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The Effect of Addition of Andaliman Fruit *(Zanthoxylum acanthopodium dc)* on Physical Quality and Organoleptic Testing of Buffalo Meat Sausage

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ABSTRACT

Meat is one of the ingredients that is susceptible to physical damage caused by biochemical activity. Andaliman has biological activities such as antioxidants, anti-inflammatory, and antimicrobial. This study aims to determine the effect of giving Andaliman fruit (Zanthoxylum acanthopodium DC) on the physical quality and organoleptic test of buffalo meat sausages which were carried out in May-June 2025 at the Animal Production Laboratory, Animal Husbandry Study Program, Faculty of Agriculture, Universitas Sumatera Utara. The design used in this study was a Completely Randomized Design with 4 treatments and 5 replications. The treatment consisted of giving Andaliman extract (P0 = 0%; P1 = 0.2%; P2 = 0.4%; P3 = 0.6%). The parameters observed were the physical quality of the sausage, including pH value, percentage of water binding capacity, and percentage of cooking loss as well as organoleptic tests of the sausage. The results of this study indicate that the administration of Andaliman extract (Zanthoxylum acanthopodium DC) gave very significant different results on pH value, water binding capacity and sausage cooking loss. The administration of Andaliman extract (Zanthoxylum acanthopodium DC) gave very significant different results on the color, aroma, texture and taste of sausages. The best treatment results were found in P3, namely with a concentration of 0.6%.

Keyword: Andaliman, Buffalo, Cooking loss, Meat, Sausage

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1. Introduction

Buffalo meat has a dark red color, coarser fibers, and a chewier texture than beef, as it is typically slaughtered at an older age. It is also susceptible to physical damage caused by the activity (autolysis) that occurs within the meat. This activity involves biochemical processes. Buffalo meat is not yet very popular among the public. Buffalo meat sold in markets is generally not tender, has low juices, and has a less pleasant flavor, making it less suitable for quality meat.

Sausages are widely enjoyed by almost all levels of Indonesian society due to their delicious taste. Chicken and beef sausages are widely available on the market, while buffalo sausages are rarely found, despite the protein content of buffalo meat being similar to beef and its lower price.

Ready-to-eat sausages are cooked at high temperatures and over a relatively short time. Preserving the quality of buffalo meat in processed forms like sausages can be achieved through various methods, such as heating, cooling, freezing, and the addition of preserv

A common problem in sausage production is content instability, which results in a decrease in the physical quality of the sausage. This instability is caused by the processing process. Andaliman fruit contains terpenoid compounds with antioxidant activity that are highly beneficial for health and play a crucial role in maintaining the quality of food products against various deterioration processes, such as rancidity and changes in color and aroma.

2. Method

This research was conducted at the Animal Production Laboratory of the Animal Husbandry Study Program, Faculty of Agriculture, Universitas Sumatera Utara in March-April 2025.

2.1. Tools and materials

2.1.1. Tools

The tools used in this study were a blender, a cutting knife, gloves, an AMT 16 pH meter, a measuring cup, tissue, Whatman No. 42 paper, a digital scale, filter paper, a Soxhlet test tube, graph paper, a glass plate, a thermometer, a food processor, a gas stove, a stainless steel pan, a spoon, a stove, a basin, a baking sheet, a spatula, a bowl, a cutting board, a plastic sample bottle, a name sticker label, a ruler, a pen, and a data book.

2.1.2 Materials

The materials used in this study were buffalo meat, Andaliman, tapioca flour, salt, ground pepper, garlic, egg white, ice water, MSG, KCl solution, distilled water, and cooking oil.

2.2. Data Collection Instruments

The design used in this study was a Completely Randomized Design (CRD) with 4 treatments and 5 replications. The treatment arrangements were as follows:

1. P0: Sausage dough + Andaliman
2. P1: Sausage dough + Andaliman 0.2%
3. P2: Sausage dough + Andaliman 0.4%
4. P3: Sausage dough + Andaliman 0.6%

2.3. Research Parameters

2.3.1 Potential of Hydrogen (pH)

According to the pH value of marinated beef was measured using a meat pH meter. Before use, the instrument was calibrated using buffer solutions with pH 4 and 7 [1]. A 5-gram sample was weighed, then the pH meter electrode needle was inserted into the sample. The pH value was indicated by a stable reading on the instrument. The test was conducted in duplicate.

2.3.2 *Water Holding Capacity*

Water holding capacity refers to the ability of meat to retain water. This water holding capacity can be measured using the Hamm method [2]. Measurements are made by assessing the free water content in the wet area and the existing moisture content.

