Effect of *Lactobacillus plantarum* Concentration Level on Physicochemical Properties of Fermented Goat Meat Dendeng

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Abstract. This research aimed to determine the effect of *Lactobacillus plantarum* on the manufacturing process of fermented goat meat dendeng. The completely randomized design with four treatments and four replications was applied to determine the moisture content, water activity (A_w), protein content, dissolved protein content, and protein profile as physicochemical quality indicators. The level of *Lactobacillus plantarum* was 0 ml (T0), 0.3 ml (T1), 3 ml (T2), and 30 ml (T3), respectively. The obtained result was analyzed with SPSS for windows 16 then followed with Duncan's Multiple Range Test. The highly significant result (P<0.01) was shown on A_w, with values at 0.61 – 0.70, moisture content  at 44.24 – 46.65%, protein content  at 31.98 – 38.70%, and dissolved protein content at 3.55 – 4.21%; while the molecular weight of protein profile was ranged from 16.69 to 143.54 kDa, and showed an unreadable protein band on T0, six protein bands on T1, seven protein bands on T2, and eight protein bands on T3, respectively.

1. Introduction
Meat is a livestock product that rich in nutrition content such as protein, carbohydrate, and lipid have been classified into a food product that can be utilized easily by a human being. The consumption level of beef in Indonesia is gradually increasing year by year. In the opposite, the level of local beef production had been decreased, that condition leads the Indonesian government to make a policy about importing beef from other countries [1].

Beef sufficiency that projected by the Indonesian government is still far from expectations, replacing the beef with goat meat can be a prospective plan to fulfill the lack of protein sources. However, a specific aroma and tough/clay texture of the goat meat has been directly affecting the low level of goat meat preference of Indonesian society. Goat meat processing technology such as goat meat dendeng could be produced for reducing the specific aroma and tough/clay texture, while it's expected to increase the preference level of goat meat product.

Processing meat becomes dendeng consider to increase the flavor of the meat and can extend the shelf life. Spices neutralize any unpleasant odors present in food. The fermentation process can change complex compounds to be simpler so that fermented food can absorb well by the human body. The fermentation process is considering improving the quality of food. Fermentation is a relatively...
inexpensive process that forms for a long time. According to [2], Fermentation is an ancient process that use to prevent foods, and this process widely practices in the meat industry as a method of preparing and preserving meat. The bacteria, Lactobacillus, Staphylococcus, and Micrococcus, play the most critical role in this microbial process.

Additionally, certain types of yeasts and molds also use in the production of some unique fermented meat products. The fermentation process using Lactobacillus plantarum assists. L. plantarum produces different antimicrobial compounds such as organic acids, hydrogen peroxide, diacetyl, and also bacteriocins and antimicrobial peptides [3]. The addition of Lactobacillus plantarum may affect moisture content, Aw, protein content, dissolved protein content, and change molecular weight in protein profile on fermented goat dendeng.

2. Materials and method

2.1 Materials
The materials used were: 1) Goat meat (Capra hircus) aged from 1 – 2 years. 2) The other ingredients were palm sugar, garlic, coriander, galangal, cumin, salt, pepper. 3) Lactobacillus plantarum FNCC 0027, deMan Rogosa Sharp Agar (MRS-A), deMan Rogosa Sharp Broth (MRS-B), skimmed milk, and sugar. The equipment used were: an analytical scale with accuracy 0.01 gram, soxhlet, oven, incubator, autoclave, spectrophotometer (M508), and a set of electrophoresis.

2.2 Methods
The research method was using an experimental design with four treatments 10^7 cfu/ml (0, 0.3, 3, 30 ml of Lactobacillus plantarum) and four replications. Statistical analysis was used SPSS for windows 16 then continued with Duncan’s multiple ranged tests.

3. Results and discussion
This research was successfully produced Fermented goat meat dendeng with characteristic: a brown color, crunchy texture, spicy, specific flavor, and without goat aroma. The result is accepted by [4] dendeng had a sweet taste because its sugar content and intense taste of spices and dried meat provided a distinctive flavor.

Dendeng was one of the durable meat products that classified as preservation meat. According to their high nutritional value and a greater ratio of unsaturated fatty acids, goat meat had the potential to improve the health of people who rarely consumed meat products from their daily diet. Goat meat consumption was becoming accessible and often available [5]. The physicochemical properties of fermented goat meat dendeng were described in table 1.

| Treatment | Moisture content (%) | Aw | Protein Content (%) | Dissolved Protein Content (%) |
|-----------|----------------------|----|---------------------|------------------------------|
| T0        | 44.24±0.75^a         | 0.61±0.01^a | 31.98±0.64^a | 3.55±0.13^a |
| T1        | 44.93±0.72^a         | 0.67±0.02^b | 35.28±0.81^b | 3.95±0.03^b |
| T2        | 46.48±0.44^b         | 0.68±0.02^b | 38.34±0.40^c | 4.14±0.02^b |
| T3        | 46.65±0.55^b         | 0.70±0.00^b | 38.70±0.88^c | 4.21±0.17^c |

