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Influence of Pomelo Albedo on Characteristics of Chicken Sausage Emulsion Systems

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Abstract

The purpose of this research was to study the effect of the addition of albedo from pomelo peel on the properties of meat emulsions. The meat emulsion models were prepared by increasing the concentration of the albedo from pomelo peel (fresh and dried) from 0, 2.5, 5, 7.5 and 10% (by weight). The analysis of the forming stability, color, viscosity and flow of emulsion was carried out. It was found that the addition of albedo from the pomelo peel resulted in increased the stability and occurrence of emulsion; the maximum values were reached with the inclusion of 5 percent albedo. The stability of the emulsion was higher with albedo inclusion under non-dried conditions and also resulted in lower brightness values for a* and b* and increased viscosity. Emulsions that included dry albedo were not as viscous as emulsions that included fresh albedo. Ultimately, this study demonstrates that albedo, Addition of pomelo albedo at 5% can be improved and developed the chicken sausage. Moreover, the addition of fresh pomelo albedo resulted in chicken sausage has good characteristic which affected on consumer's acceptance of all attribute. For sensory evaluation, acceptance score from consumer in appearance, color, flavor, hardness, elasticity and overall liking were 8.56±0.64, 8.36±0.75, 8.40±0.61, 8.24±0.59, 8.18±0.52, 8.20±0.53 and 8.16±0.58, respectively at a level of p value < 0.05.

Introduction

Processed meat products have a higher material cost; there are also a variety of consumption needs. In order to reduce the cost of production, meat byproducts are added to processed meat products such as crushed, ground, and emulsified meat products (Sarıçobanc et al., 2008).

It is considered that abesity has been widespread in industrialed societies, then it is deduced that this problem will be able to reach about 1.12 billion people by 2030. (Kastorini et al., 2011). However, increased health problems may be attributed to the consumption of high fat foods included in the emulsions. Foods popular in most industrialized countries are often rich in fat and sugar, which are overpriced. It is also the main cause of health problems. Choi et al. (2010) improved the recipe of emulsions by reducing fat from traditional products. Choi et al. (2009) used bran oil as a replacement for traditional emulsifiers to provide consumers with a

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healthier product. Furthermore, it is recommended that consumers increase their amount of fiber in the daily diet (Sarıçobanc et al., 2008). There are many approaches have been in attempt to generate emulsified meat products with reducing fat content. The substitution of animal fat for dietary fiber with is appeared as it is the most effective strategies demonstrated by several results of researches. (Campagnol et al., 2012; Ktari et al., 2014; Petersson et al., 2014; Tomaschunas et al., 2013; Zhuang et al., 2016).

Albedo is a white tissue component derived from the citrus fruit cellulose. (Ferna´ndez-Gine´s et al., 2004). As a potential source of dietary fiber, albedo not only provides nutritional value, but is also important for use in meat products (Thebaudin et al., 1997). There are also studies on the use of alfalfa and other fruit fibers, alone or combined with other ingredients. To see the influence of albedo on the properties of emulsion in meat products and the physical and chemical qualities, the products utilizing albedo have been studied (Sarıçobanc et al., 2008).

This study sought to examine the effect of albedo inclusion in emulsified meat products. In general, the properties of the emulsion emulsion utilizing pomelo albedo were studied. Emulsion properties were studied for five levels of albedo inclusion. This research provides valuable data for academic and industrial sectors. In addition, this research attempts to study the chemical and physical properties of a skewered chicken product made using varying levels of albedo from pomelo peel, to study effect of adding fresh and dried pomelo peel (Fresh and dried) on the performance of emulsion systems in a skewered chicken product, and to study the quality of chicken sausage products supplemented with albedo from pomelo peels.

