EFFECT OF PRE-GELATINIZED PORK SKIN SLURRY ON THE QUALITY OF TAIWANESE-STYLE MEATBALL (KUNG-WAN)

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Abstract – The physicochemical, textural, and quality characteristics of Taiwanese-style meatball containing different pre-gelatinized pork skins slurry were evaluated. P25 (pork skin slurry contained 25% water) had the lowest cooking loss and the hardest texture among all treatment. P100 (pork skin slurry contained 100% water) had the highest total fluid expressed (TEF). In sensory evaluation, higher off-flavor appeared in P25 and P50 (pork skin slurry contained 50% water) . In addition, the sensory scores of P75 (pork skin slurry contained 75% water) were similar with control and also indicated that P75 was acceptable. According to these results, using pre-gelatinized pork skin slurry as meat replacer was feasible which not only decreased the product's cost but also showed the similar quality with control.

Key Words – Taiwanese-style meatball, pre-gelatinized pork skin slurry, total fluid expressed, off-flavor

I. INTRODUCTION

Taiwanese-style meatball (also known as kung-wan in Taiwan) which is made from pork and pork back fat is a popular emulsified product in Taiwan. The textural characteristics of Taiwanese-style meatballs are required to be hard, springy, and juicy (Hsu and Chung, 1999). Some studies have reported applications of various hydrocolloids or non-meat protein in meat products as meat binders and texture stabilizers. A previous study has shown that simultaneously adding soy protein isolate and carrageenan or respectively adding could increase hardness, springiness and chewiness of low-fat pork batters (Gao *et al.*, 2015). Another study reported that meatballs extended with blackeye bean flour and lentil flour resulted in greater cooking yield, fat retention and water retention values (Serdaroglu *et al*., 2005).

Gelatin applications in foods are derived largely from its gelation and film-forming properties, which are a consequence of an extended, fibrous tertiary structure and triple helical cross-linked quaternary structure (Simon-Lukasik and Ludescher, 2004).

Therefore, the objective of this study was to evaluate the quality of Taiwanese -style meatball with added different pre-gelatinized pork skins as meat replacers.

II. MATERIALS AND METHODS

Preparation of pre-gelatinized pork skin slurry

Pork skin was purchased from local food Co., Ltd in Taichung, Taiwan. Mixture of pig skin and different % of water (M25-25%water, M50-50%water, M75-75 % water and M100-100%water) were cooked at 121℃ for 30min, individually. The formulations are presented in Table 1. After cooking, each pre-gelatinized pork skin slurry was minced by blender for 2 min.

Preparation of meatball

The experimental treatments was divided into four groups such as C-70% pork ham＋30% pork back fat, P25-55% pork ham＋15% M25＋30% pork back fat, P50-55% pork ham ＋15% M50＋30% pork back fat and P100-55% pork ham＋15% M100＋30% pork back fat. The seasoning ingredients contained (w/w) 1.65% salt, 0.15% polyphosphate, 0.15% white pepper, and 0.05% onion powder. The processing of meat ball was described as the report of Liu and Chen (1992). The meat batter was shaped into balls then cooked in water at 85℃ for 30 min. The meatballs need be chilled and vacuum packaged and finally stored at -18℃ for one day. All analysis were finished in one week.

Proximate composition
Frozen meatballs for analysis were thawed in a cooler (2℃) before sampling. Then thawed meatballs were homogenized for determining proximate compositions (crude protein, crude fat , moisture and ash) using the AOAC (1995) methods.

Cooking loss
The cooking loss of the meat balls was calculated as the following formula, weight of non-cooked meat-ball – weight of cooked meatball / weight of non-cooked meat-ball ×100%.

