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## PHYSICAL PROPERTIES OF EMULSION-TYPE SAUSAGE PREPARED FROM DEER MEAT AND PORK FAT

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**Backgrounds and Objectives**

In Japan, the numbers of inhabitants of wild deer have recently been increased, so that some of them usually have spoiled and are still spoiling agricultural products by eating. The extent of damage of agricultural products has also been increased. Therefore, some of them, especially of male deer, are permitted to hunt during a few weeks in the winter season in order to control the population of wild deer. Unfortunately, however, the consumption of deer meat has been done only by a limited numbers of people such as hunters, and people who like to have gourmet meals. In addition, only a few kinds of deer meat products, such as dried meat and " Sigure-ni (sweetened cooked deer meat)", are sold as attractions for visitors in secluded places in the mountains in Japan. In New Zealand, on the other hand, a number of red deer are raised in farms, and it is reported that the numbers of red deer are increased almost equal numbers of dairy cows[1]. Most of those red deer are sold as raw steak meat not as meat products.

There have been a few studies investigating the chemical composition of deer meat and deer fat[2, 3], so that the chemical properties of deer meat have considerably been unveiled. Unfortunately, however, almost no research regarding processing of deer meat has been made so far.

The objectives of this study were to attempt to prepare an emulsion-type sausage composed of deer meat and pork fat, and to investigate rheological properties of the sausage, and compare the rheological properties of deer meat sausage and that of sausage sold in market.

**Materials and Methods**

*Preparation of emulsion-type sausage* : Deer meat was dissected out from deer carcass hunted in Kyushu University Forest (Shiiba-Mura, Miyazaki, Japan) and was stored at -80°C until use. The frozen deer meat was thawed at 5°C for 2 days. Then, the deer meat was cut into a small cubes (approximately 3 cm in diameter), and was subjected to dry curing with a curing mixture {2.0 % sodium chloride, 0.3 % polyphosphate mixture (SH-50 ; Poly-Phos Chemical Ltd.), 150 ppm sodium nitrite, 550 ppm sodium ascorbate and 1.5 % sugar} for 3 days at 5°C. Pork fat was also dry cured as above. Then, five parts of the cured deer meat and two parts of pork fat were mixed with 20 % (vol./wt. of meat) ice-water, 5% (wt./wt. of meat) starch, 1.5 % sodium caseinate (Nippon Shin-Yaku. Ltd., Kyoto, Japan), 0.4 % (wt./wt. of meat) gelatin, 0.5% (wt./wt. of meat spice mixture and 0.1 % sodium glutamate in a food cutter and was cut for 4 min. The resulting emulsified sausage mixture was staffed in a collagen casing (30 mm in diameter), followed by weighing. Then, the resulting raw sausage was subjected to smoking (approximately 50°C for 30 min) and cooking (75 °C for 30 min at the center of the sausages) in order. After cooling, droplets of water on the surfaces of the sausages were wiped out, and the weight of each sausage was measured. Cooking loss during smoking and cooking was estimated by subtracting the final weight of the sausage from the initial weight (the weight before cooking).

*Color and Rheology :* Deer sausage, experimental pork sausages, all-pork sausages (Fukudome Ham, Co. Ltd., Hiroshima, Japan) and fish sausages (Maruha, Ltd., Tokyo, Japan) purchased at a grocery store were cut into pieces having the shape of column (1.5 cm in height). The color (L*, a* and b*) of the pieces of those sausages were measured with a color meter.

Physical properties of the pieces of the four kinds of sausages were evaluated with a Rheoner (RE 2-33005, Yamaden Ltd.) using a cylindrical plunger (12mm in diameter) with a constant rate of biting of the plunger to 80% pressing[4]. Each parameter (hardness, cohesiveness and gumminess) was calculated according to the analytical procedure of Bourne[5].

*Extractability and composition of muscle proteins and pH value:* Deer meat stored at 0°C for 3days after slaughter and pork meat (purchased from a wholesaler) before curing was cut into small pieces (2g). Half of each 2g meat samples was homogenized with a Polytron (Kinematica Ltd., Switzeland) in 4 ml of 40 mM Tris-HCl (pH 7.2), followed by centrifugation (10, 000×g for 20 min). The resulting supernatant was filtrated through two layers of gauze. The filtrate was used as sarcoplasmic protein fraction. The remaining half of the meat samples was subjected to homogenize in Weber-Edsall solution[6], centrifugation and filtration as described above. The resulting filtrate was used as salt-soluble protein fraction. Protein concentration of each fraction was determined by Biuret method[7] using bovine serum albumin as a standard. Protein composition of the two fractions was examined by SDS-PAGE[8] using a gradient gel of 7.5 - 20% acrylamide. The pH value of deer meat and pork meat was determined after homogenizing 5g of those meat with 25 ml distilled water.