Materials and methods

1. Study on chemical and physical properties of albedo from pomelo peel

1.1 Preparation of pomelo peels

Albedo was prepared from fresh pomelo peel. Albedo was reduced in size to 1-3 mm., then fermented with crushed salt in a 2:1 ratio for 12 hours, rinsed with clean water 2 times, then the juice was squeezed out of the shell and kept at -30 °C. Before being used, the juice was increased to a temperature of 4 °C to defrost for 24 hours.

Preparation of albedo from dried pomelo peel. Albedo was prepared from the pomelo peel in the abovementioned way and dried in an oven at 50 °C for 48 hours. Then it was sifted through a 100 mesh sieve filled with aluminum foil in Freud Sealed Vacuum Storage at room temperature

1.2 Preparation of chicken meat

Chicken meat was stored at -30 °C. Prior to use, its temperature was increased to 4 °C for 24 hours to defrost.

1.3 Analyses of chemical and physical properties of albedo from both fresh and dried pomelo peels and chicken meat were conducted pH (pH meter), protein, fat, ash, fiber and moisture content (AOAC., 2000)

2. Study on the effect of albedo extraction from pomelo peel on the performance of emulsion in chicken meat from the skewers

Preparation of the emulsion system (modified from Sarıçobanc et al., 2008). Five emulsions were made by adding varying amounts of fresh and dried albedo (0.0, 2.5, 5.0, 7.5 and 10 by weight) to 25 g of skewers and phosphate salts. The emulsions were spun in a blender jar for 2 minutes at high speed. Then 50 ml of corn oil was blended into the mixture for 10 seconds at low speed. Gradually corn oil was added to obtain a total of 100 ml. The analyses were as follows.

Color measurement of Hunter emulsion using handy colorimeter

Emulsion capacity (modified from Cui et al., 1993). Fresh and dried albedo was added at 5 levels (0.0, 2.5, 5.0, 7.5 and 10 by weight) to create 25 g skewers with an added salt solution. 100 ml of phosphate was blended in a blender jar for 2 minutes at high speed (13,000 rpm); 50 ml of corn oil was mixed into it for 10 seconds at low speed (5,000 rpm). More oil was added in 5 ml increments to reach 100 ml. 10 ml of emulsion was centrifuged at a speed of around 2,750 rpm for 5 minutes. The emulsion equation is as follows:

$$\text{Emulsion value (\%)} = \frac{\text{Height of emulsion layer}}{\text{Height of total liquid layer}} \times 100$$

Emulsion Stability Analysis (modified from Cui et al., 1993). A 25 g emulsion was prepared as a 10 ml volumetric emulsion by boiling the emulsion in water at 80 °C for 30 minutes and allowing the mixture to cool with water until room temperature. The centrifuge was rotated at 2,750 rpm for 5 minutes and then the equation below was used.

$$\text{Emulsion stability (\%)} = \frac{\text{Height of remain emulsion layer}}{\text{Height of total liquid layer}} \times 100$$

Analysis of emulsion viscosity and emulsion flow properties (modified from Sarıçobanc et al., 2008). A 25 g emulsion was prepared in a beaker using 6 speed levels (2.5, 5, 10, 20, 50 and 100 rpm) for 60 seconds at 20 ± 2 °C. Viscosity was measured using a Brookfield viscometer using a needle pin number 4.

3. Quality study of chicken sausage products with albedo filling from pomelo peel

The study on the quality of chicken sausage products containing albedo from peel pomelo in the indicated quantities entailed an analysis of the quality of physical products, including texture (cutting force) and color, chemical composition, pH value, and sensory quality analysis. A 9-point hedonic scalability test was administered to 50 testers to assess the quality, appearance, color, aroma, taste, texture and overall liking.

4. Statistical Analysis

Analysis of physical and chemical qualities involved a complete randomized design (CRD), 3 replications, ANOVA, and difference between means using the Duncan's New Multiple Range Test (DMRT) method at 95% confidence intervals. Sensory quality analysis utilized a 9-point hedonic scale test with a confidence level of 95%.

