Effect of Restructured Beef Steak on Quality Characteristics with Different Binding Agents during Frozen Storage

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Abstract – The effects of added plasma powder or emulsion-type binding agents on the pH, color, cooking loss, texture properties, and the thiobarbituricacid reactive substances (TBARS) values of restructured beef steaks were investigated. Beef treatments were restructured with: plasma powder 4% (T1), plasma powder emulsion 12% (T2), plasma powder and TGase emulsion 12% (T3). The pH values of control were significantly lower than other restructured beef steaks (p<0.05). In all samples the pH values were decreased and then increased after 2 weeks (p<0.05). Added plasma powder was decreased lightness, increased redness. Cooking loss were decreased (p<0.05) with storage time. Cooking loss were lower than control in all binding agents (p<0.05). T1 showed the lowest (p<0.05) cooking loss after 2 weeks. Texture properties a significant was no found between hardness, adhesiveness, springiness and gumminess as restructured beef steaks (p>0.05). Added binding agents were improved cohesiveness (p<0.05). TBARS were significantly lower following added binding agents (p<0.05), however, no significant difference was found between added binding agents.

Key Words – restructured beef steak, plasma powder, TGase, emulsion system

I. INTRODUCTION

Meat products manufactured using muscles that were ground, chopped, emulsified, sliced, or flaked as restructured meats [1]. Meat to meat binding in restructured meat products may be achieved though the formation of gels that set thermally (hot-set) of chemically (cold-set). In hot-set restructuring, myofibrilar proteins are extracted by the combined effect of salt, phosphate, and mechanical action [2]. Cold-set binding systems have been developed to meet the demand for restructured meat products that can be sold in the chilled, raw state and that have eating characteristics similar to cuts from intact muscles [3]. Also, binding of muscles can be achieved by combination of protein extraction and cold-set binding system. In this study, the term restructured free-flow cube meat is used to define restructured products manufactured from whole boneless cuts that bound with cold-set binding system.

The binding agents can be use of various ingredients, such as, alginate, polysaccharide, fibrinogen, and transglutaminase (TGase). Plasma proteins contain a complex mixture of proteins, of which serum albumin, globulins and fibrinogen are the most important. Albumin and globulins are globular proteins representing about 60 and 40% of the total plasma protein, respectively. Fibrinogen is a fibrous protein that represents around 3-4% of blood plasma proteins [4]. Also, the meat industry may produce texture modifications by using cold binding agent were TGase catalyzes an acyl transfer reaction between the γ-carboxylamide group of a peptide-bound residue and a primary amine [5].

The objective of this experiment was effect of plasma powder and emulsion-type binding agents, physicochemical properties of restructured beef steaks were investigated during frozen storage.

II. MATERIALS AND METHODS

Restructured beef steaks were prepared from the muscles of top rounds obtained from a local retailer. Excess fat was trimmed from the meat and coarsely diced about 1×1×1 cm. Ingredient composition of the steaks is presented in Table 1 and mixed by KitchenAid (KitchenAid, Model 5K5SS, USA) for 3 min, stuffed into fibrous casing (90-mm diameter) and storage -20°C overnight and samples were sliced to a 2 cm during 4 weeks of storage at frozen. Emulsified sample was mixed with binder, tallow and water (1:1:1 w/w/v) to obtain a sonicator (VCX750, Sonics&Materials, Inc. USA) mixture.

For pH determination, 3 g of sample were homogenized with 90 ml of distilled water. The

Table 1. Formulation of restructured beef steaks

Ingredients (%)	Treatments[1)]			
	C	T1	T2	T3
Beef meat (1×1×1cm)	84	80	80	80
Tallow	10	10	6	6
Salt	2	2	2	2
Water	4	4	-	-
Plasma powder (PP)	-	4	-	-
PP emulsion	-	-	12	-
PP+TGase emulsion	-	-	-	12
Total	100	100	100	100

[1)]C, control; T1, added plasma powder 4%; T2, added plasma powder emulsion 12%; T3, added plasma powder and TGase (1:1) emulsion 12%.

pH value of the sample was determined using a pH meter (MP230, Mettler Toledo, Switzerland). Cooking loss (%) was recorded for each sample by weighing before and after cooking at 200°C frying pan as 5 min. The color (CIE L^*, a^*, b^*) were determined using Chromameter (CR-300, Minolta Co., Japan). Textural analysis were obtained with a 20 kg load cell applied at a cross-head speed of 2 mm/s using of Rheo-meter (Compac-100, Sun scientific Co., Tokyo, Japan).