Free water content measurement: A 0.3 g sample of jerky is placed on Whatman 42 filter paper and then placed between two glass plates loaded with a 35 kg load for 5 minutes. Mark and draw the area covered by the flattened jerky sample and the wet area surrounding the filter paper on graph paper using a candling tool.

2.3.3 Cooking loss

Cooking loss is the ratio between the weight of meat before cooking (initial weight) and cooked (final weight). Cooking loss can be measured using the boiling method [2]. Sausages with Andaliman extract added were weighed at 25 g before cooking. The soaked sausages were then placed in polyethylene plastic, tightly closed, and vacuum sealed. The sausages were boiled for 1 hour at 80°C, then drained. The weight of the boiled sausages was recorded as the final weight.

2.3.4 color

The color test was conducted using the hedonic test method by 30 semi-trained panelists with a score range of 1 to 5.

Table 1. Organoleptic color test

Criteria	Score	Variables
Color	1	Pink
	2	Red
	3	Dark red
	4	Red-brown
	5	Grey-brown

2.3.5 Aroma

The aroma test was conducted using the hedonic test method by 30 semi-trained panelists with a score range of 1 to 5.

Table 2. Organoleptic aroma test

Criteria	Score	Variables
Aroma	1	Sausages without Andaliman flavor
	2	Sausages lacking Andaliman flavor
	3	Sausages with moderate Andaliman flavor
	4	Sausages with moderate Andaliman flavor
	5	Sausages with a distinctive Andaliman flavor

2.3.6 Taste

Taste testing was conducted using the hedonic test method by 30 semi-trained panelists with a score range of 1 to 5.

Table 3. Organoleptic taste test

Criteria	Score	Variables
Taste	1	The sausage doesn't taste like Andaliman, but rather meaty.
	2	The sausage doesn't taste like Andaliman, but it tastes like meaty.
	3	The sausage tastes quite a bit like Andaliman.
	4	The sausage tastes a little like Andaliman.
	5	The sausage tastes like Andaliman.

2.3.7 Texture

Texture testing was conducted using the hedonic test method by 30 semi-trained panelists with a score range of 1 to 5.

Table 4. Organoleptic texture test

Criteria	Score	Variables
Texture	1	Rough and very soft texture
	2	Slightly soft texture
	3	Slightly soft and slightly dense texture
	4	Slightly chewy and dense texture
	5	Dense, chewy, and not soft texture

3. Result and discussion

3.1. Potential of Hydrogen (pH)

The pH value is the concentration of dissociated hydrogen ions in a solution. The purpose of measuring pH is to determine the acidity or alkalinity of a material or product. The average pH value of buffalo sausage with Andaliman extract is shown in the following table.

Table 5. Average pH value of buffalo sausage with Andaliman extract

Treatment	Replication					Mean ± SD
	1	2	3	4	5	
P0	5,32	5,38	5,28	5,34	5,38	$5,34^{A} \pm 0,04$
P1	5,74	5,82	5,88	5,88	5,80	$5,82^{B} \pm 0,06$
P2	5,92	5,89	5,90	5,92	6,10	$5,95^{BC} \pm 0,09$
P3	6,05	6,03	5,94	6,12	6,09	$6,05^{C} \pm 0,07$

Note: Different superscripts in the same column indicate a highly significant difference (P<0.01).

The results of the analysis of variance (ANOVA) showed that the addition of Andaliman extract at different doses had a highly significant effect (P<0.01) on the pH of buffalo meat sausage. The table above shows that the lowest mean value was obtained at P0, with a value of 5.34, while the highest mean value was found at P3, with a value of 6.05. Processed meat products such as sausages have a pH value ranging from 5.8 to 6-2 [3]. This proves that the addition of Andaliman extract to P1 (0.1%) had an effect compared to P0 (the control).

The results of the Duncan's further test showed that P0 was highly significant (P<0.01) compared to the other treatments. The treatment at P1 showed a highly significant difference (P<0.01) compared to P0 and P3, but not significantly different (P>0.05) compared to P2. Treatment at P3 showed a very significant difference (P<0.01) to P0 and P1, but was not significantly different to P2. Treatment at P1 had shown a difference to P0, presumably because the potential of Andaliman extract in buffalo meat sausage was able to work as a natural preservative which showed that there was an increase in pH value with increasing concentration of Andaliman extract.

3.2. Water Holding Capacity

Water Holding Capacity (WHC) is the ability of meat to retain water during processing and storage. A high-water holding capacity in sausages results in a better texture and prevents water from escaping during cooking. The average DIA values for buffalo meat sausages are shown in Table 10.

