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Research Article

Utilization of Lard to Replace Margarine in the Short and Layer Crust Pastry with Filling

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Abstract: The possibility of replacing margarine with lard in the short and layer crust pastry with filling (ab. SLCPF) was analyzed in this study. As is detected the lard has higher fat content (99.97%) than margarine (87.7%), the lard has less saturated fatty acid (30.81%) than margarine (43.95%),the extensibility of the lard was better than margarine. The influence of the addition of lard and margarine (2.5-12.5% based on flour, variation interval 2.5) on dough physical characteristics and SLCPF quality were respectively investigated. The results showed that the water-oil dough contained 7.5% lard achieved a better quality of SLCPF (sensory evaluation was 89.3) than margarine (sensory evaluation was 74.2). The influence of the addition (50%) of lard and margarine (40-70% based on flour, variation interval 10) on oil-mixed dough and SLCPF quality showed SLCPF (sensory evaluation was 87.5) produced by oil-mixed dough added the lard was better than that of the margarine.

Keywords: Fatty acid composition, sensory properties, short and layer crust pastry with filling, texture analyzer

INTRODUCTION

The short and layer crust pastry with filling composed with repeated folding of a layer of oil-mixed dough and a layer of water-oil dough with a well-developed gluten network, so that the baked product had light, delicate and flaky texture (Fine *et al*., 2006). The water-oil dough was composed of flour, water and fat, while the oil-mixed dough was made by flour and fat. The fat of short and layer crust pastry with filling had several functions in the final product. Part of fat was used to improve the water-oil dough properties. Part of that, however, was mixed with the flour to form oil-mixed dough to keep the layers of dough separated (Bessler and Ortheoefer, 1983). During baking, the moisture of the dough and the fat of short and layer crust pastry with filling were vaporized to lift and separate the layers and then it generated the typical stratified texture of the final baked production. The fat must have certain specific structural characteristics, such as plasticity (optimal solid fat content), consistency (firmness) and melting properties (Skogerson *et al*., 2006).

Butter is the traditional fat in short and layer crust pastry with filling. A number of reasons including availability and cost, butter has been replaced by other fats (Fine *et al*., 2006). These fats (shortening or margarine) have relatively flat solid fat content curves, for the considerable solids at high temperatures (Wassell and Young, 2007). Various processes were used for the preparation of these fats; the partial hydrogenation of vegetable oils (Mozaffarian *et al*., 2006) was one of them. Use of partially hydrogenated oils, however, leads to the presence of Trans fat (Parcerisa *et al*., 1999). As we all know, intake of hydrogenated oils leads to cardiovascular disease (Wassell and Young, 2007). A higher intake of Trans fat will increase the risk of Coronary Heart Disease (CHD) through multiple mechanisms. It conveyed a profound meaning to replace them with some new fats.

Lard plays an important role in Chinese cooking culture as a major fat. It contributes an unique flavor and function to some Chinese-style bakery foods (Arul *et al*., 1988). Compared with other animal fats, lard contains rich food energy and a large number of saturated fatty acid as well. Moreover, lard contains 0.3~0.5% arachidonic acid which contributes to reducing blood lipid levels and it barely exists in plants. Objective of this study was to study the possibility of replacing margarine with lard in the short and layer crust pastry with filling.

MATERIALS AND METHODS

Materials: Commercially available wheat flour (13.9% moisture, ash content 0.46% on dry basis, protein content 12.6% on dry basis, wet gluten 36.2 and 60.4% water absorption in farinograph), Lard (fat content 98.9%, melting point 37.8°C, manufactured by Oil Co.

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Ltd, Anhui China), margarine (fat content 87.7%, melting point 34.5°C, produced by edible oil industry Co. Ltd, Qinhuangdao China).

Methods:

Fat content: The fat content of lard and margarine was detected by the Fat measuring device (AOAC, 2000).