*Scanning electron microscopy (SEM) :* Specimens of the two types of sausage for SEM were prepared according to the method of Haga et al.[9]. Then, microstructure of the emulsion-type deer meat sausage, experimental all-pork sausage were observed by SEM (S-2050, Hitachi Ltd.).

**Results and Discussion**

*Extractability of muscle proteins and their composition :* It is generally recognized that myofibrillar proteins play very important roles in the development of specific properties, such as binding property and water-holding capacity, of processed meat products, i. e., myosin and actin molecules solubilized into cytosol from muscle cells during curing usually form so-called three dimensional networks, responsible for the development of binding property and water-holding capacity, in meat products during the gelation process of cooking. Even in the case of the emulsion-type sausage containing deer meat as a protein source, it is easily considered that the principle underlying sausage making is the same as that of pork meat. Therefore, the extractability of muscle protein and their composition of deer meat were compared with those of pork meat. The extractability of the two muscle protein fractions, mg of extracted protein / g muscle, of pork meat was slightly greater than that of deer meat. SDS-PAGE pattern of myofibrillar protein fraction of deer meat was almost the same as that of pork meat. However, there was a difference in the electrophoretogram of sarcoplasmic proteins fraction, i. e., a band of 17 kDa (corresponding to myoglobin) was stained more clearly in deer meat than in pork meat. This tendency was consistent with the previously reported data. The pHs of deer meat and pork meat before curing were 5.87 and 5.70, respectively. This pH value was an ideal pH value for making emulsion-type sausages.

*Physical properties of meat products :* Firmness of deer meat sausage (Resistant force against the plunger when the plunger was penetrated into the pieces of the sausage) was significantly lower than that of the experimental sausage. However, the difference in the Firmness between deer meat sausage and the sausages on the market was not statistically significant. Cohesiveness (an indicator of internal binding force) of the deer meat sausage as well as fish sausage was significantly higher than that of the experimental pork sausage. Gumminess, one of the secondary parameters calculated from both of firmness and cohesiveness, of deer meat sausage was appreciably lower than that of the experimental pork sausage, pork sausage and fish sausage on a market. These results indicate that deer meat sausage probably give us more softer touch than other sausages do. Cooking loss, a good indicator of water-holding capacity and binding property of row meat, of deer meat sausage was apparently lower than that of the experimental pork sausage, indicating that meat particles in the sausage properly bind each other to make the three dimensional network. The result of the cooking loss of deer meat sausage also coincide with that of cohesiveness.

In general, rheological properties of gelled foods are well dependent on the three-dimensional structure of the foods. In the case of deer meat sausage, three-dimensional structure was also clearly observed by SEM. In comparing the microstructure of deer meat sausage and that of the experimental pork sausage, the diameter of each stick composing the three-dimensional structure like a jungle-gym of deer meat sausage was considerably smaller than that of each stick of the jungle-gym of the experimental pork sausage, and the space in the jungle-gym of deer meat sausage was more coarse than that of the experimental pork sausage. Soft touch in the texture of deer meat sausage described above was probably dependent on these characteristics of the network structure of deer meat sausage.

*Color of meat products :* The color of deer meat sausage was slightly darker than that of experimental pork sausage, i. e., L* value of deer meat sausage was lower than that of the experimental pork sausage, and a* and b* values of the former were higher than the latter. However, these parameters of the former were lower than those of the pork sausage on a market except b* value. In addition, H° value (hue angle), an indicator of the profoundness of redness, of the former showed an intermediate value between that of the experimental pork sausage and that of fish sausage. These results indicate that such characteristics in color of deer meat sausage are dependent on higher content of myoglobin in row deer meat. As a result, each color parameter of deer meat sausage is quite similar to that of dried sausages[10].

In summarizing the results in the present study, deer meat sausage showed a softer texture than the experimental pork sausage did. However, the rheological parameters obtained in the present study were in the range usually observed for sausages sold in markets. Therefore, the present results indicate that emulsion-type sausage using deer meat will be acceptable by consumers.

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