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Effect of Reducing Fat and Using Fat Replacers in the Crust of Flaky Chinese Pastry

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ABSTRACT

Flaky Chinese pastry (Pia), is a small Chinese pastry filled with mungbean conserve and is a popular bakery product. Its crust is made from wheat flour, fat, water, sugar and salt, with mungbean conserve stuffed inside. This research aimed to lower the fat content in Pia by using fat replacers in the outer crust that had high liking scores from untrained panelists. Maltodextrin gel and inulin gel were used as fat replacers. The results indicated that the hardness of the product increased slightly with the reduction in fat content, while the extension and puffiness decreased. Panelists liked products in which the fat content in the outer crust was reduced by 45% and replaced by 50% of its weight with inulin gel in the formula. The overall liking of the developed product was at a moderate level, which was not significantly ($p > 0.05$) different from the control. The chemical composition of this formula was analyzed and showed that the fat, total calories and calories from fat could be reduced by 10.5, 3.02 and 10.05%, respectively.

Keywords: Chinese pastry, reduced-fat, fat replacer, inulin, maltodextrin

INTRODUCTION

Nowadays, consumers have a deep concern for their health and so they would like to limit the quantity of fat in their diet. Therefore, many types of fat replacer are used to improve the quality of food and this affects the appearance and taste of the food. The three main categories of fat replacers are based on a carbohydrate, protein or lipid (Calorie Control Council, 2004). Fat replacers in baked products should be stable at high temperatures and be classified as GRAS (Generally Recognized As Safe). O'Brien *et al.* (2003) studied the performance of inulin gel in wheat bread compared with normal shortening and found that bread containing 2.5% inulin gel was similar in qualitative characteristics to the control. Pimdit *et al*. (2008) also used maltodextrin gel as a fat replacer in puff pastry.

Flaky Chinese pastry (Pia) is a baked product. Most consumers like the small Chinese pastry stuffed with mungbean conserve (Khanom Pia Lek) (Marischai, 2003; Pitukboonyarat, 2004). The flaky crust is made from wheat flour, fat or oil, water, sugar and salt with mungbean conserve for the stuffing. A well prepared product should

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have many layers of thin soft crust without any cracking in the surface. The filling is not exposed except where intended to provide a specialized appearance (Aiumpituk, undated; Thai Industrial Standards Institute, 2006). The process for making flaky Chinese pastry-making involves dividing the crust into two parts (an inner and an outer crust). Fat in each part of the crust performs different functions. Fat in the inner crust is important for the layering formationand the puffiness that is specific to flaky Chinese pastry. In contrast, fat in the outer crust provides structure, stability and the film-forming property, due to a gluten lubrication effect. Hence, using a fat replacer will affect the characteristics of product. The objective of the present research was to develop a reduced-fat crust of flaky Chinese pastry by reducing the fat content together with adding fat replacers to obtain an acceptable product overall that had appearance, texture and flavor that were accepted by consumers. The developed reduced-fat crust will be used as a guideline for success in producing reduced-calorie flaky Chinese pastry (Khanom Pia Lek).

Therefore, the level of fat reduction and the application of fat replacers (maltodextrin gel and inulin gel) were investigated and the chemical compositions of the products were analyzed.

MATERIALS AND METHODS

Materials

All-purpose wheat flour (Kite), cake flour (Red Lotus), shortening (Cream Topp), rice bran oil (King), cane sugar (Mitr phol) and peeled mungbean (Raitip) were used to make flaky Chinese pastry. Inulin (Raftiline HP) and maltodextrin DE10, provided by the Abbra Corporation Co. Ltd, were used as the fat replacers in this research.

Production of flaky Chinese pastry (Khanom Pia Lek)

The crust of this product consisted of two parts (Table 1). The inner crust was prepared by mixing cake flour and shortening together at a low speed in a mixer (Kitchen Aid, Model 5KPM50) for 3 min. After that, the inner crust was divided into pieces (3 g) and rested for 10 min. The outer crust was prepared by mixing the ingredients at a medium speed for 3 min, after which the dough was cut into pieces (5 g) and rested for 15 min.

Table 1 Ingredients of flaky Chinese pastry filled with mungbean conserve.

