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The Effect of Soaking with Randu (*Ceiba pentandra*) Honey on Physical Quality of Beef

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Abstract *— This study aimed to determine the effect of randu honey marination on the physical quality of beef. The research was conducted from January 22 to March 2, 2024, at the Laboratory of Nutrition and Animal Product Technology, Department of Animal Husbandry, Faculty of Agroindustry, University of Mercu Buana Yogyakarta. The research materials used were 2 kg of beef - thigh muscle (Biceps femoris) and 250 ml of randu honey. This research used a completely randomized design with a unidirectional pattern consisting of 4 marination treatments using randu honey, namely P1 (5%); P2 (10%); P3 (15%); and P4 (20%), with 3 replications of each. The variables observed were meat pH, water holding capacity, meat mortality and meat tenderness. Data were analyzed using analysis of variance, if there were significant differences then further tests were carried out with Duncan Multiple Range Test (DMRT). The results showed that the mean pH of meat treated with marination using randu honey with a percentage of 5; 10; 15; and 20% were 4.9; 4.9; 4.6; and 4.1, respectively. The water holding capacity was 6.49; 14.87; 18.87; and 23.71%. The meat cooking shrinkage was 44.76; 43.68; 38.99; and 34.66%. The meat tenderness was 1.50; 1.60; 1.16; and 0.97 kg/cm^2. The results of variance analysis showed that the meat pH and the water holding capacity were not influenced by the treatment (P>0.05), while the cooking shrinkage and the meat tenderness were influenced by the treatment (P<0.05). Based on the results of the study, it can be concluded that meat marination treatment using randu honey (Ceiba pentandra) at a percentage of 15% produces the best physical quality of beef.*

Keywords *— Beef, Physical quality, Randu honey.*

I. Introduction

Meat plays a big role in human life in the context of national food security because meat is one of the commodities with sufficient nutrition to fulfill half of human nutrition (Lestari, 2019). Meat is a food with high nutritional value because it is rich in protein, fat, minerals and other substances that the body really needs. According to Rohmah et al. (2018) beef is a food commodity with high nutritional content, beef contains an average moisture content of 77.65%, an average fat content of 14.7%, and an average protein content of 18.26%, while meat that has been processed has less protein and water content and contains more fat and minerals. Unyu et al. (2017) stated that the quality of meat is also determined by tenderness, the proportion of meat as well as the level of fat distribution into the tissue, besides that the meat should not be a lot of fat and veins, fat and veins contained in the meat should be separated first.

Honey is one of the natural sweeteners commonly consumed by humans as a substitute for sugar. Honey is thick like syrup, but is thicker and sweeter. Honey is a natural sweetener produced from flower nectar as it's raw materials (Zuhairiah et al., 2019). Randu honey has greater antibacterial activity compared to other types of honey, such as rambutan honey and longan honey. Randu honey contains high level of flavonoids as one of the antibacterial compounds compared to other types of honey such as longan honey and rambutan honey, which is 12.92 mg/100 ml.

Meat normally has an acidic pH. The acidic pH in meat will facilitate the growth of microbes that can damage the quality of meat. Physical and chemical deterioration of meat quality can be known from several meat quality testing methods, including the pH test (Wibisono, 2018).

The water holding capacity test is a test to determine how much meat is able to bind free water. Meat with low water holding capacity will lose a lot of liquid, resulting in weight loss. The smaller the value of water holding capacity, the greater the cooking shrinkage of meat, so the lower the quality of meat because many components are degraded (Lapase et al., 2016).

Cooking shrinkage is the weight lost after boiling, the moisture content lost is an indicator of the nutritional value of meat associated with meat juice which is a component of meat. The cooking shrinkage value is strongly influenced by the pH value of the meat, if the pH value is higher or lower than the isoelectric point (5.0 - 5.1), the cooking shrinkage value of the meat will be low.