Table 6. Average DIA values for sausages with added Andaliman extract (%)

Treatment	Replication					Mean ± SD
	1	2	3	4	5	
P0	32,27	37,74	34,59	30,04	38,03	$34,53^{A} \pm 3,46$
P1	36,01	36,78	38,75	34,17	39,06	$36,96^{AB} \pm 2,02$
P2	39,10	40,77	37,18	41,20	43,77	$40,40^{BC} \pm 2,46$
P3	40,48	41,40	40,93	48,78	42,72	$42,86^{C} \pm 3,41$

Note: Different superscripts in the same column indicate a highly significant difference (P<0.01).

Based on Table 6, the highest average water binding capacity was found in P3 at 42.86%, and the lowest average water binding capacity was found in P0 at 34.53%. The results of the analysis of variance (ANOVA) showed that the addition of Andaliman extract had a highly significant effect (P<0.01) on the water binding capacity of buffalo meat sausages. The DIA range obtained in this study was between 34.53% and 42.86%.

The results of the Duncan's further test showed that P3 was highly significant (P<0.01) compared to P0 and P1, but not significantly different (P>0.05) from P2. The treatment in P2 was highly significant (P<0.01) compared to P0, but not significantly different (P>0.05) from P1 and P3. P1 was significantly different (P<0.01) from P3 but not significantly different (P>0.05) from P0 and P2. Furthermore, treatment on P0 gave a very significant difference (P<0.01) from P2 and P3, but not significantly different (P>0.05) from P1.

3.3. Cooking loss

Cooking loss is an indicator of a product's nutritional value, related to the amount of water within and between muscle fibers. A lower cooking loss percentage indicates less water and water-soluble nutrients are

lost from the product [2]. The average cooking loss values for buffalo sausages are shown in the following table.

Table 7. Average cooking loss of buffalo sausages with added Andaliman

Treatment	Replication					Mean ± SD
	1	2	3	4	5	
P0	27,32	27,16	25,17	26,21	26,17	$26,41^{tn} \pm 0,87$
P1	28,30	26,24	25,24	26,23	25,19	$26,24^{tn} \pm 1,26$
P2	26,17	26,29	27,33	25,22	25,18	$26,04^{tn} \pm 0,89$
P3	25,33	26,31	24,31	23,14	26,30	$25,08^{tn} \pm 1,36$

Note: TN: Not significantly different (P>0.05).

Based on the results above, the administration of Andaliman extract did not significantly affect the cooking loss of buffalo sausage (P>0.05). The average cooking loss according to Table 7 ranged from 25.08% to 26.41%. Factors that can influence cooking loss include the protein in meat, which can bind water. Therefore, the more water retained by the meat protein, the less water will be released, resulting in lower cooking loss [4].

3.4. Color

Color is a crucial factor influencing consumer perception of product quality, including freshness, doneness, and even flavor. The average color rating for buffalo sausage with Andaliman extract is shown in the table below.

Table 8. Average color of buffalo sausage with Andaliman extract

Treatment	Replication					Mean ± SD
	1	2	3	4	5	
P0	1,17	1,17	1,13	1,17	1,17	$1,16^{A} \pm 0,01$
P1	2,20	2,13	2,13	2,17	2,17	$2,16^{B} \pm 0,03$
P2	2,70	2,77	2,70	2,67	2,73	$2,71^{C} \pm 0,04$
P3	3,43	3,23	3,03	2,93	2,87	$3,10^{D} \pm 0,23$

Note: Different superscripts in the same column indicate a highly significant difference (P<0.01).

Table 8 shows that the lowest mean value was obtained for P0 (control) with a value of 1.16, while the highest mean value was obtained for P3 with a value of 3.10. The analysis of variance (ANOVA) results showed that the addition of Andaliman had a highly significant effect (P<0.01) on the color of buffalo meat sausages. The increase in the average color value in the sausages is suspected to be due to the increasing dosage of Andaliman with each treatment. [5] Stated that differences in color in the same product will lead to different perceptions by panelists or consumers.

Duncan's further test results showed that each treatment produced a highly significant difference (P<0.01) compared to the other treatments. Treatment P1 already showed highly significant results compared to P0, presumably because the dosage in P1 was sufficiently effective in influencing the color of buffalo meat sausages.

3.5. Aroma

Stated that aroma is detected when volatile compounds enter the nasal passages and are received by the olfactory system, then transmitted to the brain [6,7]. The results of the analysis of variance (ANOVA) showed that the addition of Andaliman extract had a highly significant effect (P<0.01) on the aroma of buffalo meat sausage. The lowest mean value obtained in this study was P0 (control) at 1.00 (no Andaliman taste at all), while the highest mean value was P3 at 2.49 (slight Andaliman aroma). The average aroma of buffalo meat sausage can be seen in the following table.

