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Flank steak of local Thai beef preparation of sous-vide process

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Abstract

Steak has been widely served as valuated main dish in hotels and restaurants. The price of raw steak is varied depending on parts of beef and species. Local Thai beef (Bos indicus) has been used as material in many kinds of Thai foods because of lower price than those of imported beef. Since local Thai beef was tough, it had the limitation to produce steak. The objective of this study was to improve the quality of local Thai beef using sous-vide process. Effects of temperature and time in sous-vide beef production were designed using response surface methodology (RSM). Flank steak of local Thai beef was used as sample. It was injected with brine solution and marinated at 4°C for 2 hrs before vacuum packing. After that, sample was processed by sous-vide in water bath at temperatures of 55-65°C for 24-48 hrs and then rapidly chilled at 4°C. It was found that temperature and time in sous-vide process affected physical properties of flank steak. Sous-vide samples were found to have less toughness and firmness than that of raw sample. Temperature did not significantly affect ΔL^*, while using of low temperature (at 55°C) resulted sous-vide flank steak with Δa^* value decreased.. Cook yield and water holding capacity were higher in samples cooked at 55°C for all cooking times and resulted flank steak with cooking weight loss increased. Samples cooked at 60°C for 36 hrs showed the lowest toughness and firmness ($p \leq 0.05$). Sous-vide process could be used to improve flank steak as a material for valuated dish.

Keywords: Beef, Local Thai beef, Preparation, Sous-vide, Steak

1. Introduction

Local Thai beef is popular to cook Thai cuisine and consumed in Thailand since it has lower price than those of imported beef. However, local Thai beef is tough then it has the limitation to cook western cuisine because beef spends long time during cooking some of western menu.

Steak is classified as western cuisine and popular around the world. The price of raw steak is varied depending on parts of beef and species. Steak can be made of many parts of beef such as tenderloin, rib eye, flank, for example. Parts of beef to cook steak should be thick and tender since it must be grilled and roasted until different doneness achieved.

On the other hand, flank part of local Thai beef was then limited to process as "flank steak". The method of cooking by pasteurization under the vaccum condition at low temperature for long time, known as "sous-vide" can help improve tenderness, better flavor and color retention [1]. Sous-vide process was also succeeded in improvement of texture and other physical properties of pork, lamb and chicken [2,3,4]. This research applied sous-vide process for qualities improvement of flank steak achieved from local Thai beef. The optimized condition of sous-vide process on physical properties of flank steak was studied using response surface methodology (RSM).

2. Materials and Methods

2.1 Preparation

2.1.1 Beef preparation

Flank of beef (Rectus abdominus) muscle from local Thai beef was purchased from Bangyai market, Nonthaburi province, Thailand. It was rinsed using cold water (4°C) to release the retained blood before trimming fat and connective tissue. Flank was sliced into 4×3×1 inches^3 with approximately 200-250 g. Then, flank was wrapped and stored at 4°C not over than 1 hr until use.

2.1.2 Brine injection

Sodium lactate ($NaC_3H_5O_3$) was purchased from Nature Friend Co.,Ltd, Thailand and prepared at concentration of 3% (w/w) by dissolving sodium lactate 3 g. in 97 ml. distilled water. applied from [4]. The solution was injected in flank steak to increase weight of steak approximately 10% (w/w). Positions of beef injection was followed by [5]. Then, marinated at 4°C for 2 hrs [6].

2.2 Sous-vide

Flank steak achieved from 2.1.2 was vacuum packed into laminated low density polyethylene bag of 7x11 cm^2. Samples were sous-vided in water bath at temperatures of 55°C - 65°C for 24-48 hrs [7] and rapidly cooled to below 3°C for 2 hrs using iced water and stored at 4°C [8] until analyzed.

2.3 Experimental design

Central Composite Design in RSM was applied using temperature of 55°C - 65°C and time of 24-48 hrs. Treatments of 13 runs were temperatures (^{o}C): times (min) of 55:24; 55:36; 55:48; 60:24; 60:36; 60:36; 60:36; 60:36; 60:48; 65:24; 65:36 and 65:48, respectively.

2.4 Physical analysis

2.4.1 Color

L^*(lightness) and a^*(redness) values were measured using a Minolta Colorimeter (CR-400, Japan) by measuring at the central of the sample. Data was expressed in terms of ΔL^* and Δa^*, which were calculated from changes of color after and before sous-vide process of sample at each condition.

2.4.2 Shear force

Shear force analysis of cooked samples was performed using a Warner-Bratzler blade according to [9]. Firmness (kg/f) and toughness (kgsec) of samples were displayed.