TBARS of steaks were determined by the spectrophoto-meter method [8]. The statistical analysis was performed by SAS program [9]. The data were subjected to analysis of variance (ANOVA) and Duncan's test to compare the sample means. The significance level was P>0.05.

III. RESULTS AND DISCUSSION

As shown in Table 2, the pH was added binding agents higher than C, and emulsion type binding agents were lower than T1 (p<0.05). In all samples the pH values were decreased and then increased after 2 weeks (p<0.05). The pH values increased added fibrinogen/thrombin, alginate and phosphate/salt restructured beef and emu steaks [10]. The pH of restructured beef steak [3] has been reported to increase slightly with frozen storage.

Added Plasma powder binding agents were decreased lightness, increased redness. While yellowness all samples were unaffected (p>0.05) by binding agents and frozen storage. Other authors [11, 12] have reported that refrigerated storage of fresh pork sausage patties or restructured beef resulted in decreased lightness, redness and yellowness, although this effect was attributed to extended exposure of products to retail lightness conditions.

Table 2. Changes of pH, color and cooking loss of restructured beef steaks during frozen storage

Treatments[1)]		Storage (weeks)				
		0	1	2	3	4
pH	C	5.78±0.01^{Ca}	5.74±0.01^{Db}	5.68±0.03^{Cc}	5.71±0.00^{Cbc}	5.72±0.02^{Cb}
	T1	5.92±0.01^{Aa}	5.91±0.01^{Aab}	5.83±0.02^{Ac}	5.89±0.01^{Ab}	5.90±0.03^{Aab}
	T2	5.83±0.01^{Ba}	5.81±0.01^{Ca}	5.75±0.02^{Bb}	5.81±0.01^{Ba}	5.81±0.01^{Ba}
	T3	5.84±0.00^{Bab}	5.85±0.01^{Ba}	5.78±0.02^{Bc}	5.82±0.01^{Bab}	5.81±0.02^{Bb}
L^* (lightness)	C	37.38±2.96^{ab}	36.12±1.38^{Bb}	41.38±3.85^{a}	37.97±5.21^{ABab}	40.37±1.02^{Aab}
	T1	38.78±2.18^{a}	34.81±0.42^{Bb}	39.73±1.21^{a}	33.05±2.55^{Bb}	34.46±3.78^{Bb}
	T2	37.78±2.28^{ab}	41.70±2.28^{Aa}	40.28±4.05^{ab}	41.67±3.10^{Aa}	36.03±2.28^{Bb}
	T3	37.27±2.31^{b}	37.15±1.67^{Bb}	39.16±4.78^{ab}	42.87±2.34^{Aa}	37.39±2.24^{ABb}
a^* (redness)	C	7.09±0.95^{B}	7.34±0.26	7.16±0.66	7.63±0.42^{AB}	7.13±0.63^{B}
	T1	6.91±0.84^{Bb}	8.19±0.88^{a}	7.87±0.66^{ab}	8.78±1.15^{Aa}	8.55±0.99^{Aa}
	T2	8.19±0.79^{A}	7.34±1.71	7.82±1.55	6.97±0.70^{B}	8.63±0.77^{A}
	T3	7.83±0.87^{ABab}	7.02±0.65^{ab}	7.99±1.27^{ab}	6.75±1.01^{Bb}	8.51±0.83^{Aa}
b^* (yellowness)	C	11.17±1.23	9.86±0.26	10.45±1.11	10.41±0.83	10.30±0.41
	T1	11.32±1.44	10.93±0.85	10.97±1.01	10.41±1.97	10.33±0.92
	T2	12.01±0.99	10.37±0.55	11.68±1.85	11.09±0.67	10.64±1.50
	T3	11.55±1.76	9.87±1.04	11.29±1.28	11.04±1.41	10.93±2.17
Cooking loss (%)	C	15.13±0.09^{Aa}	14.44±0.27^{Ab}	13.38±0.18^{Ac}	14.52±0.24^{Ab}	13.96±0.29^{Ab}
	T1	13.48±0.63^{Ba}	13.19±0.12^{Ba}	11.62±0.22^{Bb}	11.25±0.32^{Cb}	11.11±0.16^{Cb}
	T2	12.66±0.13^{Bc}	12.44±0.26^{Cc}	14.24±0.24^{Aa}	13.76±0.09^{ABab}	13.49±0.40^{Ab}
	T3	14.41±0.03^{Aa}	13.69±0.19^{Bab}	13.43±0.56^{Ab}	13.20±0.44^{Bbc}	12.28±0.36^{Bc}

