International Food Research Journal 23(2): 904-908 (2016)
Journal homepage: *http://www.ifrj.upm.edu.my*

Effect of carrageenan on quality of frozen Moo yor

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Article history

Received: 8 January 2015
Received in revised form: 25 June 2015
Accepted: 9 July 2015

Keywords

Sausage
Texture
Hydrocolloid
Carrageenan
Frozen

Abstract

Moo yor is a local meat emulsion sausage product. Normally, Moo yor has short shelf-life as it is pasteurized at below water boiling point to avoid the damage of emulsion. Chilling temperature storage can prolong the product's life for a few weeks. Frozen may an alternative to extend storage time but product will lose the quality due to freezing damage. Addition of hydrocolloids may maintain product's quality during frozen storage. In this study, quality characteristics of frozen Moo yor with different texturizing agents were examined. The 1% w/w of tapioca starch (TPS as control sample) and two texturizing agents, ι-carrageenan (KCG) and ι-carrageenan (ICG) at the level of 0.5 1.0 and 1.5 % w/w, were used. The result showed that ICG favorably affected cooking loss and expressible moisture content better than KCG and TPS. Both types of carrageenan induced the darker products as it decreased in L* of the products at the higher level. ICG increased hardness, chewiness, springiness, gumminess and cohesiveness. ICG and KCG (1.0-1.5%) added to Moo yor should be suitable texturizing agents to maintain frozen Moo yor quality.

Introduction

Traditional sausages, known in Thailand as ''Yor", are the most popular meat emulsion product in the country. It is made by grinding and blending meat with ice cubes, fat, and various curing and flavoring agents (sodium chloride, phosphate, garlic, pepper, sugar, starch and monosodium glutamate). The finished product has a paste-like texture in the raw state but gradually changes into a more rigid structure during heating. Its shelf life is about two weeks in refrigerator (Nicomrat, 2004).

Frozen storage is one of the most important preservation methods for maintaining microbiological and chemical stability and extending the shelf life of food products. However, some chemical reaction still occur which adversely affect product quality. Changes in texture, water-binding capacity, emulsifying capacity, and cooking yields during frozen storage have been reported in chicken (Orr and Wogar, 1979 and Dhillon and Maurer, 1975).

Many muscle foods are frozen to preserve quality, including red meats (primarily beef and pork), fish and others seafood and poultry. Properly freezing process and storage will maintain good texture and flavor for many months. All muscle foods are high-protein foods with cells containing an orderly sarcomere structure and with tissues held together by membranes and collagenous material. Each requires the proper mix of firmness and tenderness for optimum texture, as well as the retention of moisture for optimum juiciness.

Hydrocolloids with their unique characteristics are of great interest in processed meat due to their abilities to bind water and form gels (Candogan and Kolsarici, 2003a and Candogan and Kolsarici, 2003b). The aim of this research was to study the effect of some texturizing agents addition on qualities of Moo yor during frozen storage.

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 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), κ-carrageenan (Satiagel ME5, Degussa texturant systems, Inc., Legaspi village Makati, the Philippines), ι-carrageenan

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Table 1. Formulation of Moo yor batter with different carrageenan

Ingredients/Treatments	TPS (control)	KCG 0.5 %	KCG 1.0 %	KCG 1.5%	ICG 0.5 %	ICG 1.0 %	ICG 1.5%
Pork lean meat	69	69	69	69	69	69	69
Pork back fat	21	21	21	21	21	21	21
Ice	6.9	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	1.5
KCl	0.5	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	0.1
Tapioca starch	1	-	-	-	-	-	-
κ-carrageenan	-	0.5	1.0	1.5	-	-	-
ι-carrageenan	-	-	-	-	0.5	1.0	1.5

(Genuvisco®carrageenan type J, CP Kelco company, Levallois-Perret, France) 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.

Samples were contained into 50 ml centrifuge tubes approximately 40-45 grams and sealed with a plastic cap. The samples were pre-heated in water bath at 80°C for 30 min. After that they were removed from the hot water bath and immediately cooled in cold water (5°C, 10 min). Pre-heated Moo yor samples which removed from 50 ml centrifuge tubes were packed in vacuum bag in vacuum condition and stored at -18°C up to 1 month before analysis. Prior analysis, frozen samples were thawed using running water until internal temperature of 0-2°C was reached.

