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Effect of texturizing agents on quality of Moo yor in a model system

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Abstract

Hydrocolloids are texturizing agents which are used in food industry. They are widely utilized due to their excellent physical functional properties, such as thickening, gelling and stabilizing abilities. Hydrocolloids with their unique characteristics are of great interest for processed meat due to their ability to bind water and form gel. In this study, quality characteristics of Moo yor with different texturizing agents were examined. Texturizing agents such as tapioca starch (TPS), modified starch (MTS), κ -carrageenan (KCG), ι -carrageenan (ICG), sodium alginate (ALG) and carboxymethyl cellulose (CMC) at 1% level were added. ALG favorably affected rheological properties of Moo yor batter. It also decreased cooking loss and expressible moisture content. ICG and ALG can improve product texture. They increased hardness, chewiness, springiness, gumminess and cohesiveness. Scanning electron microscopic study indicated that Moo yor with ALG had a lot of filamentous deposition and the cavities were smaller. Moreover, Moo yor with ICG showed small strands of hydrocolloid gel outer protein gel matrix. ICG and ALG should be suitable texturizing agents for improving Moo yor texture.

Introduction

Yor is a popular Vietnamese meat emulsion sausage, made from pork by mixing the minced meat with fat, water, salt and ground spices. Their structures are usually set by streaming or boiling. (Supavititpatana and Apichartsrangkoon, 2007). The batter has a paste-like texture but gradually changes into a rigid structure during heating. Its shelf life is about two weeks in refrigerator.

The processed meat products texture depends on the structure of the proteins gel matrix, the soluble matters and moisture were entrapped in the gels structure. A failure to form the gel can produce an excessive loss of water and fat producing a mushy and mealy texture. A successful gel is balanced between protein–water and protein–protein interactions. Several texturizing agents are used for improving water binding properties and modifying texture.

The texturizing agents that often used as meat gel forming are hydrocolloids such as tapioca starch, carrageenan, alginate, carboxymethyl cellulose and modified starch. First at all, tapioca starch is the traditional starch which is used in Moo yor formulation. It is used as binder and filler agent. Iota-carrageenan (ICG) and kappa carrageenan (KCG) can form reversible gel. ICG solubilizes at 50^{o}C and it gives flexible gel with calcium ion. Ayadi *et al.* (2009) reported that ICG at 0.2 and 0.5% increased gel elasticity and water holding capacity of turkey meat sausage. KCG can forms brittle gel with potassium ion during cooling after it solubilizes about 60-70^{o}C. Many researchers revealed that KCG can enhance gel strength and water retention in the protein gel matrix (Verbeken *et al.* (2005), Pietrasik (2003) and Defreitas *et al.* (1997)). In addition, alginate (ALG) is a type of hydrocolloid which has gel forming ability. ALG gel is reasonably heat stable and show less or no syneresis. The calcium salt of alginate is insoluble. The insoluble salt results from the auto cooperative reaction between calcium ions and the G-block regions of the chain. Moreno *et al*. (2010) showed that using sodium alginate with tranglutaminase presented enhanced change in gel strength properties. Moreover, carboxymethyl cellulose (CMC) consists of numerous ionized carboxyl groups. The carboxyl end can also interact with proteins, as long as the pH of the food system is greater than the isoelectric point of the protein. In such a case, ionic interactions between the anionic CMC chain and the cationic protein chains generate a higher viscosity than is otherwise expected. Ruusunen *et al*., (2003) reported that bologna-type sausage with addition of KCG and CMC at 0.5% decreased frying loss but increased firmness. Finally, modified starch (MST) in this study is referred to hydroxypropyl distarch phosphate. It

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is being widely used in f ood products where they provide the desired viscosity, texture, and stability for processing and storage (Tuschhoff, 1986). Tuankriangkrai and Benjakul (2010) showed that MST at 1% level added could reduce those changed and rendered the surimi gel strength subjected to five freeze-thaw cycles with the highest score for texture, appearance and overall liking.

The objectives of this study were to evaluate the effect of texturizing agents (tapioca starch, kappa carrageenan, iota carrageenan, sodium alginate, carboxymethyl cellulose and modified starch) on rheology properties, textural properties and cooking properties of Moo yor.