Results and discussion

1. Study on chemical and physical qualities of albedo from pomelo peel and chicken meat

The study on chemical and physical qualities of albedo from both fresh and dried pomelo peels provided the values of moisture, fat, protein, ash, crude fiber, carbohydrate, pH, L*, a* and b* (Table 1). Albedo is suitable for use; due to low humidity, it is not deteriorated by microbes and enzymes. In regards to the pH value, the dried albedo had higher acid value than fresh albedo. Dried albedo had a lower luminance (L*) value due to evaporation. For some foods, the brightness depends on the moisture content. The red value analysis (a*) was found to be higher and evapotranspiration also has a significant effect on yellowing (b*), which is consistent with Sarıçobanc et al. (2008).

The analysis of protein content in chicken meat demonstrated that the product was 18.31% protein, which is close to that of chicken protein, 20-23%, according to Sarıçobanc et al. (2008).

Table 1 Chemical and physical qualities of albedo from fresh and dried pomelo peels and chicken meat

Quality	Albedo from the fresh pomelo peel	Albedo from dried pomelo peel	Chicken fillet
Chemical quality (Percent)			
Moisture	**70.00±0.35**	**8.06±0.41**	**70.64±1.18**
Protein	**1.16±0.32**	**5.40±0.07**	**18.31±0.58**
Fat	**0.24±0.20**	**0.37±0.08**	**0.45±0.32**
Ash	**0.93±0.05**	**5.89±0.25**	**1.40±0.04**
Crude Fiber	**27.03±0.01**	**72.25±0.19**	**0.50±0.33**
Carbohydrate	**0.62±0.20**	**8.00±0.59**	**8.68±1.33**
Physical quality			
pH value	**4.96±0.00**	**4.78±0.02**	**6.26±0.01**
Color value L*	**67.90±0.30**	**61.56±0.80**	**38.93±0.68**
Color value a*	**-0.86±0.11**	**1.36±0.40**	**3.63±1.00**
Color value b*	**4.30±0.17**	**6.33±0.28**	**8.26±0.20**

2. Effect of addition of albedo from fresh and dried pomelo peels on emulsion performance in chicken

2.1 Physical qualitative study of emulsion with albedo extract from fresh pomelo peel

The emulsion value of the emulsion enriched with fresh albedo (Table 2) was 2.5%, 7.5%, and 10%, respectively ($p > 0.05$). There were statistically significant differences ($p \leq 0.05$) between formulations, with the 5 percent having the highest emulsion value. Emulsion stability at 2.5, 5, 7.5 and 10% fresh albedo levels were not significantly different ($p > 0.05$), but were different than the control ($p \leq 0.05$). The 5% fresh albedo had the highest stability. This was due to the properties of albedo fiber, whose structure retains liquid viscosity, increased viscosity, stability and water holding capacity in the emulsion system. Acidity, L*, a* and b* were not significantly different ($p > 0.05$) at all levels.

2.2 Physical qualitative study of emulsion enrichment system of albedo from dried pomelo peel

It was found that at 0, 2.5, 5, 7.5 and 10% albedo (Table 3) the pH values, emulsion values and stabilities of the emulsions were significantly different ($p \leq 0.05$). This is due to the properties of a structurally-based albedo that retains fluid, thus enhancing viscosity, stability and water retention. The pH value, at the 0% level of aldehyde drying, was highest, whereas L*, a* and b* were not significantly different ($p > 0.05$).

The study of fresh and dried albedo additions found that the emulsion value and emulsion stability were higher for fresh albedo at 5%. The 5% dry albedo had higher water absorption ability because drying resulted in increased surface area and porosity. Furthermore, drying also produces fine particles of coarse fibers.

