REMOVAL OF MYOGLOBIN, LIPID AND SPECIES ODOR DURING PRODUCTION OF SURIMI-LIKE MATERIAL FROM GOAT MEAT

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Abstract –This study aimed to investigate the effect of conventional washing process on removal of myoglobin, lipid and species odor during production of surimi-like material from goat meat. Gel-forming ability of the resulting surimi-like material was also determined in comparison with unwashed minced goat meat. The results showed that washing with cold water for 3 cycles was capable of elimination of myoglobin, lipid, total volatile base nitrogen (TVB-N) from minced goat meat. Thiobarbituric acid reactive substances (TBARS), species odor and redness index also decreased with corresponding increase in whiteness compared to unwashed mince ($p<0.05$). In addition, surimi-like material showed superior gel strength, water holding capacity, whiteness and oxidative stability to unwashed minced goat meat ($p<0.05$). Therefore, washing process can be potentially applied for production of surimi-like material from goat meat.

Key Words – surimi, goat meat, myoglobin, lipid, species odor

I. INTRODUCTION

Surimi production has been very successful in the fish industry due to a world-wide variety of products made from fish surimi [1]. Recently, there has been considerable interest in manufacturing surimi-like materials from the muscle of animal species other than fish including poultry meat, beef, pork, sheep meat and meat by-products [2, 3]. Goat meat has limited commercial use due to its higher distinctive species flavor/odor compared to lamb or other red meats [4]. Also, goat meat like other red meats contain red muscle associated with high content of lipid and myoglobin [1, 2]. The application of the surimi technology in the production of a surimi-like material from goat meat could provide a new approach towards increasing its value and utilization. Therefore, the objective of this study was to determine the effect of conventional washing process with cold water on removal of myoglobin, lipid and species odor from goat meat and to evaluate the gelling properties of resulting surimi-like material.

II. MATERIALS AND METHODS

Goat meat sample and washing procedure

Meat loins at 24 h *postmortem* from native goat (*Capra aegagrus hircus*), about 2 years old at slaughter, were obtained from local market in Thasala, Nakhon Si Thammarat. The goat meat loins were kept in ice, using the meat/ice ratio of 1:2 (w/w), and transported to the laboratory within 30 min. Upon arrival, the goat meat loins were trimmed and the skin, bone and visible connective tissues were removed. Thereafter, the meat was manually cut and subsequently minced to uniformity using a meat grinder. The muscles were kept on ice during preparation. Minced goat meat was subjected to washing with cold water. The washing process was performed 3 cycles using the mince to washing medium ratio of 1:5 (w/v) for 10 min and the dewatering was made by hydraulic press. The resulting washed mince was referred to as 'surimi-like material from goat meat'. Unwashed minced goat meat was used as control. Both surimi-like material and control were subjected to analyses of pH, myoglobin content, color, lipid content, TBARS, TVB-N and species odor. To prepare the gel, surimi-like material or unwashed minced goat meat with the same moisture of 81% was mixed with 2.5% (w/w) of dry NaCl and chopped for 5 min to obtain the homogeneous sol. The sol was then stuffed into polyvinylidine casing with a diameter of 2.5 cm and both ends of the casing were sealed tightly. After thermal gelation using a commercial practice for meat ball (setting at 60°C for 30 min

prior to heating at 70°C for 20 min), gel properties including breaking force, deformation, whiteness, expressible drip, TBARS and relative metmyoglobin content were determined.

Determination of pH

The pH was determined according to the method as described by Chaijan *et al*. [1].