Fatty acids composition: Fatty acid composition of lard and margarine were determined from their methyl esters. Methyl esters were prepared with methanol and extracted using hexane. Esters were analyzed by gas chromatography-mass spectrometry GC-MS (Varian, US) according to ISO15304 (ISO, 2002), GC-MS equipped with capillary column (30 m×0.25 mm ×0.25 μm). Helium was used as carrier gas runs at a constant rate of 1.0 ml/min. The column temperature program was 80°C, sustained for 2 min, then increased to 240°C at a rate of 5°C /min, finally increased to 300°C at a rate of 10°C /min and sustained for 5 min.

Textural properties of lard and margarine: The firmness and stickiness of lard and margarine were analyzed using a Texture Analyzer (Model TA. XT Plus). They were determined by measuring 'work of penetration' and 'adhesiveness' (compression tests) at 25°C. A circular cone probe (HDP/SR) was used to penetrate the samples at 3 mm/s to 23 mm of their height.

The manufacture and assessment of short and layer crust pastry with filling: Short and layer crust pastry with filling was manufactured by water-oil dough, oil-mixed dough and bean paste. Firstly, water-oil dough was kneaded for a few minutes by hand, then shaped into a ball and left to rest for 10 min, covered to prevent drying. The dough formulation consisted of wheat flour 100.0 g, sugar 5 g, dough fat of lard or margarine (2.5, 5, 7.5, 10 or 12.5%, respectively on flour basis) and water with temperature 20°C according to farinograph water absorption. Secondly, oil-mixed dough was prepared in a bread board with fat and flour. The dough was consisted of wheat flour 100.0 g, dough fat of lard or margarine (40, 50, 60 and 70%, respectively on flour basis). Thirdly, the water-oil dough and oil-mixed dough were sheeted to a thickness of about 10 mm. The oil-mixed dough was placed into the water-oil dough and the remaining one third was folded over the rest and the whole turned 90°. The dough was laminated to a thickness of about 8 mm, folded by one three-fold and rerolled to 8 mm. The dough was folded into fourths and left to rest for 45 min covered at room temperature. These steps were repeated more than two times. The dough was cut into circular shapes and then baked at 200°C for 25 min. After cooling, the short and layer crust pastry were evaluated by Texture Analyzer and sensory.

Texture measurements of water-oil dough and oil-mixed dough: The hardness and stickiness of the water-oil dough and oil-mixed dough were measured on Texture Analyzer which use a 6 mm cylinder probe (P/6) and load cell of 5 kg. The parameters tested were as follows: pretest speed 1.0 mm/s, test speed 1.0 mm/s, post-test speed 10.0 mm/s, distance 50% of their original height and trigger type auto 5 g.

Texture measurements of short and layer crust pastry with filling: The firmness and positive peak numbers of short and layer crust pastry with filling were outer mined after baking two hours then following with 2mm cylinder probe (P/2) and load cell of 5 kg. The test was conducted under conditions: pretest speed 1.0 mm/s, test speed 0.5 mm/s, post-test speed 10.0 mm/s, distance 35 mm. The area under the characteristic curve is a measure of the total amount of work involved in performing the test.

Sensory evaluation: In order to define the effect related to the addition of lard and margarine on the sensory characteristics of the short and layer crust pastry with filling, a points-based method was applied. One hour after baking, the sensory characteristics of the short and layer crust pastry with filling were evaluated by ten-member board, which were given marks based on the 1.0-5.0 grade scale. The sensory mark included the following parameters of quality: external appearance (the shape, color, surface properties); structure (flakiness, flakiness uniformity, color uniformity), smell and taste. The quality category of the short and layer crust pastry with filling was determined based on the total sum of the points obtained: very good (20.0-25.0), good (15.0-20.0), acceptable (10.0-15.0) and unacceptable (<10.0).

Statistical analysis: All analyses were carried out in triplicate and the experimental results were expressed as the mean±standard deviation. Difference significance test and multiple comparisons were done using MATLAB (version 7.12, Math Works, Inc.). Figures were draw using Origin Pro (version 9, Origin Lab Corporation).

