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Effects of Salt,Polyphosphates and Reheating on Quality of Ready-to-Eat Frozen Fried Chicken

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Abstract

The effects of salt, polyphosphates and reheating on the quality of ready-to-eat frozen fried chicken were studied. Chicken was marinated with salt and polyphosphates then pre-fried. After cooked, the color value, L* was increased but a* and b* of all samples were increased) p<0.05 (while reheating was not significant difference (p>0.05). The cooking loss after reheated of fried chicken were determined, sample of 1.00% salt and 0.30% polyphosphates gave the best results of 34.99% and 7.47% respectively compared to control sample (41.31% and 10.75% respectively). These related to shear force value of 2.81±1.14 kg compared to 3.42±1.04 kg of control sample. The composition of reheated fried chicken, fat and moisture content of 1.00% salt and 0.30% polyphosphate were 4.90±0.47^{a}% and 50.18±0.16% respectively.

Key words: salt, polyphosphate, fried chicken, ready to eat

1. Introduction

Fried chicken is one of the most popular in fried food. The characteristic of fried chicken is brown outside, crispy, good flavor and taste. Frying process, moisture is removed from food to frying oil. The effect of process shows reducing size and moisture loss in food pieces (Gamble *et al.,*1987). Moreover, thermal process effects on chemical compositions in poultry meat such as protein denature, cooking yield loss and other important quality factors, such as loss of juiciness, color and flavor. Now a days, polyphosphate and salt is widely used for improve quality of meet such as increase water holding capacity and reduce cooking loss in the products (Grey *et al.*, 1978). Previous studied, Bendall (1954) used polyphosphate for improving the juiciness and succulence of chicken meat.

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In Thailand, ready-to-eat frozen food is important. Heating and freezing is the best processes for maintain the physical, chemical, microbiological and storage time of food product. Therefore, these processes are important to improve the fried products for consumers (Juneja and Vijay, 2006). The re-heating process of foods has become an essential role in the general meal. This process can maintain quality and microstructure of food, as well as fresh materials (Clark *et al*., 2000). In this study, we determined the effect of salt and polyphosphate, including reheating process to improve the quality of ready-to-eat frozen fried chicken.

2. Materials and Methods

2.1 Samples preparation

Frozen Chicken skinless breast meat was obtained from local Betagro shop in Songkhla, Thailand. Chicken meat was kept frozen until used. Chicken meat then thawed at 4±1ºC in refrigerator for 12 h. Chicken breast meat was cut into size approximately 9×7×2 cm. (about 125±5 grams). The ingredients such as garlic, white pepper, soy bean sauce and fish sauce monosodium glutamate and salt were added. Chicken samples were injected with saline and polyphosphates and kept at 4ºC for 5–7 h. The final concentration of salt and polyphosphates were below.

(1) control (without salt and polyphosphates)

(2) 1.0% salt

(3) 0.3% polyphosphates

(4) 1.0 % salt and 0.3% polyphosphates

Samples then fried in a deep fat fryer using palm oil at 175±5ºC for 14 min, after 30 min cooling, samples were packed and kept frozen at -18±2ºC. Reheating of frozen fried chicken was performed using a commercial microwave oven at the power of 800 watts for 3–4 minutes which core temperature was about 72ºC or above.

Frozen chicken breast was reheated with microwave (800 watt for 3-4 min). After that, sample was used in next experiment.

2.2 Color determination

Outside and inside color of fried chicken were determined using a Hunterlab colorimeter. Samples were determined in nine replications of each treatments (n=9). The determination was reported as the complete International Commission on Illumination (CIE) system color (profile of lightness -L^*, redness -a^*, and yellowness -b^*).