Myoglobin analysis

The myoglobin content was determined by direct spectrophotometric measurement, as described by Benjakul and Bauer [6]. A chopped sample (2 g) was weighed into a 50 ml polypropylene centrifuge tube and 20 ml of cold 40 mM phosphate buffer, pH 6.8, were added. The mixture was homogenized at 13,500 rpm for 10 s, followed by centrifuging at 3,000 ×*g* for 30 min at 4°C, using a RC-5B plus centrifuge (Sorvall, Norwalk, CT, USA). The supernatant was filtered with Whatman No. 1. The absorbance of the filtrate was read at 525 nm using a UV-1601 spectrophotometer (Shimadzu, Japan). Myoglobin content was calculated from the millimolar extinction coefficient of 7.6 and a molecular weight of 16,110. The myoglobin content was expressed as mg/g sample.

Color measurement

Colorimetric values of the protein isolate and its gel were obtained by using a portable Hunterlab Miniscan/EX instrument (10° standard observers, illuminant D65, Hunter Assoc. Laboratory; VA, U.S.A.). The tristimulus L* (lightness), a* (redness/greenness), and b* (yellowness/blueness) measurement mode was used as it relates to the human eye response to color. The redness index (a*/b*) was calculated according to Chen *et al*. [5]. The whiteness was calculated as described by Chaijan *et al*. [1] as follows:

$$\text{Whiteness} = 100 - [(100 - L^*)^2 + a^{*2} + b^{*2}]^{1/2}$$

Lipid extraction

Lipid was extracted by the Bligh and Dyer method [7]. The total lipid content in samples was calculated and expressed as g/100 g sample.

Determination of TBARS

TBARS assay was performed as described by Buege and Aust [8]. TBARS was calculated and expressed as mg malonaldehyde (MDA) equivalent/kg sample.

Determination of TVB-N

TVB-N contents were determined using the Conway micro-diffusion assay as described by Ng (1987). A sample (2 g) was added to 8 ml of 4% TCA (w/v) and homogenized at a speed of 11,000 rpm for 2 min. The homogenate was centrifuged at 3,000×*g* for 15 min at room temperature. The supernatant referred to as 'sample extract' (1 ml) was placed in the outer ring of the Conway apparatus. The inner ring solution (1% boric acid containing the Conway indicator) was then pipette into the inner ring. To initiate the reaction, K_2CO_3 (1 ml) was mixed with sample extract. The Conway unit was closed and incubated at 37°C for 60 min. The inner ring solution was then titrated with 0.02 N HCl until the green color turned to pink. The TVB-N was calculated and expressed as mg N/g sample.

Sensory evaluation of species odor

The species odor intensity of unwashed minced goat meat and surimi-like material was investigated by 40 assessors. Attention was given to recognize the intensity of species odor, which was marked on a scale from 0 to 10. On this scale, 0 and 10 indicated no smell and maximum species odor, respectively.

Determination of gel strength

Texture analysis of the gels was performed using a TA-XT2 texture analyzer (Stable Micro Systems, Godalming, Surrey, UK.) equipped with a spherical plunger (diameter 5 mm; depression speed 60 $mm.min^{-1}$) as described by Chaijan *et al*. [1]. Breaking force (gel strength) and deformation (elasticity/deformability) were recorded and the gel strength (breaking force × deformation) was

calculated.

Expressible drip

Expressible drip of gel was measured according to the method of Ng [10]. A sample with a thickness of 0.5 cm was weighed and placed between two pieces of Whatman filter paper No. 1 at the top and three pieces of the same type of filter paper at the bottom. The standard weight (5 kg) was placed on the top of the sample and maintained for 2 min. The sample was then removed and weighed again. Expressible drip was calculated and expressed as percentage of sample weight.

Measurement of metmyoglobin content

The analysis of metmyoglobin content was performed as described by Benjakul and Bauer [6]. The sample solution was prepared by the method previously mentioned for myoglobin content determination. The extract was subjected to absorbance measurement at 630 and 525 nm using a buffer as blank. A high A_{630}/A_{525} ratio indicates a high relative proportion of metmyoglobin.

Statistical analysis

A completely randomized design (n = 3) was used in this study. All parameters studied were determined in triplicate. A T-test was used for pairwise comparison. Statistical analysis was performed using the Statistical Package for Social Science (SPSS 8.0 for windows, SPSS Inc., Chicago, IL).