Emulsifying stability
Emulsifying stability was determined as followed as the procedure of Hughes and others (1997). Raw batter (25 g) was placed in a 50-mL centrifuge tube and centrifuged at 2700 × g for 1 min. The sample was heated at 70℃ in water bath for 30 min and centrifuged at 2700 × g for 3 min. Supernatant was decanted into a tared crucible and the centrifuge tube (plus pellet) was reweighed.
TEF = (weight of centrifuge tube and sample) – (weight of centrifuge tube and pellet)
%TEF = [TEF/original sample weight] × 100
% Fat = {[(Weight of crucible + dried supernatant) – (Weight of empty crucible)] /TEF} × 100

Texture-profile analysis
Five thawed meatballs from each treatment were heated at 85℃ in water for 15 min, and cut to cycle size with 25mm diameter and 10mm height. Five samples were compressed 2 times with 50% compression using a texture analyzer (Model Compac-100, Sun Rheo Meter, Japan). Measuring speed was 60 mm/min, and the plunger diameter is 30 mm. Gel strength, hardness, springiness and chewiness were recorded.

Scanning electronic microscopy
Meat batters were carefully put into plates and frozen at -70℃ for three days and then lyophilized (FDU-540, Eleya, Japan) for two days. The lyophilized samples were put onto a double-sided adhesive tape, mounted on aluminum stubs and coated with white-gold. The samples were observed by scanning electron microscope (JSM-6700F, JEOL, Japan).

Sensory evaluation
Ten graduate students of the Department of Animal Science, National Chung-Hsing University, were trained as panelists. Appearance, springiness, juiciness, off flavor and overall acceptability of meat balls were evaluated by using a 7 point of hedonic scale system. 1 indicated very low desirability in appearance, springiness, juiciness and overall acceptability and 7 indicated very high desirability. However, 0 in off flavor indicated weak off-flavor and 7 indicated strong off-flavor.

Statistical analysis
Statistical analyses were by Duncan's new multiple range test using the statistical analysis system (SAS Institute, 1991).

III. RESULTS AND DISCUSSION

The appearance of Taiwanese style meat ball
The surface and internal of Taiwanese style meat balls were showed in Figure 1 and 2. The gelatin particles were found in internal of meat ball with different styles of pre-gelatinized pork skin slurry (picture 2).

Proximate composition, cooking loss and emulsion stability
The data of proximate composition, cooking loss and emulsifying stability of Taiwanese-style meatball were showed in Table 2 and 3. Control had higher moisture than other treatments because of its lowest fat content. The highest protein content was found for P25 treatment. All meat balls with pre-gelatinized pork skin slurry had significantly higher crude fat content than control due to pork skin containing higher fat. However, P25 had the lowest cooking loss because of its highest protein content. Youssef and Barbut (2009) reported that higher protein content in beef meatball could lower more cooking loss. In this research emulsifying stability was expressed by the percent total fluid expressed (%TEF). Except of control and P25 meat balls with more P50 presented significant higher TEF and fat (%Fat) released.

Texture-profile analysis

Texture profiles analysis of Taiwanese style meat balls were listed in Table 4. The P25 had the highest gel strength, hardness, and chewiness. This results also indicated that use of M25 pre-gelatinized pork skin slurry had good improving effect for texture of meat ball and even better than control. However, meatballs with M50, M75 and M100 showed more softer texture of meat ball because higher moisture content was found in pre-gelatinized pork skin slurry. Lin and Lin (2004) reported that increasingly bacterial cellulose adding could decrease the texture of Chinese meatballs because of higher water content in bacterial cellulose.

Table 1. The ingredient and processing condition of pre-gelatinized pork skin slurry

Treatments	Ingredients (g)		121℃, cooking time (min)
	Pigskin	Water	
M25	100	25	30
M50	100	50	30
M75	100	75	30
M100	100	100	30

Scanning electronic microscopy

The microstructure of internal of meat batters was showed in Figure 3. The batter of control and P25 formed more firm structure and smooth gel clusters (Fig. 1a and b). More holes or spores in batter was found with pre-gelatinized pork skin slurry of M50-100 (Fig. 1c, d and e). These changes in microstructure could evidence why P100 had the lowest gel strength and hardness. Jones and Mandigo (1982) reported that these pores play a definite function in the emulsion system and smoother surface showed thin protein layer surrounding fat globules.