Table 9. Average aroma of buffalo meat sausage with the addition of Andaliman extract

Treatment	Replication					Mean ± SD
	1	2	3	4	5	
P0	1,00	1,00	1,00	1,00	1,00	$1,00^{A} \pm 0,00$
P1	1,70	1,73	1,77	1,77	1,73	$1,74^{B} \pm 0,03$
P2	2,23	2,43	2,37	2,37	2,40	$2,36^{C} \pm 0,08$
P3	2,37	2,43	2,50	2,57	2,57	$2,49^{D} \pm 0,09$

Note: Different superscripts in the same column indicate a highly significant difference (P<0.01).

Duncan's further test results showed that each treatment produced a highly significant difference (P<0.01) compared to the other treatments. This highly significant difference between the treatments is thought to be due to the increased aroma associated with the addition of Andaliman extract to the buffalo meat sausage.

3.6. Texture

Food texture is the result of the tactile response to physical stimuli when contact occurs between the oral cavity and food [8]. According to [9,10,11], food texture is one of the physical and sensory attributes consumers use to assess the quality of a food product. The average texture of buffalo sausage with added Andaliman extract can be seen in the table below.

Table 10. Average texture of buffalo sausage with added Andaliman extract

Treatment	Replication					Mean ± SD
	1	2	3	4	5	
P0	2,33	2,47	2,43	2,33	2,33	$2,38^{A} \pm 0,06$
P1	2,87	2,83	2,87	2,83	2,87	$2,85^{B} \pm 0,02$
P2	3,37	3,37	3,33	3,33	3,33	$3,35^{C} \pm 0,02$
P3	4,00	3,93	3,97	4,00	3,97	$3,97^{D} \pm 0,03$

Note: Different superscripts in the same column indicate a highly significant difference (P<0.01).

The results of the analysis of variance (ANOVA) showed that the addition of Andaliman extract had a highly significant effect (P<0.01) on the texture of buffalo meat sausage. The results of this study obtained a mean value ranging from 2.38 to 3.97. The lowest mean value was found in treatment P0 (control) with a value of 2.38 (not chewy), while the highest mean value was found in treatment P3 with a value of 3.97 (chewy).

The results of the DMRT further test showed that each treatment produced a highly significant difference (P<0.01) compared to the other treatments. This indicates that the Andaliman extract in treatment P1 was quite effective in affecting the protein (myofibrils) and water content of buffalo meat during the manufacturing process, resulting in a chewy texture that consumers prefer.

3.7. Flavor

One factor that determines food quality is the consumer's taste response [12]. Flavor is a chemical reaction between various ingredients, creating a new taste that is perceived by the tongue [13,14]. The average flavor of buffalo sausage with added Andaliman extract can be seen in Table 11 below.

Table 11. Average flavor of buffalo sausage with added Andaliman extract

Treatment	Replication					Mean ± SD
	1	2	3	4	5	
P0	1,00	1,00	1,00	1,00	1,00	$1,00^{A} \pm 0,00$
P1	2,23	2,27	2,23	2,23	2,27	$2,25^{B} \pm 0,02$
P2	2,93	3,03	2,83	2,83	2,77	$2,88^{C} \pm 0,10$
P3	3,03	3,27	3,17	3,10	3,10	$3,13^{D} \pm 0,09$

Note: Different superscripts in the same column indicate a highly significant difference (P<0.01).

Table 11 shows that the highest average score was found in treatment P3 with a score of 3.13 (sausages with a moderate Andaliman flavor), while the lowest average score was found in P0 (control) with a score of 1.00 (sausages without Andaliman flavor, with a distinct meaty flavor). The analysis of variance (ANOVA) results showed that the addition of Andaliman extract had a highly significant effect (P<0.01) on the flavor of buffalo meat sausages.

The results of the DMRT further test showed a highly significant difference (P<0.01) between each treatment. This highly significant difference occurred because the dosage of each treatment produced different responses (tastes) in consumer assessments.

4. Conclusion

4.1 conclusion

The addition of Andaliman extract at increasing concentrations improved the physical and organoleptic quality of buffalo meat sausages. The best treatment was P3 with an Andaliman extract concentration of 0.6%.

4.2 Recommendations

Further research is recommended to increase the concentration of Andaliman extract until it reaches the required optimal threshold. Furthermore, sausage quality parameters to be studied will not only focus on physical and organoleptic qualities, but also include chemical and microbiological testing of the sausages.

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