Ingredient	Amount (%)
Crust	
- Inner crust	
Cake flour	27.45
Shortening	10.98
- Outer crust	
All-purpose flour	31.37
Shortening	10.20
Sugar	6.27
Water	13.73
Filling (mungbean conserve)	
Peeled mungbean, steamed and mashed	51.28
Sugar	30.77
Rice bran oil	17.95

Source: UFM Baking and Cooking School (1995).

The inner crust was then wrapped with the outer crust and rolled and three-folded twice. The mungbean conserve (15 g) was then wrapped in the crust and baked in an electric oven (EKA, Model 648E) at 200°C for 15 min.

The mungbean conserve filling was prepared by soaking dehulled mungbeans in water for 2 h. Then, the soaked beans were steamed for 30 min before being finely mashed and then mixed with sugar and rice bran oil (Table 1) and stirred at 80°C for 20 min.

Preparation of fat replacer for producing the crust

Inulin gel and maltodextrin gel were used as fat replacers. Inulin gel was prepared by dissolving inulin powder at a concentration of 20% (w/w) in water at 80-90°C for 3 min and cooling down at room temperature. This solution was stored at 4°C for 24 h (modified from Kim *et al*., 2001; Zoulias *et al*., 2002). Maltodextrin gel was prepared by dissolving maltodextrin powder in water at 30% (w/w) at 72±1°C for 15 min and then standing at 5.5°C for 24 h (Leslie, 1999). In addition, the qualities of both gels were compared to shortening. The hardness of the gel was analyzed by a texture analyzer (Stable Micro System, Model TA-XT2i, England) using compressive force with a 6 mm diameter cylinder probe (P/6), 1.0 mm/s test speed, 50% strain and 1.0 s test time. Color was measured by a chromameter (Ultra Scan, Model XE/IX7, USA). Color values were expressed as L*(lightness), a*(redness/greenness) and b*(yellowness/blueness). The chemical qualities were determined by proximate analysis with the standard method described in AOAC (2000).

Reduction of fat in crust

A full-fat formula was used as a control product and the fat content in the crust was reduced using a completely randomized design (CRD) experiment. Shortening used for the outer crust was reduced at levels of 15, 30, 45 and 60% of shortening weight. The product samples were evaluated for texture profile analysis at room temperature by using a cylinder probe (50 mm diameter; P/50) and color analysis was performed according to previously described methods, while the size and volume of products were measured by a set of vernier calipers and sesame seed displacement (Lee *et al*., 1982), respectively. The formula which had the lowest fat level whilst still providing manufacturing ability, having many thin layer crusts and being soft and having an unbroken surface, was selected for use in the fat replacement experiments.

Replacement of fat in crust with fat replacer

The content of fat replacers was varied using a completely randomized design (CRD). Inulin gel or maltodextrin gel was added at levels of 25, 50, 75 and 100% by shortening weight in the outer crust. These levels were determined based on practicability, texture, color, size and volume of products, which were made according to previously described methods and using sensory evaluation with a randomized complete block design (RCBD) when the sample size was less than or equal to six and with a balanced incomplete block (BIB) design when the sample size was greater than six. The samples were rated by untrained panelists for the degree of liking using a 9-point hedonic scale (from 1 = extremely dislike to 9 = extremely like). The formula of the sample with the highest scores was accepted for this study.

Determination of chemical composition

The chemical composition of the product was determined by proximate analysis with the standard methods described in AOAC (2000).

Statistical analysis

Data obtained from this study were analyzed statistically using a t-test at the 95% level of confidence, analysis of variance (ANOVA) and the differences between average values were compared by Duncan's new multiple range test (DMRT) using the SPSS computer software, Version 16.0. (Niyomvit, 1994; Khuantham, 1999).