Thawing loss (TL)

Moo yor samples for each treatment were manually blotted with a paper towel to remove visible exudates. Thawing loss (TL) was calculated as the weight difference between frozen sample and thawed sample (López- López *et al*., 2010).

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 (Moreno *et al.*, 2010).

Color value (CIE Lab)

Internal color of Moo yor was determined by a Hunter Lab colorimeter (Color flex, Virginia, USA).

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 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

Thawing loss and expressible moisture content of frozen Moo yor

Thawing loss and expressible moisture content of frozen Moo yor are shown in Table 2. Control sample (TPS) were the highest level in thawing loss and expressible moisture, probably due to denaturation of protein occurred before starch gelatinization in meat/starch system (Li and Yeh, 2003a). Myosin gel formation occurred in two steps during processing,

Table 2. Thawing loss and expressible moisture content of frozen Moo yor

Treatments	Thawing loss (%)	Expressible Moisture (%)
TPS (control)	1.13 ± 0.06^{a}	18.32 ± 0.80^{a}
KCG 0.5 %	0.92 ± 0.11^{b}	17.54 ± 0.53^{ab}
KCG 1.0 %	0.86 ± 0.06^{b}	16.55 ± 1.98^{ab}
KCG 1.5 %	0.72 ± 0.09^{c}	15.53 ± 2.32^{bc}
ICG 0.5 %	0.74 ± 0.09^{c}	14.01 ± 1.99^{cd}
ICG 1.0 %	0.57 ± 0.09^{d}	13.31 ± 1.68^{cd}
ICG 1.5 %	0.50 ± 0.11^{d}	12.73 ± 1.19^{d}

Means with the different letter in the same column are significantly different ($p<0.05$).

Table 3. Color values of frozen Moo yor

Treatments	Color		
	L*	a*	b*
TPS (control)	73.83 ± 0.34^{a}	0.38 ± 1.14^{a}	15.70 ± 0.88^{a}
KCG 0.5 %	74.11 ± 0.62^{a}	0.93 ± 1.03^{a}	14.67 ± 0.19^{c}
KCG 1.0 %	74.00 ± 0.32^{a}	0.89 ± 0.52^{a}	14.90 ± 0.48^{bc}
KCG 1.5 %	73.35 ± 0.38^{b}	0.18 ± 1.16^{a}	15.98 ± 0.85^{a}
ICG 0.5 %	74.01 ± 0.46^{a}	0.76 ± 0.32^{a}	15.38 ± 0.27^{ab}
ICG 1.0 %	73.95 ± 0.39^{a}	0.46 ± 0.33^{a}	15.67 ± 0.40^{a}
ICG 1.5 %	72.83 ± 0.66^{c}	0.71 ± 0.15^{a}	15.71 ± 0.47^{a}

Means with the different letter in the same column are significantly different ($p<0.05$).

first at 30-50°C (involving aggregation of the globular head of myosin) and second, at above 50°C (involving structural changes leading to network formation) (Tornberg, 2005). At 59°C starch granules were embedded in the protein matrix, but at 64°C starch granules deformed, possibly due to shrinkage of the protein matrix during heating meaning the starch granules and protein matrix were not in close contact (Li and Yeh, 2003b). Consequently, since tapioca starch gelatinization occurred between 56°C and 69°C (Collado and Corke, 2003) and myosin already formed the main protein gel matrix, affecting water binding and textural properties. In this experiment, expressible moisture and thawing loss of samples with carrageenan added were lower than those of samples added with tapioca and decreased with increasing the concentration of carrageenan. ICG and KCG were more effective in retaining water. This was probably due to their chemical structures, synergistic interaction and gel formation, which were enhanced by the presence of other ions (García-García and Torosaus, 2008). As shown in Table 2, ICG shown more effective in expressible moisture and prevent thawing loss than KCG, because of iota-type carrageenan is more hydrophilic and form fewer junction zones than kappa-type carrageenan (BeMiller and Whistler, 1996).