2.3 Cooking loss

Cooking loss determined and was calculated from differences in the weight of samples before and after frying. The measurements were conducted in 9 replications. Calculation for cooking loss was as follow:

% cooking loss = {(raw chicken weight – cooked weight) / raw chicken weight} × 100

2.4 Shear value

The fried chicken and reheated samples were cut to the size of 1.0×2.0×0.5 cm for shear analysis using the Texture Analyzer equipped with Warner-Bratzler shear apparatus (Dawson *et al*., 1991). The operating parameters consisted of cross head speed of 2 mm/s and 50 kg load cell. The shear force, perpendicular to the axis of muscle fiber, was measured in 30 replicates for each treatment on all samples. The peak of the shear force profile was regarded as the shear force value.

2.5 Moisture and Fat content

Moisture and fat content were determined according to Association of Official Analytical Chemists (A.O.A.C., 2000).

2.6 Statistical analysis

Data were evaluated statistically as factorial design using computer program. Significant different between samples and reheat method means were analysis by Duncan's multiples rang test (Steel and Torrie, 1998)**.**

3. Results and discussion

3.1 Color determination

Colors of fried chicken (outside and inside) are shown in Table 1. The CIE system values of outside color in lightness (*L**) of sample using 1.0% salt and 0.3% polyphosphates were significantly difference. The *a** and b* value of samples were also different significantly. The inside lightness *L** of samples 3 and 4 was significantly different from sample 1 and 2. Color value of fried chicken was different from which reported by (Nute *et al.,* 1999). They studied the injection polyphosphates 3–5% into pork steak the can increased in *L** value. (Fletcher *et al.*, 2002). With increased heating temperature, meat tended to be lighter and also turned to brown-grey hue. The lightening is due to an increased reflection of light, arising from light scattering by denatured protein and change (Lawrie, 1994), the compound involved in increasing of redness should be globin hemochomes, in which the iron was in the Fe^{2+} state.

Table 1 Effect of salt and polyphosphates on color of fried chicken

samples	Color-outside			Color-inside		
	L*	a*	b*	L*	a*	b*
1	40.82 ± 8.31^{c}	9.37 ± 4.02^{a}	22.89 ± 3.94^{ab}	54.95 ± 3.19^{b}	1.77 ± 0.36^{ab}	12.56 ± 1.41^{bc}
2	38.53 ± 10.14^{bc}	9.65 ± 4.77^{ab}	22.69 ± 4.63^{ab}	53.95 ± 3.30^{b}	1.68 ± 0.40^{a}	12.33 ± 1.07^{b}
3	37.19 ± 7.04^{b}	10.56 ± 0.85^{b}	24.61 ± 3.48^{b}	51.31 ± 4.85^{a}	1.94 ± 0.23^{b}	13.21 ± 1.28^{c}
	34.20 ± 9.61^{a}	9.69 ± 3.99^{ab}	21.22 ± 3.70^{a}	49.69 ± 5.21^{a}	1.56 ± 0.39^{a}	11.40 ± 0.91^{a}

Note: Values are shown as mean ± standard deviation.
Symbols bearing different letters in the same column are significantly different ($p<0.05$).
(1) control, (2) 1.0 % salt, (3) 0.3% polyphosphates and (4) 1.0 % and 0.3% polyphosphates.

Changes in color of reheated samples on ready-to-eat frozen fried chicken are show in Table 2. The value of outside color of lightness (*L**), redness (*a**) and yellownes (*b**) of all samples are not significantly different ($p\geq0.05$). Inside color of *L* was* not significantly different ($p\geq0.05$). The increasing of *a** value and decreasing of *L** due to reheating and browning reaction during frying process. The browning reaction was effect on water activity (a_w), pH component of food and temperatures were reported (Carabasa and Ibarz, 2000). Ngadi *et al*., (2007) studied the change of color in chicken nugget after fried at 19±02ºC for 30,60,90,120,180,240 and 300 seconds. Sunisa (2010) also reported the color of chicken drumsticks after frying at various temperature and times which lightness (*L**) was decreased, while redness (*a**) was increased. Meat cooked with microwaves does not have typical browned surface associated with other methods of cooking because of short cooking time. (Mohammad and Aziz, 2011)