RESULTS AND DISCUSSION

Physical and chemical qualities of fat replacers

The inulin gel was like a thick, white cream but the maltodextrin gel was thicker and like a light brown gel. The physical and chemical parameters of both gels are presented in Table 2. In addition, shortening was used as a control. The maltodextrin gel had a higher hardness and was darker than the inulin gel and shortening, respectively, because the maltodextrin gel was prepared by heating for a longer time causing water evaporation and a decrease in its lightness value (L*) (Leslie, 1999). The shortening contained higher amounts of fat and total energy than both gels, because the main composition of the shortening was fat. Both the inulin gel and the maltodextrin gel were carbohydrate-based and were prepared by dissolving in water, so they contained more moisture than the shortening. Since inulin is a source of dietary fiber (Roberfloid, 1999; Veerotai, 2002), the crude fiber content was detectable in the inulin gel, while it was not detectable in the shortening and maltodextrin gel.

Reduction amount of fat in crust

The appearance of the products with the outer crust having three different levels of reduced fat content (15, 30 and 45% of shortening weight) was similar to the full-fat product (control). Reducing fat up to 60% resulted in the dough not being able to be spread, causing denser texture and less puffiness of the final product. Table 3 shows the results of the analysis of texture, color, size and specific volume of the products with various fat reduction levels in the crust. The hardness, fracturability, cohesiveness and chewiness of the products increased, while the springiness decreased with decreasing fat content. However, these products were not significantly ($p > 0.05$)

Table 2 Physical and chemical parameters of fat replacers. (Data shown are mean ± standard deviation, where applicable).

Parameter	Shortening	Fat replacer	
		Inulin gel	Maltodextrin gel
Physical			
Hardness (g)	2.04±0.78	5.25±0.19	8.43±0.02
Color value			
Lightness (L*)	88.09±0.81	88.39±0.12	69.75±2.07
Redness (a*)	(-2.75)±0.04	0.06±0.02	(-0.34)±0.03
Yellowness (b*)	12.02±0.01	4.98±0.49	5.97±0.29
Chemical			
Moisture (%)	15.10	76.10	45.50
Fat (%)	84.90	0	0.02
Protein (%)	0	0	0.02
Crude fiber (%)	0	1.20	0
Ash (%)	0	0.03	0.08
Carbohydrate (%)	0	23.87	54.38
Total calories (kcal/100g)*	764.10	95.48	217.78

* Calorie value by calculation.

different from the control, because the Chinese pastry contained a greater amount of filling than crust and their sizes were small. Hence, moisture from the filling could transfer to the crust easily, making the crust softer after baking (Kanto, 2002). Color measurement indicated that the fat-reduced crust had higher L* values than the control. On the other hand, the redness and yellowness values tended to be lower. The sizes of the samples with different levels of fat content were not significantly ($p > 0.05$) different, but the specific volumes were significantly ($p \geq 0.05$) different. Reducing the fat content caused a decrease in the expansion of the products because of the shortening properties of the fat in the pastry dough (Chammek and Naivikul, 2003). Although it was possible to produce a product with the fat content reduced to 60%, it was quite hard to mold the shape of the product due to the stickiness of the dough. Therefore, 45% fat reduction in the outer crust was selected for further study on fat replacement, because this represented the highest reduction of fat where the product looked close to that of the control and the practicability of the process was maintained.

Replacement of fat in crust with fat replacer

The outer crusts of flaky Chinese pastry containing inulin gel or maltodextrin gel were hard to sheet and fill with the mungbean conserve. Moreover, the hardness of the products was increased. The dough of the outer crust was too sticky when the fat replacement was at levels of 100% inulin gel or at 75 or 100% maltodextrin gel. Therefore, the crusts with the fat replaced at levels of 25, 50 and 75% inulin gel, as well as 25 and 50% maltodextrin gel were analyzed for their physical and sensory qualities and compared with the full-fat (control) and the 45% reduced-fat outer crusts.

Table 3 Physical qualities of the products in which the fat content in the outer crust was reduced (mean±standard deviation).

