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Quality of Slaughtered Pork on Stunning with Captive Bolt and Without Stunning Review of Water Holding Capacity, Wetted Area and Cooking Loss

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Abstract. Pigs are livestock that have great potential in the economic field, judging from the level of pork consumption in Bali, which is in great demand and has always been a superior commodity among the public. The purpose of this study was to determine the quality of pork slaughtered at the grounding using a captive bolt and non-stunning which was reviewed from the parameters of water holding capacity, wetted area and cooking loss. This study used 40 samples of pork on the hamstrings (musculus biceps femoris), weighing 50 gr/head taken from two different slaughterhouses in the Darmasaba area. The results showed that the value of water holding capacity and wet area of meat without stunning and with captive bolt stunning showed no difference, while the cooking loss of meat without stunning and with stunning had differences. Further research needs to be done on the right method that can reduce the movement of animals when slaughtered to make it easier for butchers.
Keywords: Pig, Slaughter method, Pork quality.

I. INTRODUCTION

Pigs are livestock that have great potential in the economic field, judging from the level of consumption of pork in Bali, it is considered to be in great demand and has always been a leading commodity among the community, besides the need for pork which is used as a means of ceremonies in Bali is also high every year. The advantages of pigs compared to other livestock, including being easy to breed, easy to find sources of feed, efficient in changing feed ingredients if supported by good quality rations, fast growth rate, have a fairly high percentage of carcass and, prolific nature shown by the ability to have many children. in each birth which ranges from 8-14 birds in a year can give birth twice [1].

Meat is one of the foodstuffs that have nutritional value in the form of protein containing a complete composition of amino acids. Meat has a chemical composition consisting of 75% water, 18.5% protein and 3% [2]. The definition of meat is all animal tissues and all products resulting from the processing of these tissues that are suitable for eating and do not cause health problems for those who consume them [3]. The criteria for quality meat are determined by taste, aroma, tenderness or tenderness, fat content (marbling), color, and humidity [4].

Meat quality can be influenced by intrinsic and extrinsic factors. Intrinsic factors that can affect meat quality include age, genetics, species, nation, type of livestock, type of livestock, and animal feed. Extrinsic factors include cooking method, withering method, electrical stimulation, carcass and meat pH, additives including meat tenderizing enzymes, antibiotics, fat intramuscular or marbling, hormones, storage and preservation methods, types of meat muscle and location in a meat muscle [3].

Appropriate slaughter method plays an important role in determining meat quality and can affect post mortem muscle metabolism [5][6]. The slaughter method is divided into two, namely without stunning (non-stunning) and use stunning (stunning). Stunning is a treatment that aims to stun the animal before slaughter [7]. Stunning This can be done by three methods, namely the electrical, mechanical and gas methods. Electrical stunning carried out by means of a clamp that is electrified at the head or body of an animal, mechanically carried out using captive bolt stun gun where stunning with gas was carried out using gas exposure at 80-90% levels for 3 minutes [8][9].

Mechanical stunning using tools captive bolt has been widely used to cause immediate loss of consciousness in livestock and has changed little in the basic design since it was first launched. The basic principle is the same and involves the transfer of kinetic energy from the object to the brain, resulting in nerve dysfunction or destruction, and subsequent insensitivity provided the bolt captive bolt pierce the animal's skull in the correct place [10].

Efficient handling of livestock using the recommended techniques and facilities can reduce pain in animals will reduce stress on livestock and maintain quality in meat and by-products [11]. Meat quality parameters such as temperature, water holding capacity and cooking loss have an interrelated relationship. The increase in temperature will affect the decrease in the pH of the meat and cause denaturation of the meat protein.

Enzymatic denaturation of proteins cathepsin enzyme) and the decrease in water holding capacity due to protein denaturation will cause a change in consistency. Meanwhile, water holding capacity and cooking loss have an inverse relationship [12].