Table 2. The proximate composition of Taiwanese-style meatball (kung-wan) added different pre-gelatinized pork skin slurry

	(%)			
Trt	Moisture	Protein	fat	Ash
C	50.9 ± 0.2^{A}	15.3 ± 0.1^{B}	30.7 ± 0.6^{C}	2.0 ± 0.1^{A}
P25	49.6 ± 0.1^{C}	16.1 ± 0.0^{A}	31.3 ± 0.2^{BC}	1.9 ± 0.1^{B}
P50	49.7 ± 0.1^{BC}	14.9 ± 0.1^{B}	31.8 ± 0.2^{AB}	1.8 ± 0.1^{BC}
P75	49.9 ± 0.1^{BC}	14.5 ± 0.4^{C}	32.1 ± 0.1^{A}	1.7 ± 0.1^{C}
P100	49.9 ± 0.1^{B}	14.3 ± 0.3^{C}	32.3 ± 0.3^{A}	1.8 ± 0.1^{BC}

n=3

A-C:Means within the same column without the same superscript are significantly different (P<0.05) .

C = control; P25-100 = meatball with M25-M100 pork skin slurry.

Sensory panel evaluation

The data of sensory panel evaluation of Taiwanese-style meatball were listed in Table 5. All sensory items of meat balls in all treatments and control were no significant ($p>0.05$) difference. But data analysis presented higher off-flavor in P25 and P50 because pre-gelatinized

Table 3. The cooking loss (CL) and emulsion stability (ES) of Taiwanese-style meatball (kung-wan) added different pre-gelatinized pork skin slurry

	(%)		
Treatment	CL	TEF	Fat
Control	4.67 ± 0.39^{D}	2.23 ± 0.34^{D}	26.02 ± 0.58^{A}
P25	2.55 ± 0.63^{E}	2.44 ± 0.06^{D}	21.65 ± 0.37^{B}
P50	5.76 ± 0.15^{C}	5.84 ± 0.21^{A}	20.28 ± 0.67^{C}
P75	8.87 ± 0.44^{B}	3.66 ± 0.14^{C}	17.52 ± 0.39^{D}
P100	12.34 ± 0.23^{A}	4.57 ± 0.08^{B}	25.90 ± 0.86^{A}

n=3

A-E:Means within the same row without the same superscript are significantly different (P<0.05) .

C = control; P25-100 = meatball with M25-M100 pork skin slurry.

Table 4. The gel strength, hardness, springiness, and chewiness of Taiwanese-style meatball (kung-wan) added different pre-gelatinized pork skin slurry

	TPA [a]			
Trt	GL (kg)	HA (N)	SP	CH (N)
C	4.1 ± 0.2^{B}	40.3 ± 2.1^{B}	0.85 ± 0.03^{A}	25.4 ± 2.6^{B}
P25	5.0 ± 0.2^{A}	48.6 ± 2.0^{A}	0.87 ± 0.01^{A}	32.4 ± 3.1^{A}
P50	3.0 ± 0.5^{C}	29.5 ± 4.9^{C}	0.85 ± 0.01^{A}	19.1 ± 4.2^{C}
P75	2.5 ± 0.2^{D}	24.7 ± 2.1^{D}	0.85 ± 0.02^{A}	15.9 ± 1.3^{CD}
P100	2.0 ± 0.1^{E}	19.8 ± 1.4^{E}	0.85 ± 0.01^{A}	12.6 ± 0.9^{D}

n=5

A-E:Means within the same column without the same superscript are significantly different (P<0.05) .

[a] GL = gel strength, HA = hardness, SP = springiness and CH = chewiness.

C = control; P25-100 = meatball with M25-M100 pork skin slurry.