Quality	Reduction of fat in the outer crust (%)				
	0 (Control)	15	30	45	60
Texture					
Hardness ^{ns} (g)	1879.73±4.61	1880.30±4.65	1882.51±3.67	1885.97±3.71	1889.93±5.21
Fracturability ^{ns}(g)	1584.93±5.94	1585.90±5.46	1585.99±5.44	1586.95±4.41	1610.73±4.19
Springiness ^{ns}(mm)	0.32±0.02	0.31±0.02	0.31±0.01	0.30±0.01	0.30±0.01
Cohesiveness ^{ns}	0.09±0.01	0.10±0.01	0.10±0.00	0.10±0.01	0.11±0.00
Chewiness^{ns} (g.mm)	74.20±1.64	74.40±1.83	75.20±2.01	75.99±1.33	78.14±3.07
Color value					
Lightness (L*)	70.80±1.10^{c}	71.47±0.78^{c}	72.00±0.47^{b}	72.28±0.32^{b}	73.42±1.16^{a}
Redness (a*)^{ns}	1.62±0.19	1.53±0.10	1.47±0.08	1.48±0.27	1.44±0.15
Yellowness (b*) ^{ns}	16.42±0.31	16.44±0.12	16.30±1.18	16.34±0.98	16.30±1.21
Size (cm)					
Diameter^{ns}	3.95±0.05	3.93±0.76	3.95±0.05	3.93±0.06	3.95±0.09
Height^{ns}	3.17±0.06	3.18±0.03	3.20±0.00	3.20±0.00	3.20±0.00
Specific volume (cm^3/g)	1.31±0.02^{a}	1.29±0.01^{a}	1.28±0.01^{b}	1.28±0.01^{b}	1.27±0.01^{b}

^{a,b,c} = Means within the same row with the same letter are significantly different ($p \leq 0.05$).

^{ns} = Means within the same row are not significantly different ($p > 0.05$).

The physical properties of the products from the seven treatments are shown in Table 4. The cohesiveness of all products was significantly ($p \leq 0.05$) different, but there were no significant ($p > 0.05$) differences among samples in hardness, fracturability, springiness and chewiness. In addition, the products with fat replacers were harder than the control and the 45% reduced-fat products. Color measurement indicated that the products with either inulin gel or maltodextrin gel had increased redness and yellowness. These results were similar to Praznik (2002), who used inulin powder in bread making. The present results showed that the reducing power of inulin might increase the Maillard reaction, leading to a brown color in the products. Moreover, the size (diameter and height) of the products was significantly ($p \leq 0.05$) different, but there were no significant ($p > 0.05$) differences in the specific volume. Samples with fat replacers had smaller size and specific volume than the control and the 45% reduced-fat products, similar to the study of Pimdit *et al.* (2008) using reduced-fat puff pastry. This result was due to the fact that fat replacers generally absorbed more water (Akoh, 1998), so the water had a chance to form more gluten strands and there was less fat to shorten the gluten strands.

The sensory qualities of the products from the seven treatments are shown in Table 5, which were evaluated using a BIB experimental design with 21 untrained panelists. There were no significant ($p > 0.05$) differences in appearance, crust color, puffiness, flavor and taste. On the contrary, softness and overall preference were significantly ($p \leq 0.05$) different. This result may suggest that the softness of the products decreased as the level of fat replacement increased, especially when maltodextrin gel was used in the treatment. The 50% inulin gel content was selected to replace shortening in the 45% reduced-fat formula obtained from the previous experiment. The liking scores of the treatment with 50% inulin gel were not significantly ($p > 0.05$) different from those of other treatments (except the treatment with 75% inulin gel). The selection of the treatment should be based on the highest amount of fat replacer that can be used in the formulation. Therefore, in this formula, the inner crust consisted of 28.77% cake flour with 11.51% shortening, and the outer crust was composed of 32.88% all-purpose flour, 2.94% shortening, 2.94% inulin gel, 6.57% sugar and 14.39% water.

Table 4 Physical qualities of the products containing a fat replacer in the 45% reduced-fat outer crust (mean±standard deviation).