RESULTS AND DISCUSSION

Physicochemical characteristics of lard and margarine: Fatty acid's constitutions of lard and margarine are presented in Table 1. It showed that lard and margarine had more unsaturated fatty acids (69.19 and 54.05%) than saturated fatty acids. The difference in the degree of unsaturation between lard and margarine could be due to the diverse pattern of distribution of individual fatty acids. The most predominant fatty acid of lard was oleic acid (50.21%), followed by palmitic (19.63%), which was in accordance with the report of other workers (Nurjuliana *et al*., 2011). Margarine has 37.17% of oleic acid as the most dominant fatty acid, followed by palmitic

Table 1: Fatty acid composition of lard and margarine

Fatty acids	lard	Margarine
$C_{10:0}$	0.07±0.030	0.02±0.020
$C_{12:0}$	0.08±0.050	0.01±0.030
$C_{14:0}$	1.82±0.120	2.48±0.090
$C_{15:0}$	0.18±0.020	0.64±0.020
$C_{16:0}$	19.63±0.08	22.93±0.18
$C_{17:0}$	0.55±0.040	1.27±0.010
$C_{18:0}$	7.88±0.020	14.91±0.04
$C_{19:0}$	0.10±0.100	0.15±0.050
$C_{20:0}$	0.48±0.070	1.50±0.040
Saturated fatty acids	30.8100000	43.950000
$C_{14:1}$	2.12±0.070	0.29±0.040
$C_{16:1}$	3.89±0.120	1.43±0.130
$C_{18:1}$	50.21±0.32	37.17±0.07
$C_{20:1}$	1.19±0.060	0.10±0.040
Monounsaturated fatty acids	57.4100000	38.990000
$C_{16:2}$	0.47±0.050	0.15±0.050
$C_{18:2}$	18.90±0.17	14.59±0.21
Polyunsaturated fatty acids	19.3800000	14.740000
$C_{18:1}$t	0.46±0.01	3.22±0.060
Trans fatty acids	0.46±0.01	3.22±0.060

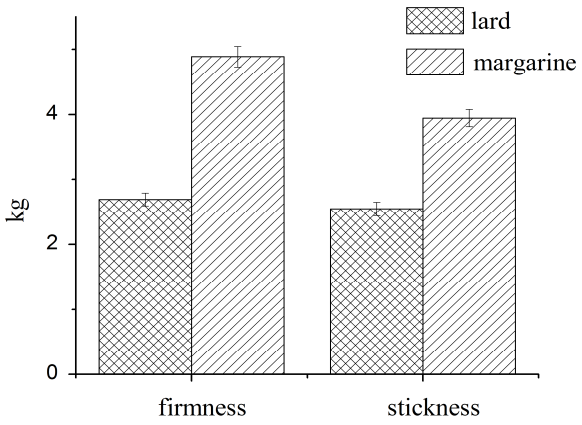

Fig. 1: Comparison of firmness and stickiness of lard and margarine

(22.93%), which has a very significant effect on hypercholesterolemia (Müller *et al*., 2001). Although lard and margarine were also found to have oleic and palmitic as their most prominent fatty acids, they have different in the third and fourth most abundant fatty acids. Linoleic was the third most fatty acid in lard and octadecanoic acid was the third most fatty acid in margarine.

Slight differences in the fatty acid composition of lard and margarine were the content of Trans fatty acid (TFA), which were 0.46 and 3.22%, respectively. A potentially positive contribution of the lard enhanced nutritive of the short and layer crust pastry with filling was reflected in a practically negligible content of TFAs (<1%), which was in accordance with the required values (WHO, 2003).

The firmness and stickiness of lard and margarine: The firmness and stickiness of lard and margarine were shown in Fig. 1. Lard was found to have lesser firmness and stickiness than margarine. This difference may be due to the different contents of saturated fatty acids of the two fats. The margarine has more saturated fatty acids than lard. The lesser firmness and stickiness, the better extensibility of the fat, which determines the quality of the short and layer crust pastry with filling.