2.4.3 Cook yield

Cook yield of sample was calculated according to [10] following equation (1);

$$\% \text{ Cook yield} = (W_{ch} / W_{cr}) \times 100 \quad (1)$$

W_{ch} = Weight of cooked sample
W_{cr} = Weight of raw sample

2.4.4 Cooking loss

Cooking loss of sample was calculated according to [11] following equation (2);

$$\% \text{ Cooking loss} = (W_0 - W_a / W_0) \times 100 \quad (2)$$

W_0 = Weight of the sample before cooking
W_a = Weight of the after cooking

Table 1. F value of color, firmness, toughness, cook yield, cooking loss and water holding capacity of sous-vide flank steak with different conditions.

Source	F VALUE							
	Df	ΔL^*	Δa^*	Firmness	Toughness	Cook yield	Cooking loss	WHC
Model	5	5.00*	5.94*	50.78***	39.33***	101.74***	82.06***	5.19*
temp	1	8.642	2.08	70.36***	8.60*	446.96***	144.22***	9.56**
time	1	9.99	1.89	3.86	16.42**	27.43***	19.89***	0.82
temp×time	1		6.38***	18.65**	23.27***	0.18		
temp^2	1		4.99	50.35**	71.32***	18.69**		
time^2	1		7.04*	49.33**	23.99***	3.95***		
Lack of fit	3	0.49	13.11**	19.91**	0.97	55.10***	0.84	0.25
R^2	-	0.5	0.8	0.97	0.96	0.98	0.94	0.5

* Significantly different at P≤ 0.05.
** Significantly different at P≤ 0.01.
***Significantlydifferent at P≤ 0.001.

2.4.5 Water holding capacity

Water holding capacity of sample was measured and calculating according to [12] following equation (3);

$$WHC = W_{bs} - (W_{bs} - W_{fs}) / W_{bs} \times 100 \quad (3)$$

W_{bs} = Weight of the sample before swing
W_{fs} = Weight of the final swing

3. Results and discussions

Physical properties of sous-vide flank consisting of color, firmness, toughness, cook yield, cooking loss and water holding capacity were shown in Tables 1 and 2.

3.1 Color

F value shown in Table 1 was found that temperature and time in sous-vide process did not affect $\Delta L^*$of sous-vide flank steak. In addition, results from Table 2 was found that temperature did not significantly affect ΔL^* of flank steak. Moreover, cooking at 24 – 36 hrs in each temperature period did not affect ΔL^* of sample, while using of 48 hrs trended to increase ΔL^* of sample with significantly different (P≤0.05). Cooking temperature and time would lead to higher denaturation and aggregation of sarcoplasmic and myofibrillar proteins, which would increase light scattering [13,14].

Temperature and time in sous-vide process did not affect $\Delta a^*$of sous-vide flank steak. However, an interaction between temperature and time affected $\Delta a^*$of sous-vide samples (Table 1). Using of low temperature (at 55°C) resulted sous-vide flank steak with Δa^* value decreased. Cooking at 60°C for 36 hrs resulted flank steak with Δa^* value increased sharply. This loss of redness with increasing cooking temperature was in accordance with the results were obtained by [15].

3.2 Shear force

Obtained values for the different textural variables using shear force analysis of sous-vide flank steak were shown in Tables 1 and 2. Temperature of sous-vide process affected firmness of flank steak with significantly different (p≤ 0.001) whearas time did not affect firmness of sous-vide sample (P> 0.05) and then its interaction affected toughness of sous-vide flank steak with significantly different (P≤ 0.01).

Table 2. Color, firmness, toughness, cook yield, cooking loss and water holding capacity of sous-vide flank steak with different conditions.

