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Preparation of Thai local beef shank for Mussaman using *sous-vide* process

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Abstract

Thai local beef shank (*Semitendinonsus*) was subjected to *sous-vide* process at different combinations of temperature (60, 70 and 80°C) and time (6, 12 and 18 hours). Physical properties of *sous-vide* beef including firmness, texture profile analysis, color, weight loss during *sous-vide* and cooking loss were studied. The study shown that increased *sous-vide* temperature resulted beef shank with weight loss and cooking loss increased. Cooking of beef at lowest temperature (60°C) for 6 and 12 hours displayed higher lightness. Increased *sous-vide* temperature resulted samples with springiness increased. In addition, results of beef shank texture after cooking in 70 and 80°C were found to significantly difference compared with in the case of 60°C in gumminess, springiness and firmness. *Sous-vide* process using 80°C for 12 hours was subjected to the further study because texture profile analysis parameters was as same as beef cooked by traditional method. Moreover, salts addition including NaCl and STPP can reduce weigh loss during *sous-vide* process and cooking loss. Adding of salts led significantly difference in physical properties comparing with control. Chewiness, cohesiveness, gumminess and firmness were decreased when salts were added.

Keywords: beef, mussaman, sous-vide, Thai cuisine, Thai local beef.

1. Introduction

Sous- vide is a method of raw material preparation or cooking under controlled conditions including temperature and time in vacuum heat- stable package and bring to pasteurization in hot water before rapid cooling to 0-3°C [1]. *Sous-vide* products could be stored for 3-5 weeks depending on types of material [2].

Sous-vide can reduce a cooking time for many kinds of food processing especially for involved process that requires long cooking time and labor intensive production. Moreover, *sous-vide* can provide better sensory qualities to the product [3]. This method is widely used in catering business particularly by chef for ready to cook meal in restaurants [4].

Beef is one of most rich nutrition foods and rich of protein consisting of essential amino acids which is essential for growth and development of brain [5]. Beef is important food source for Thai people for a long time. Consumption of beef in Thailand was approximate 3-5 kilograms per person a year less than other source such as poultry and pork which was 14-16 kilograms per person a year [6] due to several disadvantages for Thai people especially texture and flavor. Thai local beef is widely consumed and sold in local market and butcher shops along highways in the northeast part in Thailand mostly native breeds. Texture of Thai local beef is tough comparing with beef cattle and

hence the price is low and spends more time to cook in many recipes. Thai local beef requires more cooking time and not suitable for short time cooking process. *Sous-vide* process is the potential preparation technique to be used for improving native beef texture, also being alternative material product for ready to cook Thai food in catering service business.

Mussaman is the national dish of Thailand with the unique taste from delicate and meticulous cooking process which derived since long time ago. The convection material in making of Mussaman is mostly beef. Researchers found opportunity on using *sous-vide* in preparation or ready to cook beef for Mussaman, tended to reduce long time cooking from convection methods and could control material qualities for food service and catering business.

2. Materials and Methods

2.1 Material and preparation

Thai local beef (*Bos indicus*), *Semiten-dinonsus* muscle was purchased from Klong Toey market in Bangkok, Thailand. Shank was trimmed of visible fat and tough fascia and dipped in 5°C for 3 minutes to retained blood and dirt. After that, water was drained and mopped up. The beef shank was cut into 3.8 centimeters thickness.

2.2 *Sous vide* process

Beef shank from 2.1 was vacuum packed into laminated low density polyethylene (LLDPE) bag and cooked in controlled temperature water bath. After pasteurized process, samples were cooled rapidly to 2°C and kept at 2°C for 2 hours until used. Beef shank was *sous-vide* in water bath at temperatures if 60, 70 and 80°C for 6, 12 and 18 hours adapted from [7] and [8]. *Sous-vide* beef shank was determined physical properties. From there, one suitable condition was chosen by considering texture of beef comparing with beef cooked by convectional method that boiled in water for 12 hours.