Meat tenderness is influenced by several factors, namely antemortem factors including genetics, management, species, livestock physiology, and age. Postmortem factors include withering, freezing, processing methods, and the addition of tenderizing agents (Lapase et al., 2016).

The purpose of this study was to determine whether there is an effect of randu honey marination on the physical quality of beef as seen from the meat pH test, water holding capacity, meat cooking shrinkage test and meat tenderness.

II. Reseacrh Materials and Methods

Research Time and Place

The research was carried out from January 22 to March 2, 2024. This research was conducted at the Laboratory of Nutrition and Animal Product Technology, Department of Animal Husbandry, Faculty of Agroindustry, University of Mercu Buana Yogyakarta.

Research Tools and Materials

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The tools used include clear plastic, measuring glass, spuid, tissue, knife, cutting board, aluminum foil, label paper, oven, scalpel, tray, tweezers, Erlenmeyer, goblet glass, pH meter, beaker glass, electrode glass, desiccator, millimeter block paper, digital scale, analytical scale, OHAUS scale, filter paper, two glass plates, 35 kg weight tool, waterbath, ballpoint pen, notebook, clear mica, glass scale.

The materials used in the following study were 2 kg of beef thigh muscle (Biceps femoris), 3 liters of distilled water and 250 ml of randu honey.

Research Method

This research used completely randomized design (CRD) unidirectional pattern, with 4 treatments and 3 replicates. The treatment given was beef marinated with randu honey for 24 hours. The treatments were P1 (Meat marination using 5% of randu honey); P2 (Meat marination using 10% of randu honey); P3 (Meat marination using 15% of randu honey); P4 (Meat marination using 20% of randu honey).

The research procedure began with several preparations, namely (1) honey preparation; (2) sample preparation; and (3) beef marination.

The variables observed in this study were (1) meat pH; (2) water holding capacity (%); (3) meat cooking shrinkage (%); and (4) meat tenderness (kg/cm^2). The research data were analyzed using analysis of variance (ANOVA) at the $\alpha = 5\%$ level, if there were significantly different results between treatments then further testing with DMRT at the $\alpha = 5\%$ level.

III. Results and Discussion

The physical qualities of beef are meat color, taste and aroma, fatness, and meat texture. Before slaughter, the factors that determine the quality of meat are the type of cattle, sex, age, and the raising livestock methods including feeding and health care. Currently, the quality of meat after slaughter is affected by preparation methods, meat pH, hormones and storage conditions (Trantono, 2008 in Gunawan, 2013). The physical properties of meat that are commonly assessed to see the quality of good or damaged meat are pH, tenderness, cooking shrinkage, water holding capacity (WHC) (Diana et al., 2018). Based on the results of research with observation variables treated with beef marination using randu honey with a percentage of 5%, 10%, 15%, and 20%, were as follows:

pH of the Meat

The pH value is an important indicator in assessing meat quality. The pH value is closely related to the presence of microorganisms in the meat, thus determining the survival and quality (Hajravati et al., 2016). Acidity level (pH) is an indicator to determine the degree of acidity or basicity of fresh meat or products produced (Merthayasa et al., 2015). The following is the meat pH data presented in Table 1.

TABLE 1. Average pH of beef at different percentages of randu honey marination.

Replicate	Marination treatment using randu honey			
	5%	10%	15%	20%
1	5.1	4.7	5.7	4.0
2	4.8	4.8	4.0	3.6
3	4.8	5.1	4.2	4.6
Means^{ns}	4.9	4.9	4.6	4.1

ns = non significant

The results of variance analysis of meat pH showed that the percentage of beef marination using randu honey had no effect ($P>0.05$) on meat pH. This is thought to be because randu honey has an acidic character, resulting in a reaction between the acid in randu honey used as a marinade ingredient in beef. According to Mundo et al. (2004) honey has a low pH, phytochemical compounds and hydrogen peroxide as well as phenol compounds that function as antibacterials. According to Soeparno (2015) in general, a decrease in pH will affect the quality of the product. The lower the pH of a product will generally increase the shelf life of the product because bacteria will find it difficult to live at low pH except for bacteria which are resistant to low pH (Achidophilic).