T (°C)	t (hrs)	Δ L*	Δ a*	Firmness (kg/f)	Toughness (kgsec)	Cook yield (%)	Cooking loss (%)	WHC (%)
Control		0	0	2.74±0.32	26.68±2.00	N	34.84±1.09	72.59±5.49
55	24	0.49±0.08^{ab}	0.04±0.19^{c}	5.89±0.56^{b}	28.38±4.09^{abc}	78.10±0.42^{g}	12.44±0.6^{fg}	76.10±5.68^{a}
55	36	0.53±0.06^{abc}	-0.18±0.08^{bc}	5.29±0.67^{ab}	32.11±5.71^{cd}	77.16±0.88^{g}	11.99±2.04^{h}	75.43±7.6^{a}
55	48	0.64±0.24^{c}	-0.26±0.1^{ab}	7.45±0.48^{c}	45.94±4.33^{g}	74.99±0.59^{f}	8.47±1.94^{g}	75.43±4.19^{a}
60	24	0.56±0.05^{abc}	-0.25±0.07^{ab}	5.57±0.54^{ab}	28.23±3.80^{bcd}	73.72±0.44^{e}	7.38±2.22^{h}	79.76±5.23^{ab}
60	36	0.57±0.10^{abc}	-0.36±0.03^{a}	4.98±0.51^{a}	26.38±5.03^{abc}	71.90±0.76^{d}	7.54±1.61^{fg}	76.01±4.23^{a}
60	36	0.62±0.08^{bc}	-0.30±0.18^{ab}	4.97±0.46^{a}	22.67±9.79^{ab}	71.56±0.81^{d}	7.73±1.98^{fg}	85.77±7.29^{c}
60	36	0.49±0.14^{a}	-0.31±0.10^{ab}	4.83±0.36^{a}	22.90±2.78^{ab}	72.07±0.88^{d}	6.43±0.61^{de}	78.85±3.69^{ab}
60	36	0.52±0.11^{abc}	-0.31±0.23^{ab}	5.15±0.62^{ab}	20.89±5.78^{a}	71.92±0.88^{d}	5.48±1.23^{cd}	79.73±3.81^{ab}
60	36	0.51±0.13^{ab}	-0.31±0.10^{ab}	4.95±0.43^{a}	21.94±8.93^{a}	71.98±0.61^{d}	6.33±0.71^{de}	82.90±8.57^{c}
60	48	0.59±0.10^{abc}	-0.15±0.12^{bc}	7.09±0.60^{c}	33.32±2.43^{de}	66.90±0.71^{c}	4.02±0.43^{bc}	84.38±6.26^{c}
65	24	0.48±0.06^{a}	-0.18±0.18^{bc}	9.87±2.02^{e}	42.62±7.63^{fg}	61.20±0.65^{b}	3.17±0.57^{b}	81.61±10.34^{ab}
65	36	0.53±0.05^{abc}	-0.25±0.08^{ab}	7.40±0.60^{c}	38.21±4.12^{ef}	60.78±0.64^{b}	2.88±0.69^{b}	82.68±4.20^{c}
65	48	0.64±0.11^{c}	-0.18±0.13^{bc}	8.45±0.67^{d}	40.36±4.65^{fg}	58.90±0.74^{a}	0.84±0.29^{a}	83.85±0.67^{d}

Different superscript letter within the same row mean significantly different (P≤ 0.05)

By the way, toughness of sous-vide sample was significantly affected by cooking time (P≤ 0.01) than that of cooking temperature (P≤ 0.05) and hence its interaction affected firmness of sous-vide flank steak with significantly different (P≤ 0.001). It was found that temperature and time of sous-vide process affected toughness of flank steak with significantly different (p≤ 0.05) and its interaction affected toughness sous-vide flank steak with significantly different (P≤ 0.001). Cooking at 65°C in all cooking times was found that firmness and toughness of flank steak were high compared with other temperatures. Cooking for longer time under controlled temperature induced the reduction of inter-fiber adhesion of protein. Results were supported by [16].

During 50°C to 65°C to cook beef cuts represented tenderness to beef, especially for 60°C. Tenderizing was caused by weakening of connective tissue and proteolytic enzymes decreasing myofibrilla tensile strength and could significantly tenderize the meat if held for more than 6 hrs [17]

3.3 Cook yield

Cook yield analysis of flank steak with different sous-vide process was shown in Tables 1 and 2. Temperature and time affected cook yield of flank steak with significantly different (P≤ 0.001), while its interaction affected cook yield was not significantly different (P> 0.05). Using of high temperature and long time trended to decrease cook yield. Cooking at 65°C shown that cook yield of flank steak was lowest whearas cooking at 55°C represented highest data because myofibril protein denatured, shrank and released water [18].

3.4 Cooking loss

Cooking weight loss analysis of flank steak with different sous-vide process was shown Tables 1 and 2. Temperature and time of sous-vide process affected cooking weight loss of flank steak with significantly different ($P \leq 0.001$) whereas its interaction did not affected cooking weight loss ($P>0.05$). Results were found in Table 2 that using low temperature (55°C) induced cooking weight loss with significantly increased whearas cooking at 65°C shown that cooking weight loss of flank steak was lowest because of high temperature in sous-vide process. These results indicated that myofibril proteins held most of the water retained within the muscle. Increasing temperatures caused denaturation and shrinkage of such proteins and caused substantial water loss [19].

3.5 Water holding capacity

Water holding capacity of sous-vide samples were shown in Tables 2 and 3. It was found that temperature of sous-vide process significantly affected water holding capacity of flank steak ($P \leq 0.001$) whearas time did not affect water holding capacity of sample ($P \geq 0.05$). Using high temperature (65°C) in all cooking time affected water holding capacity. Results were in the same trend as in the case of cooking weight loss.

4. Conclusion

Temperature and time in sous-vide process affected physical properties of flank steak, while not much changed in color of sample. The further study could be used 60°C for 36 hrs as the optimized condition since flank steak after this condition since sample was low in firmness, toughness even though cook yield and cooking loss were high compared to other conditions. In addition, methods to decrease weight loss during and after sous-vide process are therefore interested.

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