Texture and Sensory properties of SLCPF:

The properties of water-oil dough and SLCPF with the addition of lard: The texture and sensory properties of water-oil dough and SLCPF with the lard addition of 2.5, 5, 7.5, 10 or 12.5%, respectively on flour basis are presented in Table 2. Sensory evaluation and positive peak numbers of SLCPF showed a trend from rising to declining and it reached the highest point with 7.5% addition. It proved 7.5% addition of the lard to water-oil dough was better to the quality of SLCPF than the others. The reason for the hardness and

Table 2: Properties of water-oil dough and SLCPF with the addition of lard

The addition of lard (%)	Hardness of water-oil dough(g)	Stickiness of water-oil dough(g)	SLCPF firmness (g.sec)	SLCPF positive peak numbers	Sensory evaluation
2.50	270.75±2.93a	-186.65±2.08e	278.20±3.69a	22.20±1.05c	75.3±0.83c
5.00	216.45±4.32b	-164.28±3.24d	273.65±2.78b	27.48±0.43b	78.5±1.30b
7.50	153.97±3.24d	-99.43±2.120a	264.04±4.12c	42.01±0.50a	89.3±1.23a
10.0	131.71±1.10e	-112.83±1.09b	260.32±3.26d	39.95±1.21a	80.9±0.89b
12.5	161.67±2.01c	-147.90±3.15c	258.35±1.89d	23.59±1.08c	74.2±0.83c

Table 3: Correlation

	The addition of lard (%)	Hardness of water-oil dough (g)	Stickiness of water-oil dough (g)	SLCPF positive peak numbers	SLCPF firmness (g·sec)	Sensory evaluation
The addition of lard (%)	1.000	-0.851	0.566	0.259	-0.972**	0.005
The hardness of water-oil dough (g)	-0.851	1.000	-0.896*	-0.722	0.937*	-0.479
The stickiness of water-oil dough (g)	0.566	-0.896*	1.000	0.929*	-0.739	0.807
SLCPF positive peak numbers	0.259	-0.722	0.929*	1.000	-0.468	0.895*
SLCPF firmness (g·sec)	-0.972**	0.937*	-0.739	-0.468	1.0000	-0.222
sensory evaluation	0.005	-0.479	0.807	0.895*	-0.222	1.0000

**: Correlation is significant at the 0.01 level, *: Correlation is significant at the 0.05 level

Table 4: Properties of water-oil dough and SLCPF with the addition of margarine

The addition of margarine (%)	Hardness of water-oil dough(g)	Stickiness of water-oil dough(g)	SLCPF firmness (g·sec)	SLCPF positive peak numbers	Sensory evaluation
2.50	157.27±2.05a	-96.35±2.14c	296.24±4.01a	20.4±0.670b	76.2±0.790b
5.00	135.33±3.24b	-85.18±2.76b	286.41±2.68b	24.6±0.840a	80.8±1.420a
7.50	120.54±3.70c	-79.24±3.05a	280.23±3.57b	17.2±0.600c	74.2±1.09bc
10.0	106.34±2.67d	-74.54±1.84a	271.45±2.80c	14.3±1.03cd	72.4±0.860c
12.5	132.95±2.09b	-86.45±3.26b	268.35±2.16c	11.7±1.120d	69.6±0.960d

Table 5: Correlation

	The addition of margarine (%)	Hardness of water-oil dough(g)	Stickiness of water-oil dough (g)	SLCPF positive peak numbers	SLCPF firmness (g·sec)	Sensory evaluation
The addition of margarine (%)	1.0000	-0.649	0.584	-0.864	-0.988**	-0.811
The hardness of water-oil dough(g)	-0.649	1.000	-0.993**	0.465	0.750	0.369
The stickiness of water-oil dough(g)	0.5840	-0.993**	1.0000	-0.368	-0.693	-0.270
SLCPF positive peak numbers	-0.864	0.465	-.0368	1.0000	0.816	0.993**
SLCPF firmness (g·sec)	-0.988**	0.750	-0.693	0.816	1.000	0.748
Sensory evaluation	-0.811	0.369	-0.270	0.993**	0.748	1.000