Table 2 Effect of reheating on color of frozen ready to eat fried chicken

Samples	Color-outside			Color-inside		
	L*	a*	b*	L*	a*	b*
1	27.28±4.15[a]	13.96±1.85[a]	24.05±2.82[a]	48.77±2.88[a]	1.85±0.37[ab]	11.62±0.91[a]
2	27.80±4.62[a]	13.96±1.44[a]	24.76±3.19[a]	48.10±5.85[a]	1.65±0.35[a]	11.43±1.06[a]
3	26.06±2.90[a]	13.99±1.53[a]	24.54±2.86[a]	47.91±4.47[a]	1.77±0.16[ab]	12.28±0.77[b]
4	27.18±4.48[a]	14.23±2.37[a]	25.08±±2.51[a]	46.04±3.71[a]	1.88±0.30[b]	11.26±1.11[a]

Note: Values are shown as mean±standard deviation.
Symbols bearing different letters in the same column are significantly different (*p*< 0.05).
(1) control, (2) 1.0 % salt, (3) 0.3% polyphosphates and (4) 1.0 % and 0.3% polyphosphates.

3.2 Cooking loss

The cooking loss of fried chicken and reheated fried chicken are presented in Table 3. The cooking losses of fried chicken in the sample 4 were different from all other samples (*p<0.05)*. The lower cooking loss was in sample 4 compared to sample 1, 2 and 3. According to Nut*e et al.,* (1999), investigated on the effect of injection of water and polyphosphate into pork to improve juiciness and tenderness after cooking. The percentage of weight loss at 3 and 5% polyphosphates was 34.00% and 33.90%, while on control sample was higher at 37.31%. Polyphosphates is widely used in many of frozen meat and marine products to improve the water holding capacity.

Table 3 Effect of salt, polyphosphates and reheating on cooking loss of fried chicken and reheated frozen fried chicken.

Sample	% cooking loss * (fried chicken)	% cooking loss ** (reheated)
1	41.30 ± 2.85[b]	10.75 ± 6.33[b]
2	41.92 ± 1.04[b]	6.89 ± 5.25[a]
3	43.98 ± 2.11[b]	7.68 ± 5.08[a]
4	34.99 ± 2.85[a]	7.47 ± 7.05[a]

Note: Values are shown as mean ± standard deviation. Symbols bearing different letters in the same column are significantly different (*p*< 0.05).
(1) control, (2) 1.0 % salt, (3) 0.3% polyphosphates and (4) 1.0 % and 0.3% polyphosphates.
(*) compared to raw chicken (**) compared to fried chicken before reheated

The cooking loss of reheated fried chicken was higher in control sample compared to the samples treated with salt and polyphosphates (p<0.05). The result was similar to the report of Mohammad and Aziz (2011). In cooking process, the contractile proteins of meat (myosin and actin) will denature and the connective tissue (collagen) under goes to solubilize. Microwave heating can solubilize more collagen (percentage of hydroxyproline) than does boiling. In general, Microwave-cooked meat and poultry have higher cooking losses than those cooked by conventional methods.

3.3 Shear value

Shear value of fried chicken are shown in Table 4. The sample 1 and 3 were tougher than the others. A significant increasing in shear value was found sample 1 and 3 and decreased in sample 2 and 4. These might be to due to the combination effect of salt and polyphosophates to improving the juiciness and succulence of chicken (Grey *et al.*,1978a). Increasing in toughtness at 40 and 50ºC dued to the denaturation of myofibrilar protiens. A further increased between 60 and 70ºC, because of shinkage of intramuscular collagen and dehydration of muscle at 65ºC (Bailey and Light,1989).

Table 4 Effect of reheating on shear value of frozen fried chicken and reheated frozen fried chicken.