Materials and Methods

Raw materials preparation

Lean pork and pork back fat were obtained from Betagro plc, Hatyai, Songkhla, Thailand. The lean pork was trimmed practically less of visible fat. The pork back fat was trimmed practically less of visible lean, then lean and back fat were cut into small pieces. They were packed in vacuum condition in a Nylon/LLDPE bag and were frozen in a blast freezer (-18°C). Frozen lean and back fat were kept not longer than a week. Prior to processing, the frozen lean pork and pork back fat were tempered in refrigerator and grinded through 5 mm diameter plate using a commercial meat grinder (Food Equipment, Thailand). Tapioca starch (Red cat brand, from Kriangkrai company limited, Nakornpathom, Thailand), modified tapioca starch (hydroxypropylated distarch phosphate) κ-carrageenan (Satiagel ME5, Degussa texturant systems, Inc.,Legaspi village Makati, the Philippines), ι -carrageenan (Genuvisco®carrageenan type J, CP Kelco company, Levallois-Perret, France) sodium alginate (Grindsted®Aqualine 346-M, Danisco Malaysia Soln, Bhd, Penang, Malaysia) and carboxymethyl cellulose (CMC) (Grindsted®Cellulose gum BEV 140, Danisco Malaysia Sdn, Bhd, Penang, Malaysia) and other ingredients are shown in Table 1.

Moo yor batter preparation

Lean pork, salt (NaCl food grade, Prungtip brand, Thailand), KCl and $CaCl_2$ (food grade, Witthayasom, Bangkok, Thailand.) and half of ice were chopped in a silent cutter (Scharfen, Germany) for 1 min. Pork back fat and remaining ice were added and chopped for 1 min. Finally, texturizing agents were added and chopped for 1 min. The chopping temperature was controlled below 15°C.

Rheological properties of Moo yor batter

Thermo rheological properties of Moo yor emulsions with and without texturizing agents were assessed by small amplitude dynamic oscillatory tests using a rheometer Rotational Rheometer (Haake, Rheo Stress RS75, Germany). Dynamic oscillatory measurements were monitored at a frequency of 1.0 Hz. After initial equilibration at 20°C for 5 min, the sample was heated continuously at a rate of 1°C/min from 25 to 80°C. (Hachmeister and Herald, 1998). Storage Modulus (G'), loss modulus (G") and tan δ (G'/G") were monitored.

Cooking loss

Moo yor batter was stuffed in to a 50 ml centrifuge tubes about 40-45 grams and sealed with a plastic cap. The batter tubes were pre-heated in water bath at 80°C for 30 min. They were removed from the hot water bath and allowed to cool in cold water (5°C for 10 min). Cooking loss was calculated based on the difference in weight before and after heating.

Expressible moisture content

Two grams of Moo yor was enveloped with two pieces of Whatman no. 1 filter paper and centrifuged at 3,650 rpm (approx 1,500 xg) (Refrigerated centrifuge (Hettich, Universal 32R, Tuttlingen, Germany) for 15 min at 25°C. The expressible moisture content was calculated based on the difference in weight before and after centrifuging.

Microstructure

Moo yor was cut into a cube (4 x 4 x 4 mm) with a razor blade. The prepared sampleswere fixed in 2.5% glutaraldehyde in 0.2 M phosphate buffer, pH 7.2 at room temperature for 2 h. All specimens were washed three times with deionized water for 15 min each and dehydrated with a serial concentration of 50, 60, 70, 80, 90 and 100% ethanol for 15 min each. All specimens were coated with gold. The microstructure pictures were taken at 10,000 magnification using Scanning Electron Microscope (JEOL, JSM-5800 LV) (Jones and Mandigo, 1982).

Texture profile analysis

Texture profile analysis was determined in six replications according to the procedure of García-García and Totosaus (2008) with slight modification using Texture Analyzer (Stable Micro system, TA-XT2i, Surrey, England). Moo yor samples were left at room temperature for 2 h and then cut into 25 mm long cylinders to ensure consistency between treatments. Samples were compressed to 50 % of original height in a double cycle at a constant rate of 3.3 mm/s with

Table 1. Formulation of Moo yor batter with different texturizing agents in a model system

Ingredients/Treatments	TPS	MST	KCG	ICG	ALG	CMC
Pork lean meat	69	69	69	69	69	69
Pork back fat	21	21	21	21	21	21
Ice	6.9	6.9	6.9	6.9	6.9	6.9
NaCl	1.5	1.5	1.5	1.5	1.5	1.5
KCl	0.5	0.5	0.5	0.5	0.5	0.5
$CaCl_2$	0.1	0.1	0.1	0.1	0.1	0.1
Tapioca starch	1	-	-	-	-	-
Modified tapioca starch *	-	1	-	-	-	-
κ-carrageenan*	-	-	1	-	-	-
ι-carrageenan*	-	-	-	1	-	-
Sodium alginate*	-	-	-	-	1	-
CMC*	-	-	-	-	-	1
Total	100	100	100	100	100	100

* Mean the texturizing agents.