Quality	Control	45% reduced-fat	Fat replacer (%)				
			Inulin gel			Maltodextrin gel	
			25	50	75	25	50
Texture							
Hardness ^{ns} (g)	1879.73±4.61	1885.97±3.71	1886.42±6.21	1888.56±1.93	1891.77±5.91	1888.97±2.80	1902.58±2.15
Fracturability ^{ns}(g)	1584.93±5.94	1586.95±4.41	1586.04±1.28	1587.55±3.63	1588.14±1.85	1586.05±4.14	1589.04±2.51
Springiness ^{ns}(mm)	0.32±0.02	0.30±0.01	0.29±0.15	0.32±0.01	0.31±0.01	0.31±0.00	0.30±0.01
Cohesiveness	0.094±0.20^{cd}	0.096±0.01^{cd}	0.090±0.00^{d}	0.090±0.00^{d}	0.100±0.01^{bc}	0.108±0.00^{ab}	0.114±0.00^{a}
Chewiness^{ns} (g.mm)	74.20±1.64	75.99±1.33	75.33±2.23	76.20±2.62	77.73±5.96	75.43±1.63	76.79±2.01
Color value							
Lightness (L*) ^{ns}	70.80±1.10	72.28±0.32	71.40±0.61	71.03±0.83	71.18±0.67	72.21±0.54	71.71±0.23
Redness (a*)	1.62±0.19^{bc}	1.48±0.27^{c}	1.81±0.16^{bc}	1.85±0.09^{bc}	1.98±0.05^{b}	2.47±0.03^{a}	2.52±0.46^{a}
Yellowness (b*)	16.42±0.31^{c}	16.34±0.98^{c}	17.16±0.20^{c}	18.81 ±1.08^{b}	19.30±1.32^{ab}	19.78±0.32^{ab}	20.49±1.14^{a}
Size (cm)							
Diameter	3.95±0.05^{a}	3.93±0.06^{a}	3.68±0.08^{b}	3.68±0.03^{b}	3.67±0.03^{b}	3.78±0.15^{b}	3.77±0.10^{b}
Height	3.17±0.06^{ab}	3.20±0.00^{a}	3.15±0.05^{ab}	3.07±0.03^{bc}	3.02 ±0.08^{cd}	3.00±0.05^{cd}	2.93±0.10^{d}
Specific volume^{ns} (cm^3/g)	1.31±0.02	1.28±0.01	1.27±0.04	1.25±0.02	1.24±0.03	1.28±0.07	1.28±0.02

^{a,b,c,d} = Means within the same row with the same letter are significantly different ($p \leq 0.05$).

^{ns} = Means within the same row are not significantly different ($p > 0.05$).

Chemical composition of product

The chemical composition of the products from the full-fat formula (control) and the formula with 45% reduced-fat and 50% inulin gel replacement are shown in Table 6. The fat content, total calories and calories from fat of this modified formulation were lower than the control by 10.5, 3.02 and 10.05% respectively.

CONCLUSION

Reducing the fat level in the outer crust of flaky Chinese pastry increased the hardness of the pastry and tended to decrease the specific volume and puffiness. Untrained panelists liked the pastry in which the fat content in the outer crust was reduced by 45% with the degree of liking between "like slightly" to "like moderately". Inulin gel could be used as a fat replacer for 50% by weight of the fat in the reduced-fat formula, while the maltodextrin gel used in this product could not produce the same quality as the inulin gel. Finally, the formula of the inner crust consisted of 28.77% cake flour with 11.51% shortening, and the outer crust was composed of 32.88% all-purpose flour, 2.94% shortening, 2.94% inulin gel, 6.57% sugar and 14.39% water. In the final product, approximated fat content, total energy and calories from fat could be reduced by 10.5, 3.02 and 10.05%, respectively.

Table 5 Mean 9-point hedonic scores of the products containing a fat replacer in the 45% reduced-fat outer crust.

Attributes	Control	45% reduced-fat	Fat replacer (%) based on 45% reduced-fat formula				
			Inulin gel			Maltodextrin gel	
			25	50	75	25	50
Appearance ^{ns}	6.39	6.40	6.60	7.09	5.77	5.46	5.79
Softness	6.65^{a}	6.81^{a}	7.09^{a}	6.74^{a}	5.00^{b}	6.80^{a}	4.90^{b}
Crust color ^{ns}	5.85	6.62	6.15	7.15	5.38	5.23	6.62
Puffiness ^{ns}	6.83	6.96	6.94	6.65	6.83	6.43	6.71
Flavor ^{ns}	6.44	6.69	7.03	7.38	6.08	5.58	6.73
Taste ^{ns}	7.11	6.64	6.61	6.84	6.73	6.50	6.57
Overall	7.26^{a}	6.96^{ab}	6.83^{ab}	7.20^{a}	5.43^{b}	6.78^{a}	6.04^{ab}

^{ab} = Means within the same row with the same letter are significantly different ($p \leq 0.05$).