$^{A\text{-}D}$Means with different superscript in the same column significantly differ at P<0.05.
$^{a\text{-}c}$Means with different superscript in the same row significantly differ at P<0.05.
[1)]Treatment are the same as in Table 1.

Cooking loss were decreased ($p<0.05$) with storage time. Control steak had significantly higher cooking loss than with binding agents restructured beef steak ($p<0.05$). Added Plasma powder agent lowest ($p<0.05$) cooking loss after 2 weeks.

Added fibrinogen/thrombin, alginate and phosphate/salt restructured beef and emu steaks had higher cook yields than control [10].

Texture properties of samples analyzed are listed in Table 3. A significant was no found between hardness, adhesiveness, springiness and gumminess as restructured beef steaks. The addition of plasma powder, and emulsion type binding agents were increased the cohesiveness of restructured beef steaks. Similar increases of hardness and cohesiveness have been observed when fibrinogen and thrombin from porcine blood plasma were added to meat systems as cold-set binding systems [13].

The TBARS of restructured beef steaks were decreased as added binding systems (Fig. 1). Lipid oxidation is major cause of deterioration in the quality of stored meat products and can be accelerated by several factors such as increasing unsaturation, the presence of oxygen, salt, etc. The TBARS were significantly lower following added binding systems ($p<0.05$), however, no significant difference was found between binding agents. In the control sample, the TBARS value increased ($p<0.05$) to 4 weeks from the start. Some authors have posited an inverse relationship between lipid oxidation and color stability restructured meats during frozen storage [14].

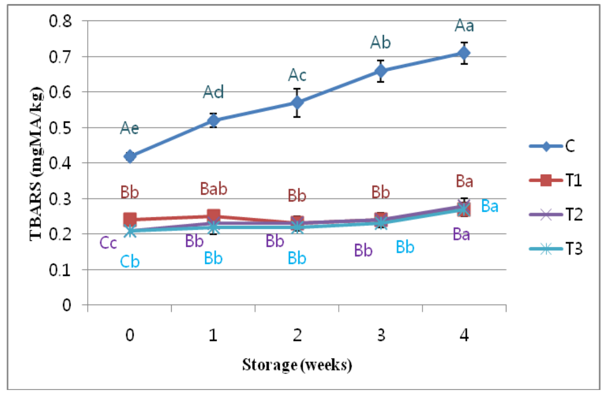

Fig. 1. Changes of TBARS values of restructured beef steaks during frozen storage.

A-CMeans with different superscript in the same column significantly differ at $P<0.05$.

eMeans with different superscript in the same row significantly differ at $P<0.05$.

1)Treatment are the same as in Table 1.