III. RESULTS AND DISCUSSION

Physicochemical properties of surimi-like material from goat meat

The pH of surimi-like material was higher than unwashed minced goat meat ($p<0.05$; Table 1). This was mainly due to the removal of organic acids, proton or buffer substances from minced goat meat during washing leading to the increase in pH value. Myoglobin content in minced goat meat was significantly decreased by washing ($p<0.05$; Table 1). About 53.5% reduction in myoglobin was observed when minced goat meat underwent washing with cold water. Generally, myoglobin is a water soluble protein which can be easily leach out. However, myoglobin can form interaction with myofibrillar proteins which makes a removal more difficult [11]. A decrease in myoglobin content resulted in a decrease in redness index with an increase in whiteness of resulting surimi-like material ($p<0.05$; Table 1). Washing also worked properly to remove lipid content and TVB-N substances ($p<0.05$; Table 1) leading to the reduction of TBARS value and species odor score ($p<0.05$; Table 1). After washing, lipid and TVB-N was reduced by 63.2 and 35.6%, respectively. Reduction of lipid oxidation, as indicated by lowered TBARS value, and TVB-N led to the decrease in species odor intensity. It has been suggested that lipid oxidation products and volatile base substances can give rise to the off-odor development [1, 4, 6]. The results also proved that elimination of myoglobin, an endogenous prooxidant, and lipid substrate can retard the lipid oxidation of surimi-like material from goat meat.

Table 1. pH, myoglobin content and color of unwashed minced goat meat and surimi-like material from goat meat

Parameters	Unwashed minced goat meat	Surimi-like material
pH	6.05±0.06a*	6.92±0.77b
Myoglobin content (mg/g sample)	7.52±0.01b	3.50±0.01a
Whiteness	36.56±0.19a	49.15±0.17b
Redness index	0.52±0.02b	0.33±0.01a
Lipid content (g/100 g sample)	13.65±2.40b	5.02±0.07a
TBARS (mg MDA/kg sample)	1.56±0.34b	1.17±0.08a
TVB-N (mg N/g sample)	5.51±0.98b	3.55±1.17a
Species odor score	7.50±0.78b	5.65±0.28a

Values are given as means±SD from triplicate determinations except for species odor score which are given as means±SD from scores of 40 assessors.

*Different letters in the same row indicate significant differences ($p<0.05$).

Gel properties of surimi-like material from goat meat

Surimi-like material from goat meat had superior gel strength, whiteness, water holing capacity to unwashed minced goat meat ($p<0.05$; Table 2). This results was in accordance with the reduction of myoglobin and lipid contents (Table 1) which have been reported as interferences for gel network formation [1]. Additionally, washing can improve the oxidative stability of myoglobin and lipid upon thermal gelation as indicated by lowered relative metmyoglobin content and TBARS value of surimi-like material gel ($p<0.05$; Table 2).

Table 2. Gel properties of unwashed minced goat meat and surimi-like material from goat meat

Parameters	Unwashed minced goat meat	Surimi-like material
Gel strength (g.mm)	558±10a*	1016±24b
Whiteness	34.20±0.05a	40.01±0.17b
Relative metmyoglobin (A_{630}/A_{525})	0.767±0.00b	0.712±0.01a
Expressible drip (%)	10.02±0.10b	4.98±0.21a
TBARS (mg MDA/kg sample)	2.27±0.02b	1.35±0.03a

Values are given means±SD from triplicate determinations.
*Different letters in the same row indicate significant differences ($p<0.05$).

IV. CONCLUSION

In order to produce a desirable surimi-like material from goat meat, washing with cold water for 3 cycles can be used. Myoglobin, lipid and species odor were effectively removed from minced goat meat by means of conventional washing. The prepared surimi-like material had better gel strength, water holding capacity and whiteness than unwashed minced goat meat. Oxidative stability of minced goat meat was also improved by washing.

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