^{ns} = Means within the same row are not significantly different ($p > 0.05$).

Table 6 Chemical composition of flaky Chinese pastry containing 50% inulin gel in the 45% reduced-fat outer crust and standard formula (control).

Chemical composition	Control	Product with inulin gel in crust
Moisture (%)	16.31	17.22
Fat (%)	17.31	15.57
Protein (%)	15.75	11.57
Fiber (%)	1.16	1.24
Ash (%)	0.67	0.63
Carbohydrate (%)	48.80	53.77
Total calories (kcal/100g)*	413.99	401.49
Calories from fat (kcal/100g)*	155.79	140.13

* Calorie value by calculation.

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LITERATURE CITED

Aiumpituk, N. undated. **Chinese Cake and Moon Cake.** Maebann, Inc., Bangkok. 51 pp.

Akoh, C.C. 1998. Fat replacers. **Food Tech.** 52(3): 47-53.

AOAC. 2000. **Official Methods of Analysis of Association of Official 17th ed.** Association of Official Analytical Chemists. Washington D.C.

Calorie Control Council. 2004. Fat replacers: Food ingredients for healthy eating, [cited: 26 January 2006]. Available from: http://www.caloriecontrol.org/fatreprint.htm.

Chammek, J. and O. Naivikul. 2003. **Introduction of Bakery Technology.** Kasetsart University, Bangkok. 224 pp.

Kanto, P. 2002. **Shelf Life Extension of Khanom Pia (Chinese Cake) by Using Humectant and Packaging.** M.Sc. thesis, Kasetsart University, Bangkok.

Khuantham, A. 1999. **Principle of Experimental Design.** Kasetsart University, Bangkok. 348 pp.

Kim, Y., M.N. Faqih and S.S. Wang. 2001. Factors affecting gel formation of inulin. **Carbohydrate Polymers** 46: 135-145.

Lee, C.C., R.C. Hoseney and E. Varriano-Marston. 1982. Development of a laboratory scale single stage cake mix. **Cereal Chem.** 59(2): 389-392.

Leslie, L.A. 1999. **Evaluation of a Maltodextrin Gel as Partial Replacement for Fat in a High-Ratio White-Layer Cake Formulation.** M.Sc. Thesis, Virginia Polytechnic Institute and State University. Virginia.

Marischai, D. 2003. Wad-wong song aok. **Exporter** 17(327): 66-74.

Niyomvit, N. 1994. **Sensory Evaluation of Food: Theory and Practice.** V.B. Book Center (K.U.), Bangkok. 738 pp.

O'Brien, C.M., A. Mueller, A.G.M. Scannell and E.K. Arendt. 2003. Evaluation of the effects of fat replacers on the quality of wheat bread. **J. Food Eng.** 56: 265-267.

Pimdit, K., N. Therdthai and K. Jangchud. 2008. Effects of fat replacers on the physical, chemical and sensory characteristics of puff pastry. **Kasetsart J. (Nat.Sci.)** 42: 739-746.

Pitukboonyarat, P. 2004. Export news in business newspaper, [cited: 3 June 2006]. Available from: http://www.sme.go.th/websme.

Praznik, W. 2002. Soluble dietary fibres in Jerusalem artichoke powders: Composition and application in bread. **Nahrung Food** 46: 151-157.

Roberfloid, M.B. 1999. Concepts in functional foods: The case of inulin and oligofructose. **J. Nutr.** 129(75): 1398s-1401s.

Thai Industrial Standards Institute. 2006. **Standard of Community Product-Chinese Pastry (Kha Nom Pia).** 115/2549. Ministry of Industry, Bangkok.

UFM Baking and Cooking School. 1995. **Training Document for Course of Chinese Pastry.** UFM Food Center Co.Ltd., Bangkok.

Veerotai, M. 2002. **Technology of Healthful Food Products.** Institute of Academic Development (IAD), Bangkok. 260 pp.

Zoulias, E.I., V. Oreopoulou and C. Tzia. 2002. Textural properties of low-fat cookies containing carbohydrate- or protein-based fat replacers. **J. Food Eng.** 55: 337-342.