Color values

Color values of frozen Moo yor are shown in Table 3. Frozen Moo yor samples added with both types of carrageenan at 1.5 % were darker than control sample, and yellowness (b^{*}) increased with increasing carrageenan level. This may be due to the fact that they had lower expressible moisture and higher moisture contents than other samples, resulting in more intensive scattering of the light (Montero *et al*., 2000). Koutsopoulos *et al.* (2008) also reported that sausage with 1-3% carrageenan were darker than sausage without carrageenan. However, no different in redness (a^{*}) were found among treatments. These results were in agreement with Bloukas *et al.* (1997) also reported that the type of carrageenan had no effect on the color of low-fat frankfurters.

Texture profile analysis

Texture profile analysis results of frozen Moo yor are shown in Table 4. Moo yor added with ICG at 1.5% had the highest hardness, cohesiveness and chewiness ($p<0.05$), whereas control sample (TPS) had the lowest hardness, springiness cohesiveness and chewiness ($p<0.05$). Addition of starch caused higher water release, so notably changing Moo yor texture. Moreover, in meat/starch systems, gelatinized starch absorbed more water, but its presence did not chemical reaction between proteins and starch because meat protein began to denature before starch gelatinization (Li and Yeh, 2002). In meat/carrageenan system, carrageenan dissolved throughout meat during thermal processing and gelled on cooling. It improved water retention, consistency and texture of comminuted meat products (Trius and Sebranek, 1996). Different findings for the effects of carrageenan on texture of comminuted meat products have been reported. A number of authors have found comminuted productswith carrageenan were tougher than control ones. It had been reported that addition of carrageenan increased gel strength of salt soluble meat protein gels in model systems (Defreitas *et al.*, 1997) and hardness of low-fat meat batters when increasing carrageenan (Foegeding and Ramsey, 1987). Xiong *et al***.** (1999) reported that κ-carrageenan (0.5%) increased hardness and bind strength at 1% salt beef sausages but had little effect on the 2.5% salt sausage. Mittal and Barbut (1994) indicated that addition of 0.5% κ -carrageenan increased cohesiveness and chewiness of low-fat frankfurters. However, Moo yor added with ICG had higher hardness and chewiness than with KCG. This result might be due to strong ICG gel formation

Table 4. Texture profile analysis of frozen Moo yor

Treatments	Hardness(g)	Springiness	Cohesiveness	Chewiness
TPS (control)	15,116 ± 896^{d}	0.853 ± 0.105^{b}	0.531 ± 0.015^{d}	7,951 ± 233^{b}
KCG 0.5 %	15,767 ± 488^{cd}	0.881 ± 0.011^{a}	0.539 ± 0.015^{cd}	7,703 ± 667^{b}
KCG 1.0 %	15,929 ± 1,057^{cd}	0.875 ± 0.015^{a}	0.560 ± 0.006^{a}	7,803 ± 560^{b}
KCG 1.5 %	16,206 ± 1,102^{bc}	0.885 ± 0.142^{a}	0.562 ± 0.003^{a}	7,849 ± 274^{b}
ICG 0.5 %	15,736 ± 1,069^{cd}	0.884 ± 0.016^{a}	0.555 ± 0.009^{ab}	7,718 ± 443^{b}
ICG 1.0 %	16,947 ± 452^{ab}	0.872 ± 0.008^{a}	0.546 ± 0.012^{bc}	8,066 ± 262^{b}
ICG 1.5 %	17,870 ± 539^{a}	0.874 ± 0.023^{a}	0.560 ± 0.003^{a}	8,731 ± 332^{a}

Means with the different letter in the same column are significantly different ($p<0.05$).

in calcium ion presence in this system. Moreover, Moo yor with ICG had more water retention when compared with KCG (Table 2).

Conclusions

The addition of hydrocolloids enhances water binding capacity, color value 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 experiment, 1.0 – 1.5 % of KCG and ICG show their higher ability to improve some physical properties in frozen Moo yor to maintain the product quality after heat processing and frozen storage.

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