Table 5. The sensory evaluation of Taiwanese-style meatball (kung-wan) added different pre-gelatinized pork skin slurry

	Sensory evaluation [b]				
Trt	AP	EL	JU	OF[a]	OA
C	5.0 ± 0.5^{A}	5.3 ± 0.8^{A}	5.3 ± 0.5^{A}	0.9 ± 0.9^{A}	5.4 ± 0.8^{A}
P25	5.0 ± 0.7^{A}	5.3 ± 0.8^{A}	5.3 ± 0.7^{A}	1.7 ± 1.2^{A}	4.9 ± 0.7^{A}
P50	4.9 ± 0.6^{A}	4.8 ± 0.9^{A}	$5.3\pm0..7^{A}$	1.7 ± 1.1^{A}	4.7 ± 0.7^{A}
P75	5.3 ± 1.0^{A}	5.1 ± 1.3^{A}	5.4 ± 1.0^{A}	1.4 ± 1.3^{A}	5.2 ± 0.9^{A}
P100	5.1 ± 0.9^{A}	4.7 ± 0.7^{A}	5.2 ± 0.8^{A}	1.5 ± 1.2^{A}	4.9 ± 0.9^{A}

n=10

[a] Means off-flavor evaluation (0 = no off-flavor detected and 7 = extreme off-flavor)

[b] AP = appearance, EL = elasticity, JU = juiciness, OF = off-flavor and OA = overall acceptability

C = control; P25-100 = meatball with M25-M100 pork skin slurry.

pork skin slurry had lower water content leading products to be gamy and more pig flavor. Nevertheless, we could find that the best pre-gelatinized pork skin slurry for Taiwanese style meatball was P75 because it had similarly sensory scores with control.

Figure 1. The surface of Taiwanese-style meatball added different pre-gelatinized pork skin slurry.

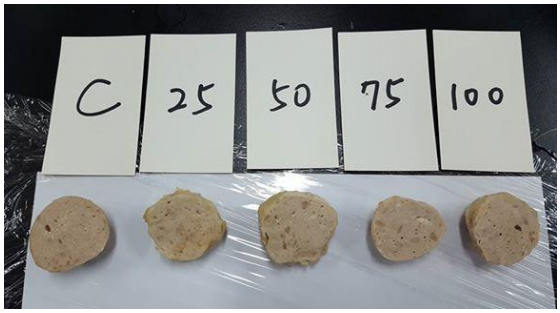

Figure 2. The interior of Taiwanese-style meatball added different pre-gelatinized pork skin slurry.

IV. CONCLUSION

In this study Taiwanese meat ball with M25 pre-gelatinized pork skin slurry had lowest cooking loss, highest emulsion stability and hardest characteristic. But in the sensory evaluation, meat ball with M75 were similar with control to be acceptable.

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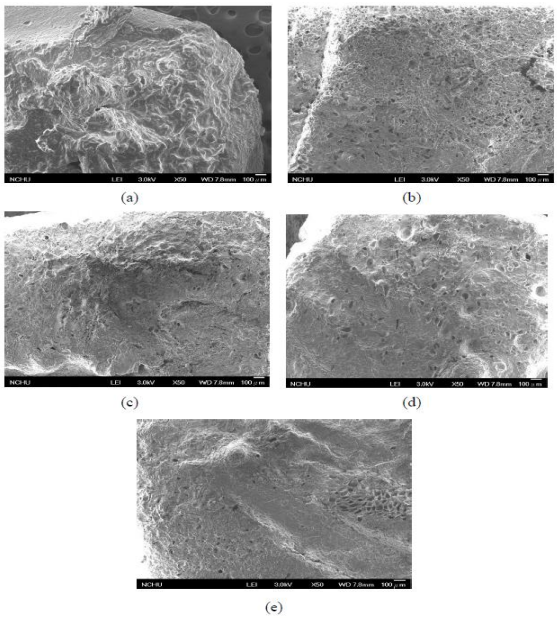

Figure 3. The internal microstructure of meat batter added different pre-gelatinized pork skin slurry. a, b, c, d, and e were C, P25, P50, P75, and P100, respectively. Bar=100 μm.

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