different ($p \leq 0.05$)**

Table 7. Products acceptance and buying decision of sandwich bread, sweet bread, butter cake, chiffon cake and cookies[/1]

Acceptance	Products				
	Sandwich	Bread	Sweet Bread	Butter Cake	Chiffon Cake
Cookies					
Product acceptance (%)					
- Acceptance	81.0	90.0	97.0	100.0	92.0
- Non acceptance	19.0	10.0	3.0	0	8.0
Decision of Buying (%)					
- Buy	52.0	60.0	53.0	56.0	61.0
- not ensure	23.0	17.0	22.0	27.0	22.0
- Not buy	25.0	23.0	25.0	17.0	17.0

[/1] **100 respondents per one product**

score was highest (7.55) in pumpkin chiffon cake. Between 90-100% of the respondents accepted and would buy the products (Table 7). Pumpkin chiffon cake was most preferred, followed by pumpkin cookies, pumpkin butter cake, pumpkin sweet bread and pumpkin sandwich bread.

Conclusion

This study revealed that pumpkin powder significantly enhances β-carotene content in supplemented bakery products. More than 15% of pumpkin powder substitution in sandwich bread, sweet bread and cookie formulations had too strong an effect on the physical and sensory properties of the products, while 20% pumpkin powder was optimum for butter cake, and chiffon cake. The substituted products had high energy content. A composite of pumpkin powder and wheat flour increased vitamin A from 1.88 to 12.92% per 20 to 40 g of the baked products consumed. Chiffon cake, sandwiches bread, sweet bread, butter cake, and pumpkin cookies were accepted by the consumers at the level of "like moderately" to "like very much". Most of the respondents (90-100 %) would accept and buy the products.

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