Table 2 Physical qualities of emulsion systems supplemented with albedo from fresh pomelo peels

Level of filling albedo (percent)	pH value^{ns}	Emulsion value (percent)	Stability (percent)	Average Color		
				L*^{ns}	a*^{ns}	b*^{ns}
0	6.78±0.01	25.80±1.22^{d}	44.28±2.68^{c}	53.56±0.25	-0.26±0.11	3.76±0.15
2.5	6.82±0.03	36.55±1.04^{c}	52.11±1.34^{b}	53.40±1.05	-0.43±0.15	3.63±0.37
5	6.78±0.00	43.80±1.36^{a}	55.52±1.81^{a}	54.63±0.25	-0.46±0.05	3.86±0.05
7.5	6.82±0.03	34.68±1.87^{bc}	51.41±0.26^{b}	54.06±0.55	-0.50±0.10	3.80±0.10
10	6.83±0.01	32.92±1.78^{b}	51.11±0.96^{b}	54.20±0.78	-0.40±0.20	3.86±0.05

Remark: Characters a, b, c, d, e are different in column. The difference was statistically significant ($p \leq 0.05$)
The letters ns are displayed in column. There was no significant difference ($p > 0.05$)

Table 3 Physical qualities of emulsion systems supplemented with albedo from dried pomelo peels

Level of filling albedo (percent)	pH value^{ns}	Emulsion value (percent)	Stability (percent)	Average Color		
				L*^{ns}	a*^{ns}	b*^{ns}
0	6.78±0.01^{a}	25.80±3.22^{e}	44.28±2.68^{c}	53.56±0.25	-0.26±0.11	3.76±0.15
2.5	6.70±0.01^{b}	33.74±2.72^{d}	58.54±1.91^{b}	52.86±0.25	-0.50±0.00	4.50±0.10
5	6.60±0.01^{c}	50.87±1.51^{a}	60.81±0.60^{a}	52.90±0.10	-0.70±0.20	4.56±0.15
7.5	6.53±0.00^{e}	41.53±1.66^{b}	58.30±1.37^{b}	52.93±0.15	-0.53±0.20	4.53±0.32
10	6.56±0.01^{d}	39.64±1.70^{c}	58.66±1.31^{b}	53.17±0.20	-0.63±0.11	4.63±0.20

Remark: Characters a, b, c, d, e are different in column. The difference was statistically significant ($p \leq 0.05$)
The letters ns are displayed in column. There was no significant difference ($p > 0.05$)

Therefore, dried albedo is suitable for use as a stabilizing ingredient in high fat food products and as an emulsifying agent. Levels of 5% resulted in water absorption in the emulsion system, making the emulsion system stable. Adding excess dry albedo results in coarse particles of the coarse mixture exceeding the amount of water in the formulation. Ultimately this leads to fiber separation and reduction in the stability.

2.3 Study of viscosity and flow behavior of emulsion enriched with albedo from both fresh and dried pomelo peels

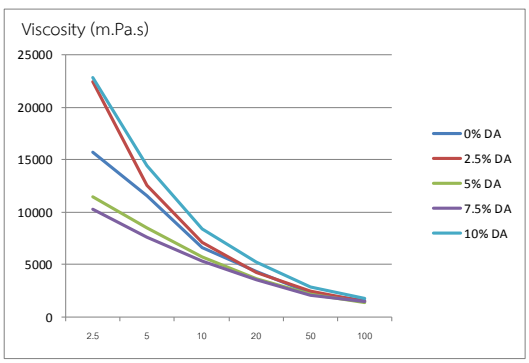
The viscosity and flow behavior of the emulsion system supplemented with 0, 2.5, 5, 7.5 and 10 % albedo gel (by weight) were significantly different ($p \leq 0.05$) (Fig. 1). The viscosity and flow behavior of both fresh and dried albedo emulsion systems decreased with increasing rotation speeds because the rotation speed affects the viscosity and flow behavior of the emulsion simulation system.

The viscosity of the emulsion system provided by fresh albedo are more useful than dried albedo. Because albedo is cellulose, it has the structure and ability to absorb water and retain water. When albedo is heated, the cellulose structure is destroyed and contracts. Albedo drying, allows the albedo to absorb more water. Dried albedo absorbs water in the emulsion, making the emulsion more corrosive and decreases the viscosity (Ferna´ndez-Gine´s et al., 2004). The viscosity decreases as the velocity of the viscosity gauge increases. It was found that the level of albedo supplementation was optimum at 5%.