Sample	Shear value (kg) (Fried chicken)	Shear value (kg) (Reheated)
1	4.14 ± 0.38^{d}	4.24 ± 1.14^{b}
2	3.21 ± 0.25^{b}	3.42 ± 1.04^{a}
3	3.51 ± 0.38^{c}	4.13 ± 1.89^{b}
4	2.78 ± 0.28^{a}	2.81 ± 0.84^{a}

Note: Values are shown as mean ± standard deviation.
Symbols bearing different letters in the same column are significantly different (p< 0.05).
(1) control, (2) 1.0% salt, (3) 0.3% polyphosphates and (4) 10 % and 0.3% polyphosphates.

3.4 Moisture and Fat content

Moisture content of reheated fried chicken

Shown in Table 7, moisture content of fried chicken were about 43.81% to 50.18%. Sunisa (2010b) explained that moisture loss was during deep frying, moisture was rapid loss during heated from the initial temperature to desired temperature. Adedeji *et al*., (2009) studied on pretreatment and moisture content of chicken nugget on effect of microwave preheating at different time duration mass transfer of chicken nugget was studied. Chicken nugget was preheated in a microwave oven for 1–2 min was fried at 160ºC. Microwave oven preheating reduced the initial moisture content sample from 1.22 to 0.82% and for the coating layer from 2.48 to 2.01%. Microwave reheated light meat was flat or bland flavored, less juicy and higher in moisture content than conventionally reheated meat (Mohammad and Aziz, 2011).

Table 5 Effect of salt, polyphosphates and reheating on Moisture content of fried chicken and reheated frozen fried chicken.

Treatment	Fried Chicken (%)	Reheated (%)
1	43.81 ± 1.23^{a}	44.08 ± 0.43^{a}
2	45.86 ± 1.10^{b}	46.16 ± 0.48^{b}
3	44.29 ± 1.41^{a}	44.58 ± 0.63^{c}
4	49.85 ± 1.12^{c}	50.18 ± 0.16^{d}

Note: Values are shown as mean ± standard deviation.

Symbols bearing different letters in the same column are significantly different ($p < 0.05$).

(1) control, (2) 1.0% salt, (3) 0.3% polyphosphates and (4) 10 % and 0.3% polyphosphates.

Fat content of reheat frozen ready to eat fried chicken

The results of fat content of fried chicken are shown in Table 8. The result of reheated chicken on the fat content from 4.90% to 5.43%. Fat content in reheated sample trended to lower as fat loss during reheating process. Oils are esters of long-chain fatty acids which have much less mobility compared to water molecules in response to oscillating electromagnetic fields. The dielectric constant and loss factor of oil are therefore very small compared to free water. The air voids in some foods reduce the loss factor and increase the penetration depth of microwaves at 915MHz and 2450 MHz. (Mohammad and Aziz, 2011).

Table 6 Effect of salt, polyphosphates and reheating on Fat content of fried chicken and reheated frozen fried chicken.

Treatment	Fried Chicken (%)	Reheat (%)
1	5.49 ± 0.60[b]	5.40 ± 0.78[c]
2	5.03 ± 0.33[a]	5.00 ± 0.10[a]
3	5.47 ± 0.41[b]	5.43 ± 0.30[b]
4	4.92 ± 0.25[a]	4.90 ± 0.47[a]

Note: Values are shown as mean ± standard deviation.
Symbols bearing different letters in the same column are significantly different (p< 0.05).
(1) control, (2) 1.0% salt, (3) 0.3% polyphosphates and (4) 10 % and 0.3% polyphosphates.

4. Conclusions

The effect of salt and polyphosphates on fried chicken were different on color of all samples. Reheated fried chicken color of all samples which lower in L^* value but increased in a^* and b^*. On the cooking loss, sample with 1.0% and 0.3% polyphosphates injection was lower in cooking loss. After reheating, frozen fried chicken without injection was highest loss in weight compared to injected samples. Shear value of sample with salt and polyphosphates trend to decrease significantly. The fat and moisture content of reheated fried chicken which a little change was 4.90±0.47 and 50.18±0.16% respectively.

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