Based on the results of research by Atmaka et al. (2011), ground beef with the addition of randu honey has a lower pH (more acidic) (pH 5.1-5.8) than ground beef without the addition of honey (pH 6.2). This is because honey has a low pH (pH 3.2-4.5), that range of acidity values is low enough to serve as a bacterial inhibitor (Molan, 1992 in Atmaka et al., 2011).

The average pH of beef treated with marination using randu honey ranged from pH 4.1 - 4.9 (Table 1). According to Rahayu (2009), live cattles have a muscle pH of around 7.0-7.2. The pH of the meat gradually decreases to around 5.6-5.7 within 6-8 hours after slaughter and reaches a final pH of around 5.3-5.7. In accordance with Soeparno (2015) the range of pH values for normal meat that has undergone the postmortem process is 5.4-5.6. The results obtained in this study show that the pH value of meat is below the normal range, even in acidic conditions.

According to Hariyati's (2010) statement, randu honey is known to have a pH value of 3.56; a_w value of 0.67 and total phenol value of 0.244. According to Suranto (2011) in Putri (2021), the low pH value of honey is caused by several organic acids contained in honey. The main acids found in honey include acetic, butyric, formic, gluconic, lactic, maleic, oxalic, pyroglutamic, citric, succinic, glycolic, α-ketoglutarate, pyruvate, 2,3-phosphoglycerate, α,β-glycerophosphate and glucose-6-phosphate. Gluconic acid is the main acid in honey, produced by dectrose through an enzyme found in honey (glucose oxidase).

Water Holding Capacity

Water Holding Capacity is the ability of meat to bind water or water added during the influence of external forces (Soeparno, 2015). Water holding capacity (WHC) is the ability of meat to bind water released by external forces such as cutting, heating, rolling and pressure of the meat (Semi, 2020). The following is the water holding capacity data presented in Table 2.

TABLE 2. Average water binding capacity of beef at different percentage of randu honey marination (%).

Replicate	Marination treatment using randu honey			
	5%	10%	15%	20%
1	3.78	7.10	13.53	37.49
2	3.90	25.91	14.48	20.49
3	11.78	11.61	28.6	13.15
Means^{ns}	6.49	14.87	18.87	23.71

ns = non significant

The variance analysis results of water holding capacity showed that the percentage of beef marination using randu

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honey had no effect (P>0.05) on water holding capacity. This is probably because randu honey does not have chemical components that are effective enough to increase water holding capacity, although the sugar content in randu honey may help retain water, however the composition in randu honey is not strong enough to bind water.

According to Nurwantoro and Mulyani (2003), the lower the water holding capacity of the meat, the lower the quality of the meat. This is because the amount of liquid from the meat that escapes causes a decrease in meat weight, reduced palatability and nutritional value. Several intrinsic and extrinsic factors are known to influence the development of water holding capacity of meat and the water content of the final product. Among the intrinsic factors, genotype and animal feeding are the most important ones, which affect muscle characteristics directly. Some extrinsic factors such as pre-slaughter handling including fasting, epinephrine injection are also reported to affect the water holding capacity of meat. Such treatments are likely to affect water holding capacity through stress, which decreases muscle glycogen reserves, a process that can lead to high pH and low moisture content of meat (Cheng and Sun, 2008).

The average results of water holding capacity of beef treated with meat marination using randu honey ranged from 6.49% - 23.71% (Table 2). Soeparno (2015) stated that the normal range of water retention capacity is between 20% and 60%. The results obtained in this study show that the water holding capacity is below the normal range, this indicates that if the pH value is low, it will affect the water holding capacity to be low. According to Rianto (2004), increasing the pH value of meat increases its water holding capacity. This is due to the low pH of the food, the structure of the meat opens up so that the water holding capacity is low and the high pH of the meat closes the structure of the meat so that the water holding capacity is high.