3. Results of quality studies of chicken sausage products supplemented with albedo from pomelo peel

3.1 Study of chemical and physical qualities

The study of the chemical and physical qualities chicken sausage (Table 4) showed that crude carbohydrate, ash and L*, a*, b* content of chicken sausage product and the formula with the albedo. Both fresh and dried albedo at the 5% level were significantly different ($p \leq 0.05$). The ash content of dried sausage with dried albedo was higher ($p \leq 0.05$) than the fresh albedo and control, equal to 1.53, 1.45 and 1.14%, respectively. In the chicken sausage product, the dried albedo was higher than that of the fresh albedo and the control formulas - 1.01, 0.99 and 0.65%, respectively. Dried albedo was lighter than the fresh albedo because of the water loss. The reduction in albedo lightness (L* values) by dehydration was determined to result from water content reduction. Lightness was presented to be affiliated with moisture content for some foods (Hutchings, 1999). The increase in redness (a* values) of dried albedo could be due to relative increase in the concentration of carotenoid compounds that supported the value in redness (Ferna´ndez-Lo´pez et al., 2002). There were not the effect of dehydration on the yellowness values. It could be seemed that these results were very related to the studies from Aleson-Carbonell et al. (2004). The chicken sausages with dried albedo had a higher coarse fiber content than the fresh albedo chicken sausages. The carbohydrate content of the control sausage was higher than that of fresh and dried albedo. The addition of both fresh and dried albedo affected the ash content. Carbohydrates and coarse fibers moisture content, protein, fat, and pH were different between formulations. The cutting force of the formulas containing the dried albedo was the highest and significantly different from other formulas ($p \leq 0.05$).



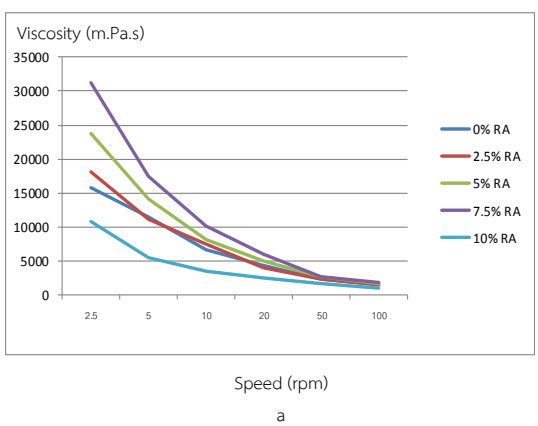


Fig. 1 Viscosity and flow behavior of emulsion enriched with albedo from dried pomelo peel (a) DA and (b) RA

Table 4 Chemical and physical qualities of chicken sausage products from control chicken formula and 5% formula containing both dried and fresh albedo from pomelo peels

Quality	Addition of albedo from pomelo peel (%)		
	Control	RA	DA
Chemical quality (Percent)			
Moisture ^{ns}	59.73±0.16	60.35±0.26	60.16±0.64
Protein ^{ns}	23.44±0.87	23.44±0.29	23.15±0.52
Fat ^{ns}	6.61±0.13	6.81±1.16	6.95±0.84
ash	1.14±0.02^{c}	1.45±0.10^{b}	1.83±0.02^{a}
Crude Fiber	0.65±0.02^{c}	0.99±0.01^{b}	1.01±0.09^{a}
Carbohydrate	8.19±0.92^{a}	6.19±0.42^{c}	7.16±0.65^{b}
Physical quality			
pH value ^{ns}	6.24±0.57	6.33±0.01	6.48±0.03
Color value L*	56.26±0.32^{b}	55.66±0.20^{c}	57.13±0.23^{a}
Color value a*	2.70±0.51^{c}	3.66±0.32^{b}	3.80±0.00^{a}
Color value b*	19.5±0.36^{a}	12.5±0.26^{b}	11.73±0.11^{c}
Cutting force (g)	281.86±1.14^{c}	300.42±1.08^{b}	387.26±3.99^{a}