2 seconds waiting period and the posttest speed was 10 mm/s. Aluminum probe with 50 mm diameter was attached to the analyzer equipped with 50 kg load cell. Hardness, cohesiveness, springiness and chewiness were calculated from the resulting force-deformation curve according to Bourne (1978).

Results and Discussion

Rheological properties

Gelation curves performed on rheological properties were shown in Figure 1. Gelation curve showed a characteristic peak during heating, which has been observed before and described to the thermal denaturation of the myofibrillar protein (Wang and Smith, 1994). At 25-43°C , G' increased slowly but decreased between 43-55°C. Above 55°C, G' increased rapidly. These results were described by Smith *et al.* (1991) who found that temperature range of 54-75°C, G' increased sharply. This may because of the development of three dimensional gel matrix by unfolded salt soluble muscle protein (Wang *et al.*, 1990).

Verbeken *et al.* (2005) reported that denaturation of the head and hinge portion of myosin and subsequent aggregation were responsible for initial increase in G'. At temperatures around 50°C, denaturation of the myosin tail lead to a large increase in fluidity and may disrupt the protein network formed at lower temperatures. Dissociation of myosin- actin complex also contributed on decreasing in G' between 50 and 55°C.

In case, Moo yor with ALG had the highest at G' and G' in the temperature range of 25-50°C

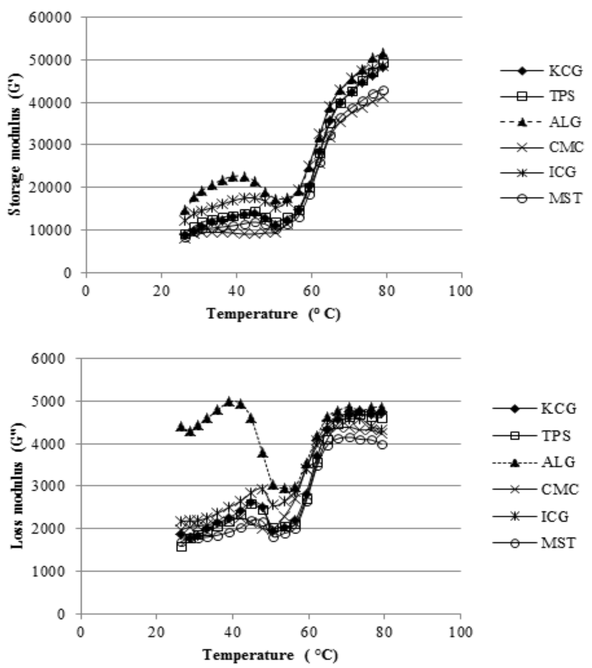

Figure 1. Rheological of Moo yor batter

.These results related to cold set binder ability of alginate (Esguerra, 1995). It can form a gel at room temperature, from the reaction between alginate salt and a calcium ion. The gel holds food pieces together and stable heat or thermo-irreversible; therefore, restructured products maintain their structural integrity through subsequent heating (Suklim *et al.*, 2004).

Cooking loss and expressible moisture

Figure 2 shows the water binding properties of

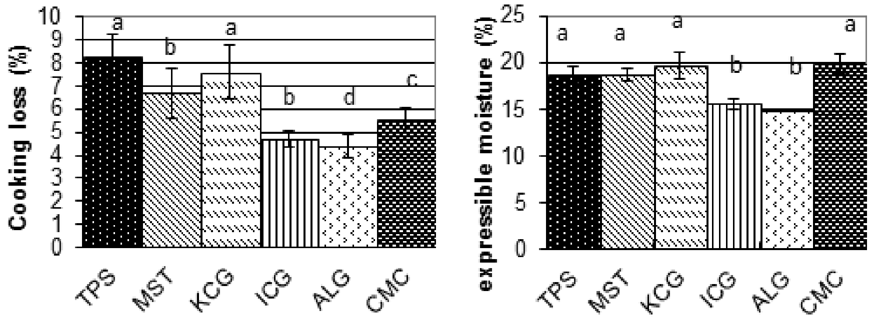

Figure 2. Water binding properties of Moo yor. Each value is presented as mean ± standard deviation (n = 6). Means above each bar with different letters differ significantly (P< 0.05).