Meat Cooking Shrinkage

Cooking shrinkage is an indicator of the nutritional value of meat related to meat juice content, which is the amount of water bound in and between muscle fibers. Meat juice is a meat component that determines the meat's tenderness (Soeparno, 2015). The following is the meat cooking shrinkage data presented in Table 3.

TABLE 3. Average cooking shrinkage of beef at different percentage of randu honey marination (%).

Replicate	Marination treatment using randu honey			
	5%	10%	15%	20%
1	46.04	45.51	41.17	30.59
2	44.33	41.57	39.74	37.11
3	43.90	43.95	36.06	36.29
Means	44.76^{b}	43.68^{b}	38.99^{a}	34.66^{a}

Means with different superscripts in the same row indicate significant differences (P<0.05).

The result of variance analysis of meat cooking shrinkage showed that the percentage of beef marination using randu honey had a significant effect (P<0.05) on meat cooking shrinkage. The average cooking shrinkage of beef with randu honey soaking at a percentage of 5%, 10%, 15% and 20% were 44.76%; 43.68%; 38.99%; and 34.66%, respectively. The results showed an increase in the value of meat cooking shrinkage at a percentage of 20%, 15%, 10% and 5%. According to Sutinu et al. (2015), a decrease in pH value due to the addition of protease enzymes to meat can cause denaturation of meat proteins so that the binding power of water by proteins is lower, thus if the value of water binding power is low, it will increase the cooking shrinkage value of meat.

Based on the results of the DMRT further test on the marination treatment with a percentage of 5%, the results of meat cooking shrinkage were not significantly different from the percentage of 10%, but significantly different from the percentage of 15% and 20%. This shows that the higher percentage of randu honey will help reduce the cooking shrinkage value of beef, because honey can maintain the protein content of the meat during the cooking process so that the moisture in the meat can be maintained.

According to Prayoga et al. (2021) the protein content in meat plays an important role in water holding capacity which can affect meat cooking shrinkage. The protein contained in the meat can bind water, thus helping to reduce the cooking shrinkage of the meat and maintain the moisture of the meat during cooking. This is in accordance with Kartikasari et al. (2018) cooking shrinkage is influenced by the water content in the meat during the cooking process, one of the factors is the protein content that can bind water, so the more protein content in the meat, the less cooking shrinkage in the meat.

The average cooking shrinkage of beef treated with marination using randu honey ranged from 34.66% - 44.76% (Table 3). According to Soeparno (2015), the cooking shrinkage value of beef generally varies between 1.5%-54.5% with a range of 15%-40%. The results obtained in this study show that the cooking shrinkage of meat is in the normal range. Based on the data of this study, it shows that beef marinated using randu honey has good quality, because the cooking shrinkage value is still in the range of good quality cooking shrinkage value.

According to Soeparno (2015), low cooking shrinkage value resulting in good meat quality. This was confirmed by Yanti et al. (2008), that meat which has low cooking shrinkage value below 35% has good quality because the possibility of the release of meat nutrients during cooking is also low.

Meat Tenderness

Meat tenderness is determined by three components of meat, namely myofibrillar structure and its contraction status, connective tissue content and the degree of cross-linking, and water binding capacity by meat proteins and marbling (Aberle et al., 2001). Meat tenderness is the characteristic that most influences the acceptance of meat by consumers, which is the ease of chewing without losing proper tissue properties (Sundari, 2016). The following is the meat tenderness data presented in Table 4.

TABLE 4. Average beef tenderness at different percentage of randu honey marination (kg/cm^2).

Replicate	Marination treatment using randu honey			
	5%	10%	15%	20%
1	1,5	1,3	1,2	1,2
2	1,4	1,7	1,4	0,8
3	1,6	1,8	0,9	0,9
Means	1,50^{bc}	1,60^{c}	1,16^{ab}	0,97^{a}

Means with different superscripts in the same row indicate significant differences (P<0.05).