Remark: The letters a, b, c are different in row. The difference was statistically significant ($p \leq 0.05$)
ns character displayed in row. There was no significant difference ($p > 0.05$)
RA is the addition of fresh albedo, DA is the addition of dried albedo

3.2 Study of sensory attributes

The 9-point hedonic scale (Table 5) was used to assess the chicken sausage product prepared by adding 5% albedo, either fresh or dried. Sensory was evaluation in attributes appearance, color, flavor, taste, hardness, flexibility and overall liking by 50 untrained panel. All recipes were statistically significantly different ($p \leq 0.05$). Chicken sausages with fresh albedo had the highest

liking score and received higher acceptance values than the dried sausage with dried albedo. Since fresh albedo has less water holding capacity than dried albedo, it was added to the chicken sausage in equal proportion with other ingredients in order to make chicken sausage products have good texture and maintain moisture. This is unlike the hard and crumbly nature of the chicken sausage with dried albedo. Sausage products with fresh and dried albedo had higher scores for all sensory attributes than the control because albedo is a carbohydrate substitute that can dissolve water and form a gel-like structure. This will increase the viscosity and texture of the product. This group of fat substitutes may be limited in use as excessive quantities produce an unpleasant odor. However, at appropriate levels, the albedo provides health benefits and serves as an effective emulsifier (Lucca & Tepper, 1994).

Table 5 Sensory properties of chicken sausage products from control chicken frame and Formula containing albedo from both fresh and dried pomelo peels at 5%

Sensory attributes	Addition of albedo from grape peel (%)		
	Control	5 RA	5 DA
characteristic	5.80±0.76^{c}	8.56±0.64^{a}	7.10±0.71^{b}
color	6.12 ±0.63^{c}	8.36 ±0.75^{a}	7.04 ±0.75^{b}
flavor	6.02 ±0.82^{c}	8.40 ±0.61^{a}	7.02 ±0.77^{b}
taste	5.94 ±0.79^{c}	8.24 ±0.59^{a}	7.08 ±0.72^{b}
hardness	5.80 ±0.76^{c}	8.18 ±0.52^{a}	7.00 ±0.76^{b}
flexibility	6.06 ±0.82^{c}	8.20 ±0.53^{a}	6.98 ±0.77^{b}
Overall liking	6.14 ±0.73^{c}	8.16 ±0.58^{a}	6.90 ±0.71^{b}

Remake: Different letters a, b in row. The difference was statistically significant ($p \leq 0.05$)
RA is the addition of fresh albedo, DA is the addition of dried albedo

Conclusion

Emulsion is important system in sausage products. Albedo from pomelo has the ability of water binding resulting in the product has stability and elasticity. The development of chicken sausage products was undertaken by adding fresh or dried albedo as an emulsifier and source of dietary fiber. Varying levels of albedo were added until the appearance of a stable emulsion with an appropriate emulsification value. The developed sausage chicken product with the highest acceptance score was the chicken sausages enriched with 5% fresh albedo. The values of pH, L*, a* and b* were 6.33, 55.66, 3.66 and 12.5, respectively. The cutting force was 300.42 g and the moisture, protein, fat, ash, fiber, carbohydrate contents were 60.35, 23.44, 6.81, 1.45, 0.99 and 6.19, respectively. The overall score of the 50 subjects was 8.16.

Sausages with added dietary fiber from albedo of pomelo peel can be used to assemble healthy menu, eaten with salads, or used in other health-focused consumables. Pomelo albedo showed good water holding property in emulsion structure. It can improved the textural properties of product added albedo. In the future should be research the albedo addition in other emulsion.

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