Table 3. Changes of texture properties of restructured beef steaks during frozen storage

Treatments[1)]		Storage (weeks) 0	1	2	3	4
Hardness (g/cm^2)	C	1589.29±211.64^{A}	1465.10±271.33	1167.27±199.75	1124.45±318.43	1348.23±387.59
	T1	1172.42±169.06^{Bab}	1141.91±22.03^{ab}	985.57±118.90^{b}	1420.13±270.92^{ab}	1260.03±147.49^{a}
	T2	1047.87±240.48^{Bb}	1580.05±125.77^{a}	1229.31±181.91^{ab}	1042.61±333.14^{b}	1436.29±71.29^{ab}
	T3	1137.01±61.46^{Bb}	1324.31±401.79^{ab}	1139.61±184.49^{b}	1066.94±115.20^{b}	1652.06±18.31^{a}
Adhesiveness (g)	C	-25.33±1.53^{Cc}	-15.00±1.41^{ABab}	-13.50±3.32^{a}	-16.50±2.38^{Bab}	-18.75±2.06^{ABb}
	T1	-14.67±1.53^{ABab}	-20.00±5.83^{ABb}	-11.00±2.65^{a}	-16.67±2.31^{Bab}	-20.33±2.31^{BCb}
	T2	-8.00±1.73^{Aa}	-22.33±6.43^{Bc}	-9.25±3.95^{a}	-9.25±0.96^{Aa}	-16.00±3.00^{Ab}
	T3	-17.50±7.14^{B}	-12.50±1.73^{A}	-12.67±3.51	-9.50±1.92^{A}	-23.67±1.53^{C}
Cohesiveness (%)	C	15.15±4.96^{Bc}	15.89±2.96^{Bc}	20.52±4.24^{bc}	25.27±2.66^{ab}	28.65±3.41^{Ba}
	T1	37.25±4.72^{Aa}	25.52±0.39^{Abc}	23.26±0.94^{b}	24.20±4.49^{bc}	32.02±5.89^{ABab}
	T2	34.15±0.53^{Aa}	17.24±3.46^{Bb}	24.23±3.36^{b}	23.42±8.44^{b}	36.64±3.38^{ABa}
	T3	29.91±7.04^{Abc}	17.89±2.29^{Bab}	24.85±7.88^{ab}	27.80±1.27^{a}	39.52±3.83^{Ac}
Springiness (%)	C	55.32±13.09^{b}	57.49±12.23^{Bb}	54.66±6.59^{Bb}	66.21±11.64^{ab}	77.41±7.46^{a}
	T1	72.02±13.64	80.37±3.28^{A}	59.01±13.68^{B}	80.49±14.78	71.46±11.63
	T2	71.76±17.31^{ab}	55.23±8.97^{Bb}	58.97±2.60^{Bb}	63.64±14.16^{b}	85.06±9.67^{a}
	T3	74.71±16.94^{b}	59.41±9.87^{Bc}	77.75±12.73^{Abc}	75.62±17.81^{b}	72.92±10.66^{a}
Gumminess (g)	C	21.70±8.42	18.27±7.36	13.53±1.86^{BC}	13.82±2.24	15.04±3.51^{B}
	T1	17.13±8.56^{ab}	12.93±2.54^{b}	9.90±3.89^{Cb}	16.46±3.61^{ab}	25.35±3.49^{ABa}
	T2	20.76±7.90	19.94±8.99	22.37±1.41^{A}	20.95±11.50	23.45±11.69^{AB}
	T3	15.55±10.15	10.88±2.17	20.09±4.48^{AB}	19.64±12.57	35.66±5.45^{A}

A-CMeans with different superscript in the same column significantly differ at $P<0.05$.

a-cMeans with different superscript in the same row significantly differ at $P<0.05$.

1)Treatment are the same as in Table 1.

IV. CONCLUSION

Restructured beef steaks can be manufactured with either plasma powder or emulsion type binding agent. In the present study, each type of binder agent is slightly different. Plasma powder treatment was decreased lightness, increased redness than the emulsion type binding agents ($p<0.05$). However, the added plasma powder and emulsion type binding agents were increased pH values and cohesiveness and decreased cooking loss and TBARS values of restructured beef steaks ($p<0.05$). It is suggested that binding meat agents could be used to extend the shelf-life and enhancing the eating quality of the restructured beef steaks.

ACKNOWLEDGEMENTS

This work is supported by the Brain Korea 21 Project from Ministry of Education and Human Resources Development, Republic of Korea.

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