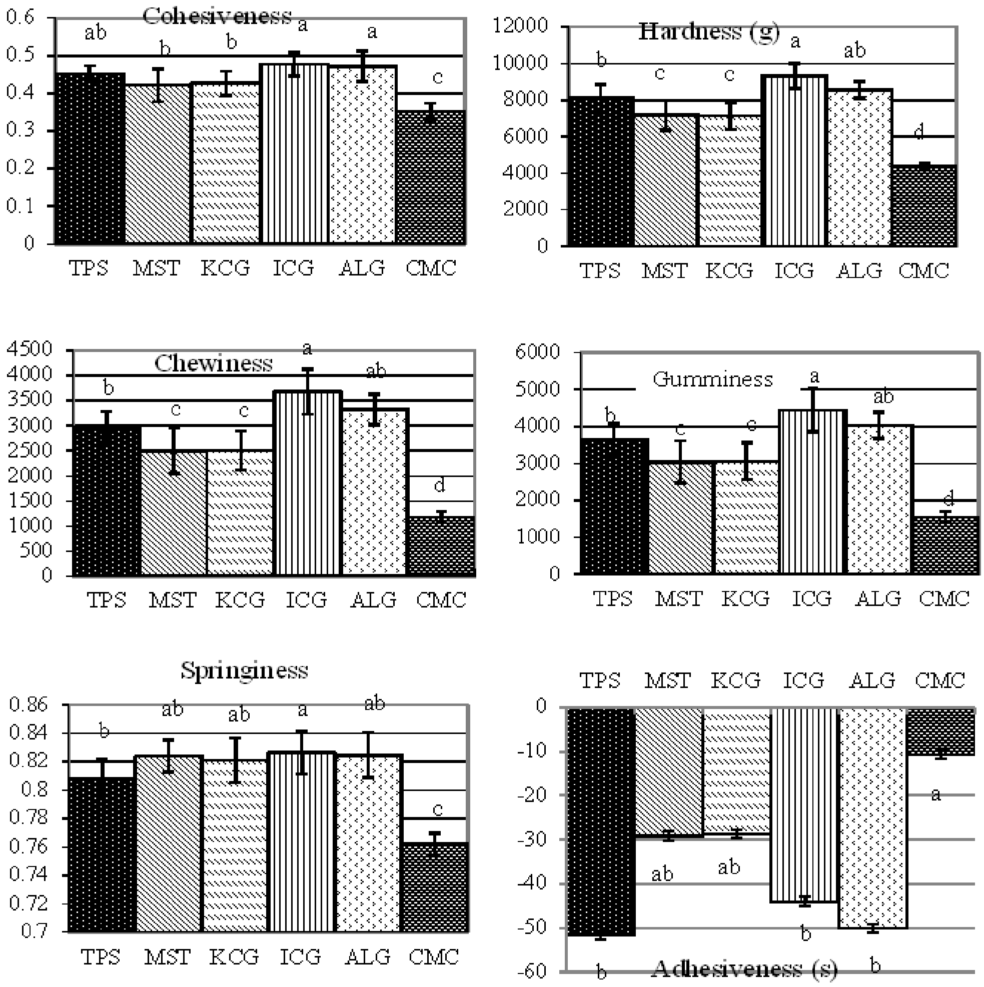

Figure 3. Texture profile analysis of Moo yor. Each value is presented as mean ± standard deviation (n = 10). Means above each bar with different letters differ significantly (P< 0.05).

Moo yor. The samples added with ALG produced significantly lower cooking loss value than other samples. Moreover, lower expressible moisture content was found in ALG and ICG samples ($p<0.05$). This may be due to the functional groups of each hydrocolloid for binding with water. ALG had a lot of carboxyl groups in its structure that can bind water and promote strong electrostatic repulsion between the chain, leading to the rapid hydration (Sánchez *et al.*, 1995). Iota carrageenan had two sulfate groups which can improve moisture retention in meat product on the basis of its ability to form complexes with water and protein (Yugushi *et al.*, 2003). The result was in agreement with Juemanee *et al*. (2009) who found the battered shrimp burger added with ALG and ICG had higher moisture content than other