2.3 Salt addition

The optimized *sous-vide* condition of beef shank achieved from 2.2 was injected with brine solution consisting of sodium tripoly-phosphate (STPP) and sodium chloride (NaCl). Three different brine solution conditions consisting of 0.25% STPP with 0.70% Nacl(w/v), 0.25% STPP with 1.20% NaCl (w/v) and non-brine solution applied from [2] were studied. After injection, beef was held at 4°C for 1 hour. Then sample was weighted, vacuum packed and held at 4 °C for 6 hours in order to allow for the distribution of brine into muscle. Experimental design was a completely randomized block design (CRD). Experimental was done in 3 repetitions.

2.4 Sample analysis

2.4.1 Firmness

Firmness analysis was performed using a Warner-Bratzler blade, obtained from $1.0\times2.0\times0.5$ cm^3 from each cooked beef by cutting cross muscle fiber [9]. Data was analyzed for 3 repetitions.

2.4.2 Texture analysis

Texture profile analysis was performed using Texture analyzer (TA.XT Plus, England) according to [10] with a flat plunger of 50 mm in diameter (P/50). Samples were cut into $1.5\times1.5\times1.5cm^3$. Chewiness, cohesiveness, gumminess and springiness were displayed.

2.4.3 Color

Surface color of beef shank was measured using a Konica Minolta CR400(Japan) and presented in terms of L^* (lightness), a^* (redness) and b^* (yellowness). Data was done in 3 repetitions.

2.4.4 Weight loss during *sous-vide*

Samples were weighted before and after *sous-vide* process. Each weight loss was determined according to equation (1).

$$\text{Weight loss (\%)} = \frac{(Weight\ before\ SV - Weight\ after\ SV)}{Weight\ before\ SV} \times 100 \quad (1)$$

2.4.5 Cooking Loss

Method was adapted from [9] by streaming sample until core temperature reached at 70°C. Sample was weighted before and after streaming and calculated according to equation (2).

$$\text{Cooking loss (\%)} = \frac{(\text{Weight before heating} - Weight\ after\ heating)}{\text{Weight before heating}} \times 100 \quad (2)$$

3. Results and discussions

Table 1 represented *sous-vide* weight loss, cooking loss and color of *sous-vide* beef. It was found that temperature and time of *sous-vide* process affected these properties. Increased *sous-vide* temperature resulted *sous-vide* beef with weight loss and cooking loss increased. Results were supported by [10], [11] and [12]. Myofibrillar had ability to hold water within the muscle. The increasing of temperature caused protein denaturation and fiber shrinkage, which occurs mainly at 40-60°C [13] and then water was released from muscle fiber to intercellular space. At 60-70°C, the connective tissue and fibers cooperatively shank longitudinally which induced the release amount of water to outside of muscle [10].

Sous-vide temperature and time affected lightness and redness of *sous-vide* beef with significantly different ($P \leq 0.05$). Cooking of beef at 60°C for 6 and 12 hours displayed higher lightness compared with others according to [10] who found that *sous-vide* lamb loin using 60°C had higher lightness that using of 70 and 80°C. Result of redness was in the same trend as lightness. A higher moisture in meat cooked using lower temperature would permit deeper penetration of light in tissue and fiber, producing a darker color of meat appearance [10] and increasing cooking temperature would lead to denaturation of fibers and myofibrillar proteins, which could increase light scattering [10,14].