**: Correlation is significant at the 0.01 level, *: Correlation is significant at the 0.05 level

Table 6: Effect of the lard addition on the properties of oil-mixed dough and SLCPF

The addition of lard (%)	Hardness of oil-mixed dough (g)	Stickiness of oil-mixed dough (g)	SLCPF firmness (g·sec)	SLCPF positive peak numbers	Sensory evaluation
40	225.30±3.14a	-87.34±1.980a	286.54±2.65a	19.6±0.97b	75.0±0.86c
50	156.15±2.07b	-108.45±2.04b	246.87±4.07b	34.5±1.43a	87.5±1.53a
60	118.88±2.13c	-166.98±3.12c	230.09±3.62c	21.4±0.78b	79±1.3100b
70	95.92±2.53d	-196.09±2.12d	224.18±2.35d	18.9±1.21b	73.5±1.46d

stickiness of water-oil dough was decreased with the increase of the lard addition was possibly that excess lard limited the formation of gluten. Different from the former two, the firmness of SLCPF has fallen by the adding of lard, which may be caused by the decreasing property of lard.

The correlation among the addition of lard, the texture and Sensory properties of the water-oil dough and SLCPF is presented in Table 3. The addition of lard and SLCPF firmness has significant correlation at the 0.01 level. The hardness of water-oil dough and SLCPF firmness has a significant correlation at the 0.05 level. The hardness and stickiness of water-oil dough have a significant correlation at the 0.05.

The properties of water-oil dough and SLCPF with the addition of margarine: The texture and sensory properties of water-oil dough and SLCPF with the margarine's addition of 2.5, 5, 7.5, 10 or 12.5%, respectively on flour basis are presented in Table 4. Sensory evaluation and positive peak numbers of SLCPF increased with the decrease of the margarine addition. On the other hand, 5% of the margarine addition was better to SLCPF. There was a significant decrease in the hardness and stickiness of water-oil dough and the increase of SLCPF firmness which manufactured by margarine, which compared with lard. This could be probably due to the different contents of saturated fatty acids in two fats.

The correlation of the addition of margarine, the texture and Sensory properties of water-oil dough and SLCPF are presented in Table 5. The addition of margarine was significantly correlated with the firmness of SLCPF ($p<0.01$). There was a significant correlation between the hardness and the stickiness of water-oil dough ($p<0.01$). The positive peak numbers of SLCPF and sensory evaluation had significant correlation ($p<0.01$).

The effect of the lard addition on the properties of oil-mixed dough and SLCPF: The texture and sensory properties of oil-mixed dough and SLCPF with the addition of lard 40, 50, 60 and 70%, respectively on flour basis are presented in Table 6. The hardness of oil-mixed dough and SLCPF firmness felled by the addition of lard. The stickiness had crosscurrent with hardness of oil-mixed dough while adding fats. The positive peak numbers of SLCPF increased with the decrease of lard. It proved 50% addition of the lard to oil-mixed dough was better to make SLCPF.

The correlation among the texture and sensory properties of the oil-mixed dough and SLCPF with the addition of lard are presented in Table 7. The result showed that the addition of lard was significantly correlated with the hardness of oil-mixed dough ($p<0.05$) and the same to the stickiness of oil-mixed dough. There was a significant correlation between the hardness of water-oil dough and SLCPF firmness

Table 7: Correlation

	The addition of lard (%)	Hardness of oil-mixed dough(g)	Stickiness of oil-mixed dough(g)	SLCPF positive peak numbers	SLCPF firmness (g·sec)	Sensory evaluation
The addition of lard (%)	1.000	-0.971*	-0.984*	-0.267	-0.936	-0.267
The hardness of oil-mixed dough (g)	-0.971*	1.000	0.938	0.071	0.993**	0.045
The stickiness of oil-mixed dough (g)	-0.984*	0.938	1.000	0.411	0.896	0.386
SLCPF positive peak numbers	-0.267	0.071	0.411	1.000	-0.024	0.973*
SLCPF firmness (g·sec)	-0.936	0.993**	0.896	-0.024	1.000	-0.064
sensory evaluation	-0.267	0.045	0.386	0.973*	-0.064	10000