Note: The different superscripts in the same column show a highly significant effect (P<0.01)

3.1 Moisture Content.
The results of the increasing Lactobacillus plantarum added on goat meat dendeng would increase the moisture content. Dendeng was produced in this research has classified as intermediate moisture food because it had a higher moisture content than commercial dendeng. Indonesian national standard recommends the value of moisture content for beef dendeng is about 12%.
The moisture content was still high due to the growth of lactic acid bacteria (LAB). Intermediate moisture foods (IMF) contain between 20 and 50% (w/w) of water [6]. Water was vital for many biological processes and essential for all living organisms [7]. The moisture content was increased due to the LAB fermentation, which Lactobacillus plantarum hydrolyze substances and produced H₂O. All types of living organisms were able to produce a variety of ribosomally synthesized antibacterial peptides or proteins [8]. The formation of one peptide bond results in the removal of one water molecule [9]. Water molecule removal in the enzymatic process increased the moisture content of dendeng.

3.2 Water activity (Aw)
The average value of Aw shows in table 1, and the results showed that more levels of Lactobacillus plantarum added would increase the Aw value. Higher Aw values in dendeng with the addition of Lactobacillus plantarum (T1, T2, T3) were due to the effect of microorganism activity compared with T0 treatment without the addition of Lactobacillus plantarum. Water activity (aw) was the amount of water that microorganisms could use for their growth [10]. Moisture content increased in dendeng also affected the increasing of Aw value. [11] stated that the relation of moisture content with an Aw indicated by the tendency that the high moisture content then, would obtain high Aw value. Moisture content expressed in percent (%) in the range of 0-100 scale, while the value of aw expressed in decimal places in the range of 0-1.0 scale.

The Aw value of dendeng was still passed the Indonesian national standard that recommends the value of Aw for meat in around 0.4-0.9. The dendeng which had an Aw between the ranged of 0.50-0.90 will had longer shelf life during storage. Intermediate Moisture Foods (IMF), a high amount of soluble compounds, which resulted in low Aw values from 0.7 to 0.9 (6).

3.3 Protein content
The average value of protein content shows in table 1, and the results showed that more levels of Lactobacillus plantarum added would increase the protein content. Dendeng was produced in this research had a higher protein than commercial dendeng due to the fermentation process that breaks the protein structure. According to the activity, the most important proteolytic enzyme was the protease, related to breaking down proteins into peptides and hydrolyzed large peptides into smaller ones and became free amino acids [12].

3.4 Dissolved protein content
The average value of dissolved protein content shows in Table 1, and the results showed that more levels of Lactobacillus plantarum added would increase the dissolved protein content. Dissolved protein content increased from T0 treatment was 3.55% to T3 treatment was 4.21%. The fermentation process used the Lactobacillus plantarum showed an effect on the dissolved protein content of dendeng. Levels of dissolved protein increased due to the fermentation process; microbe hydrolyzed complex proteins became free amino acids or simpler peptides in the presence of proteolytic enzyme activity [13]. The increasing of dissolved protein content because of the hydrolysis of protein during the fermentation and increasing moisture content.

3.5 Protein profile
Electrophoresis analysis conducted in this research using 12% separating gel and 3% stacking gel. The molecular weight can be seen only protein with molecular weight 16.69143.54 kDa. Electrophoresis analysis showed T1 treatment had molecular weight was 143.54, 126.94, 93.34, 77.62, 41.97, 27.29 kDa, T2 treatment had molecular weight was 143.54, 64.55, 50.47, 41.97, 34.90, 30.86, 16.69 kDa, T3 treatment had molecular weight was 143.54, 64.55, 50.47, 41.97, 30.86, 27.29, 18.87, 16.69 kDa, respectively.

The molecular weight of the protein changed due to the fermentation process that occurs in dendeng. The hydrolysis process that breakdown protein becomes small peptides.[14] stated that
protein composition changed along with the fermentation. Decreased protein fraction accompanied by an increase in the insoluble fraction. New bands appeared mainly on insoluble proteins. The addition of bacteria increased the value of viscosity; it might be due to the effect of proteolytic enzymes from bacteria that could break down polypeptide bonds shorten and the protein denatured until becoming solids [15]. In general, as competitive species, LAB acted to break down proteins in the surrounding media for the intracellular nutrient supply [16].

4. Conclusion
The addition of Lactobacillus plantarum to fermented goat dendeng will increase moisture content, Aw, protein content, and dissolved protein content. The molecular weight of the protein changed due to the fermentation process that occurs in fermented goat meat dendeng.

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