Sous-vide condition affected texture of beef

Table 1 Weight loss and color of *sous-vide* beef

Treatment		Sv weight loss	Cooking loss	L*(lightness)	a*(redness)	b*(yellowness)
T(°C)	t(h)	%	%			
60	6	12.97±3.63 ^{a}	14.87±4.21 ^{d}	48.58±7.89 ^{c}	14.17±2.29 ^{bc}	7.73±2.17 ^{a}
60	12	17.25±4.22 ^{ab}	12.76±2.98 ^{d}	47.21±6.32 ^{bc}	14.01±3.19 ^{b}	8.81±1.48 ^{a}
60	18	20.09±3.43 ^{bc}	9.02±2.50 ^{c}	42.39±6.74 ^{ab}	11.25±2.01 ^{a}	8.32±3.14 ^{a}
70	6	26.53±1.75 ^{cd}	5.93±2.61 ^{ab}	44.36±5.52 ^{abc}	15.57±2.56 ^{bcd}	7.20±2.77 ^{a}
70	12	29.24±1.30 ^{de}	5.68±2.67 ^{ab}	42.17±8.63 ^{ab}	16.70±1.88 ^{d}	7.50±1.93 ^{a}
70	18	27.42±2.13 ^{cde}	4.93±2.71 ^{a}	41.59±5.50 ^{a}	15.52±2.67 ^{bcd}	8.14±1.67 ^{a}
80	6	29.59±4.69 ^{de}	3.72±1.70 ^{a}	40.78±3.77 ^{a}	16.09±1.81 ^{bcd}	7.21±2.53 ^{a}
80	12	31.60±6.79 ^{de}	4.35±1.45 ^{a}	40.36±3.83 ^{a}	15.80±2.26 ^{bcd}	7.23±2.57 ^{a}
80	18	34.55±5.92 ^{e}	4.70±2.91 ^{a}	39.40±3.26 ^{a}	16.28±1.82 ^{cd}	7.55±2.06 ^{a}

Different superscript letter within the same column means significantly different ($P \leq 0.05$)

as shown in Table 2. It was found that increased *sous-vide* temperature resulted *sous-vide* beef with springiness increased while chewiness, cohesiveness, gumminess and firmness decreased. However, using of low temperature undergoing difference time was found not significantly different in chewiness, cohesiveness, gumminess and springiness to *sous-vide* beef (Table 2).

and firmness of samples after *sous-vide* process at 70 and 80°C trended not to significantly different. This might be because collagen denaturation as a consequence of high cooking temperatures, is affected myofibrilar proteins shrinking, when a cooking with longer and higher lead increased collagen solubilization that made beef more tender and easy to chew [11].

Table 2 Texture profile of *sous-vide* beef

Treatment		Chewiness	Cohesiveness	Gumminess	Springiness	Firmness
T (°C)	t(h)	(N·cm)	(N/mm^2)	(N/mm^2)	(cm)	(N)
60	6	3218.57 ± 1544.83^{bc}	0.48 ± 0.04^{e}	5858.88 ± 2003.46^{c}	0.52 ± 0.11^{a}	8.23 ± 6.75^{d}
60	12	3369.84 ± 1235.95^{bc}	0.47 ± 0.08^{e}	5915.52 ± 1578.26^{c}	0.63 ± 0.08^{bc}	4.41 ± 0.70^{abc}
60	18	3257.43 ± 1193.65^{bc}	0.47 ± 0.03^{e}	5715.60 ± 848.37^{c}	0.53 ± 0.10^{ab}	5.26 ± 0.99^{bc}
70	6	4859.14 ± 994.87^{d}	0.44 ± 0.05^{de}	7378.40 ± 1401.65^{d}	0.67 ± 0.10^{c}	6.02 ± 2.05^{cd}
70	12	4128.61 ± 1022.05^{cd}	0.40 ± 0.03^{cd}	6277.92 ± 1465.60^{cd}	0.66 ± 0.80^{c}	4.27 ± 1.38^{abc}
70	18	2783.11 ± 815.82^{b}	0.36 ± 0.03^{bc}	4305.02 ± 1323.25^{b}	0.45 ± 0.73^{c}	2.28 ± 0.56^{a}
80	6	3608.85 ± 814.58^{bc}	0.37 ± 0.05^{bc}	4129.34 ± 1778.80^{b}	0.72 ± 0.14^{c}	2.89 ± 0.48^{ab}
80	12	2755.05 ± 755.33^{b}	0.33 ± 0.03^{b}	3028.88 ± 1104.95^{ab}	0.67 ± 0.12^{c}	1.70 ± 0.78^{a}
80	18	1616.78 ± 873.57^{a}	0.25 ± 0.07^{a}	1979.16 ± 1376.78^{a}	0.61 ± 0.12^{abc}	1.72 ± 0.42^{a}
Tradition method		2774.054±430.05	0.34± 0.03	3038.37±557.56	0.64±0.09	1.67±0.47

Different superscript letter within the same column means significantly different (P≤0.05)

Results were in the same trend as [11] who found that chewiness, cohesiveness and gumminess of pork cheek after cooking at 60°C for 5 and 12 hours were not significantly different.