**: Correlation is significant at the 0.01 level, *: Correlation is significant at the 0.05 level

Table 8: Effect of the addition of margarine on the properties of oil-mixed dough and SLCPF

The addition of margarine (%)	Hardness of oil-mixed dough(g)	Stickiness of oil-mixed dough(g)	SLCPF firmness (g·sec)	SLCPF positive peak numbers	Sensory evaluation
40	878.76±3.16a	-75.52±1.46a	294.36±2.53a	16.5±1.07b	77.5±1.02c
50	461.08±4.08b	-98.05±2.35b	287.06±3.98b	22.0±1.35a	73.5±1.32d
60	211.37±2.87c	-106.54±2.16c	274.14±3.57c	23.6±0.89a	81±1.250a
70	154.54±3.06d	-132.46±2.49d	258.89±2.64d	16±1.14b	79.5±1.12b

Table 9: Correlation

	The addition of margarine (%)	Hardness of oil-mixed dough(g)	Stickiness of oil-mixed dough(g)	SLCPF positive peak numbers	SLCPF firmness (g·sec)	Sensory evaluation
The addition of margarine (%)	1.000	-0.949	-0.984*	0.003	-0.989*	0.141
The hardness of oil-mixed dough(g)	-0.949	1.00	0.919	-0.316	0.892	-0.447
The stickiness of oil-mixed dough(g)	-0.984*	0.919	1.000	0.068	0.974*	-0.090
SLCPF positive peak numbers	0.003	-0.316	0.068	1.000	0.137	0.982*
SLCPF firmness (g·sec)	-0.989*	0.892	0.974*	0.137	1.000	0.005
Sensory evaluation	0.141	-0.447	-0.090	0.982*	0.005	1.000

**: Correlation is significant at the 0.01 level, *: Correlation is significant at the 0.05 level

($p<0.01$). The positive peak numbers and sensory evaluation of SLCPF has significant correlation ($p<0.05$).

The effect of the addition of margarine on the properties of oil-mixed dough and SLCPF: After the addition of 40, 50, 60 and 70%, respectively margarine respectively on flour basis, the experiment results of the texture and sensory properties of the oil-mixed dough and SLCPF are presented in Table 8. The hardness of oil-mixed dough and SLCPF firmness were decreased with the addition of margarine. The stickiness has crosscurrent with hardness of oil-mixed dough while adding margarine. The positive peak numbers of SLCPF were increased with the decrease of the margarine addition. It proved 60% addition of the margarine of oil-mixed dough was better to make the SLCPF. The most difference between lard and margarine to manufacture oil-mixed dough and SLCPF was their optimal addition.

After the addition of margarine, the correlation among the texture and sensory properties of the oil-mixed dough and SLCPF are presented in Table 9. The addition of margarine was significantly correlated to the firmness of SLCPF ($p<0.05$) and the same to the stickiness of oil-mixed dough. There was a significant correlation between the positive peak numbers and sensory evaluation of SLCPF ($p<0.05$).

CONCLUSION

Based on the results of this study, it is possible to conclude that lard have more unsaturated fatty acids (69.19%) than margarine (54.05%). Contents of TFA are practically negligible in lard (TFA below 1%). In the production of SLCPF by the lard and margarine, without the choice of an adequate composition of the fat phase, it is of great importance to define the influence that fat exerts on the dough hardness and stickiness, firmness, positive peak numbers, sensory characteristics and the nutritive value of SLCPF. Optimal physical characteristics of water-oil dough and a very good quality of SLCPF were obtained by 7.5% addition of lard or 5.0% addition of margarine. This sample is also of maximal positive peak numbers. In order to achieve satisfactory properties of oil-mixed dough and SLCPF, the study shows that using the quantity of lard (50%) or margarine (60%) could be achieved. It means that SLCPF manufactured by lard have better quality than the same addition of margarine. There was a correlation among the texture and sensory properties of the water-oil dough, oil-mixed dough and

SLCPF. On the whole, lard could replace margarine on production with SLCPF.

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