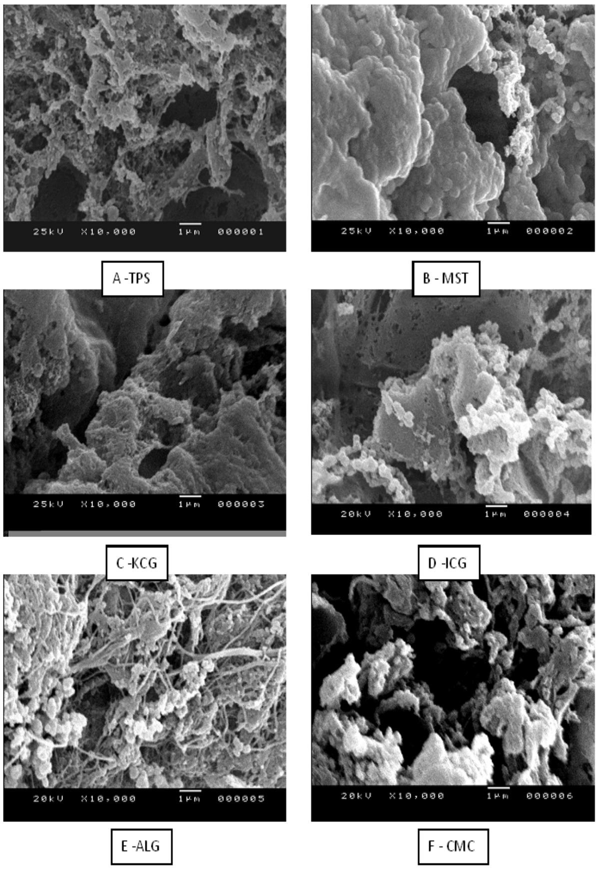

Figure 4. Microstructure of Moo yor

hydrocolloids. Moreover, they could form gel that entrap water. Results indicate that the matrix formed in those gels had a greater ability to entrap water than that of other gels. In contrast, CMC had not gel forming ability. Meat gel with CMC added had higher water release than the others after centrifuging. This result relate to study of Barbut and Mittal (1996) who reported that addition of CMC (0.5%) reduced the water holding capacity of frankfurter, probably because the CMC enveloped the myofibrillar protein before heating.

Texture profile analysis (TPA)

TPA data showed in Figure 3. The results indicated that Moo yor added with ICG and ALG had the highest hardness, chewiness, springiness, gumminess and cohesiveness ($p<0.05$). This result was in agreement with Ayadi *et al.* (2009) who found that addition of ι -carrageenan caused an increase in hardness and cohesiveness. This may due to the Ca^{2+} ion forming bridges between two sulfate groups of two different double helixes of carrageenan, thus forming inter-macromolecular bonds results in the breaking force of the gel. In addition, GÓmez-Guillén and Montero (1996) suggested that iota carrageenan from fine three dimension network with some points of connection with the protein matrix. Moreover, the results indicated that CMC had the lowest scores of all attributes.

Microstructure

Figure 4 shows microstructures of Moo yor gels with different texturizing agents. As shown in Figure 4A, starch granules become confined to the muscle protein network. This result is related to Kyaw *et al.* (2001) who found that dough from tapioca starch containing 50% fish showed strong fish muscle protein network.

Moo yor with MTS in Figure 4B showed MTS enveloped the protein. The starch granules distributed throughout the protein matrix. This may be due to the denaturation of meat protein beginning before starch gelatinization starts in the meat/starch system (García- García and Totosaus, 2008). This result may be due to the functional groups of MTS. It has a lot of hydroxypropyl groups that inhibit gelation and syneresis, by sterically interfering with formation junction zones and double helices in starch (Taro *et al.*, 2007). Moreover, MTS as a cross-linked starch, It is done to restrict swelling of starch granule under cooking condition or to prevent gelatinization of starch (Rutenberg and Solarek, 1984).

In Figure 4C and 4D show the microstructure of Moo yor with KCG and ICG, respectively. There are small strands of hydrocolloid gel at the outer and inner protein gel matrix in Moo yor added with ICG (Figure 4D), whereas there was not occurred in the gel of KCG in Figure 4C. These results related to working in pork sausage. These suggested that the different distribution of the carrageenan was due to κ -carrageenan solubilized at 60-70°C , when the myosin gel has already formed. On the other hand, ι -carrageenan solubilized at 50°C and able to penetrate the matrix before the myofibrillar protein gel has set (Trius *et al*., 1996).

In the gel containing ALG (Figure 4E), there was a lot of filamentous deposition and the cavities were smaller. These may be due to gel forming at room temperature before myosin had gelled. In addition, Lee *et al.* (1992) suggested that the calcium alginate fiber can be incorporated into composited-molded types of surimi gel products to give a chewy bite in analog products such as imitation shrimp and lobster. This result relates to TPA in previous study. Moo yor added with ALG had high score at hardness, chewiness, springiness and cohesiveness.

Figure 4F shows Moo yor with CMC, the structure had a protein matrix with large holes. This is possibly because CMC particularly requires a lot of water in order to disperse, a condition not favored by addition in dry state. Moreover, CMC enveloped the myofibrillar protein before heating (Barbut and

Mittal, 1996).

Conclusions

The addition of hydrocolloids enhances water binding capacity and textural properties of Moo yor. This may be due to they can form gel by themselves which entrapped more water and enhanced protein gel strength. In this model experiment, ALG and ICG showed their higher ability to improve some physical properties in Moo yor to maintain the product quality after heat processing.

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