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The results of the analysis of variance in meat tenderness showed that the percentage of beef marination using randu honey had a significant effect (P<0.05) on meat tenderness. The average beef tenderness with randu honey marination at 5%, 10%, 15% and 20% were 1.50 kg/cm2; 1.60 kg/cm2; 1.16 kg/cm2; and 0.97 kg/cm2, respectively. The results showed a decrease in the hardness of the meat tenderness index value at 10%, 5%, 15% and 20% soaking. Soeparno (2015) stated that the greater or stronger the load given, the lower the meat tenderness value (tough). Conversely, the smaller the load given, the higher the meat tenderness value (tender).

Based on the results of the DMRT further test on the marination treatment with a percentage of 10% showed the results of the level of meat tenderness that was not significantly different from the percentage of 5%, but significantly different from the percentage of 15% and 20%. In the treatment of marination using randu honey, the percentage of 5% is not significantly different from the percentage of 10% and 15%, but significantly different from the percentage of 20%. While in the marination treatment using randu honey with percentage of 15% was not significantly different from the percentage of 5% and 20%, but was significantly different from the percentage of 10%. In the treatment of meat marination using randu honey with percentage of 10% required a higher load (1.6 kg/cm^2) and produced a lower meat tenderness value when compared to meat marination treatment with a percentage of 5% (1.5 kg/cm^2), 15% (1.2 kg/cm2), but in the treatment of meat marination with a percentage of 20% (1.0 kg/cm^2) was able to produce better tenderness when compared to other treatments. It is suspected that the 20% percentage treatment has the ability to break down the proteins contained in the meat muscle fibers. Proteolytic enzymes work by breaking down complex proteins into smaller fragments, thus overhauling the protein structure in meat.

According to Zulfahmi et al. (2014) proteolytic enzymes are protease enzymes which are able to degrade proteins or break down peptide bonds into simpler protein molecules (amino acids) to produce tender meat. The results of protein degradation will form a bond that links two amino acid molecules called a peptide bond and the compound is called a dipeptide. Dipeptides have -COOH and -NH2 groups, then form oligopeptides including carnosine, balenine, and anserine which have the ability to inhibit meat oxidative reactions. According to Dewi (2012), the increase in tenderness (decrease in "shear force" value) after frozen meat storage is thought to be related to proteolytic enzyme activity, which will break down meat myofibril proteins. Wheeler and Koohmarie (1994) in Dewi (2012) stated that proteolytic enzymes from myofibril proteins are major contributors to meat tenderization during postmortem storage and frozen storage for 2 months.

The average result of beef tenderness treated with meat marination using randu honey ranged from 0.97 kg/cm^2 - 1.60 kg/cm^2 (Table 4). According to Soeparno's (2015) statement, if meat with a tenderness value range of more than 5 then the meat can be said to be tough. The results obtained in this study show that the meat tenderness value is in a more tender texture and not tough. This is because randu honey contains proteolytic enzymes that can break down proteins in beef muscle fibers, thus making the beef more tender. In addition, randu honey contains natural chemicals that can stimulate the process of breaking down proteins in meat, and this process can help relax the muscle fibers, making the meat more tender and easy to chew.

According to Suranto (2011) in Putri (2021) in general, honey contains superoxide enzymes, amylase, glucose oxidase, catalase, invertase, diastase, perioxidase, phosphatase and proteolytic enzymes. All these enzymes are derived from nectar, pollen and salivary gland secretions in bees.

IV. Conclusions and Suggestions

Conclusions

Based on the results of this study, it can be concluded that meat marination treatment using randu honey at a percentage of 15% produces the best physical quality of beef.

Suggestion

People could soak beef using randu honey at the percentage of 15 % as an alternative preservative agent in order to preserve beef and maintain the physical quality of beef.

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