Table 3 represented weight loss and color of *sous-vide* beef after addition of sodium chloride (NaCl) and sodium tripolyphosplate (STPP). The result shown that salts addition affected *sous-vide* loss and cooking loss of

Table 3 Weight loss and color of *sous-vide* beef after salts addition

Conditions	Sv weight loss	Cooking loss	L*(lightness)	a*(redness)	b*(yellowness)
	%	%			
NaCl 0.70%+STPP0.25%	28.17 ± 1.43^{a}	3.15 ± 0.98^{a}	40.19 ± 2.43^{a}	15.33 ± 1.33^{a}	7.09 ± 1.51^{b}
NaCl 1.20%+STPP0.25%	27.384 ± 1.34^{a}	3.55 ± 0.80^{a}	40.47 ± 2.17^{a}	14.85 ± 2.01^{a}	6.08 ± 1.03^{a}
Control	35.52 ± 1.12^{b}	4.59 ± 0.49^{b}	40.56 ± 1.93^{a}	14.76 ± 1.20^{a}	6.01 ± 0.77^{a}

Different superscript letter within the same column means significantly different (P≤0.05)

Cooking of sample at 60°C led a greater quantity of broken collagen but still not completely denatured fibers comparing to 70 and 80°C. However, results in 70 and 80°C under cooking times were found to significantly difference compared with in the case of 60°C. Gumminess, springiness

samples. Both conditions of salt added including NaCl 0.70% + STPP 0.25% and NaCl 1.20% and STPP 0.25 % were found to significantly difference compared with in the case of control (non-salt addition). The results were supported by [2] and [12] that adding both STPP and NaCl would reduced

cooking loss. This might be because addition of STPP+NaCl to muscles increased an ionic strength values, consequently enhancing the absorption of the brine inside the fibers and extraction and solubilisation of myofibrillar proteins lead fibers could retain water inside muscle [12]. Salt addition also affected yellowness of samples (Table 3). Adding NaCl 0.70 % + STPP 0.25 % slightly increased yellowness more than other conditions. However, salt addition did not affect lightness and redness as same as [15] who found that lightness and redness in cooked salts addition of beef were not significantly difference.

Salts addition affected texture of beef as shown in Table 4. It was found that physical properties of injected beef significantly different with control ($P \leq 0.05$). Chewiness, cohesiveness, gumminess and firmness were decreased when salts were added. On other hand, salt addition was not affect springiness. The result were supported by [16] who found that injection of phosphate in *sous-vide* lamb loin represented lower chewiness than control and significantly different in gumminess to sample.

The effect of myofibrillar and collagen heat denaturation on cooked meat texture, water loss from the muscle tissue upon heating also in meat toughening. Beef was added by salts could retain more water in fiber than non-injection beef that affected the beef toughness so that the greater the water lost during cooking, the higher the cooked meat toughness [16].

4. Conclusion

Increased *sous-vide* temperature resulted samples with weight loss and cooking loss increased. Cooking of beef at lowest temperature (60°C) for 6 and 12 hours displayed higher lightness to sample. Increased *sous-vide* temperature resulted samples with springiness increased. Results in 70 and 80°C conditions were found to significantly difference in texture compared with in the case of 60°C in gumminess, springiness and firmness. Salts addition including NaCl and STPP can reduce weight loss of sample during *sous-vide* process and cooking loss. Adding of salts led significantly difference in physical properties with control. Chewiness, cohesiveness, gum-miness and firmness of samples were decreased when salts were added.

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