So far, there has been no research report on the comparison of pork quality in stupor with captive bolt and without stunning in terms of temperature, water holding capacity and cooking loss. Therefore, this research is important to do to see the quality of pork in stunning with captive bolt and without stunning in order to get an overview of meat quality to complete the data and become the basis for further research on good and appropriate stunning methods.

II. MATERIALS AND METHODS

Object of research

The object of this research is using landrace pigs. The pigs used have an average weight of 80-100 kg with an age of 6-8 months. The samples taken were 40 samples of meat, each of which was divided into two groups consisting of 20 samples of meat without stunning and 20 samples of meat with stunning captive bolt.

Research variable

The variables in this study can be divided into independent variables, dependent variables and control variables. The independent variable is the stunning technique (captive bolt and without stunning), the dependent variable is the quality of pork in terms of water holding capacity, wet area and cooking loss, and the control variable is age, breed of Landrace pig, body weight.

Research procedure

Determination of Water Holding Capacity and Measurement of Wet Area

Measurement of water holding capacity by weighing 5 grams of meat, then placing it between two Whatman No. filter paper. 1 on a ceramic slab. Mark the meat samples according to the group, then place another ceramic plate on the top. The next step is to take a weight of 35 kg and place it on the ceramic slab. Then wait about 10 minutes. After 10 minutes, remove the weight and re-weigh the meat to determine the change in weight [12]. remove the weight and measure the area of wet meat using a ruler. Here is how to calculate the area of the wet area with the formula as below:

Water Holding Capacity (%) = (Final weight of meat) / (Initial weight of meat) x 100 %.

Cooking Loss Determination

Cooking loss was measured by weighing 10 grams of meat, then each sample of meat was put into a plastic clip measuring

5 × 8 cm which had been labeled with the name according to the type of treatment, then repacked it tightly using polyethylene plastic so that during the boiling process, water can't fit into the plastic bag. The meat sample is boiled inside water bath at 80°C for one hour. After the boiling process is complete, the meat samples are removed from the water bath and cooled for 15 minutes using a beaker that has been given water. Next, the sample was removed from the beaker and dried using a tissue, then re-weighed to determine the change in weight. The weighing process is carried out 3 times, and the final results obtained will be averaged. Here's how to calculate cooking loss:

Cooking loss (%) = (initial weight of meat-final weight of meat) / (initial weight of meat) x 100 %

Wet Area = Outer Area - Inner Area

Data analysis

The results of the data were first tested for normality with the Saphiro-Wilk test and then further tested with parametric and non-parametric tests according to the normal distribution. The results of the next analysis are presented in the form of tables/figures.

III. RESULTS AND DISCUSSION

Water Holding Test

Water binding capacity by meat protein or called Water Holding Capacity (WHC) is defined as the ability of meat to bind to its water or added water, for example meat cutting, heating, grinding, and pressure. Meat also has the ability to absorb water spontaneously from a liquid-containing environment (water absorption). Based on the results of statistical analysis showed that the variables of water holding capacity and the area of wet meat without stunning and stunning with captive bolt not significantly different (P>0.05) which means that the meat without stunning and stunning with captive bolt does not affect the research variables. The following are the results of the water holding capacity test on pork slaughtered without stunning and using the stunning technique captive bolt presented in Table 1 below.

Table 1. The results of the water holding capacity of pork with captive bolt stunning and without stunning.

Variable	Non stunning	Stunning with *captive bolt*	p- Value
	Mean ± SD	**Mean ± SD**	
Water holding capacity	71.47 ± 3.21	69.31 ± 3.76	0.058

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Descriptively, the mean water-holding capacity of meat slaughtered without stunning shows the value (71.47 ± 3.21) with 95% conf. interval is in the range of 69.96-72.97, while the mean water holding capacity of meat slaughtered by stunning captive bolt shows the value (69.31 ± 3.76) with 95% conf. the interval is in the range of 67.55-71.07.

Wetted Area Test

The wetted area is the area of water absorbed by the filter paper due to compression and is obtained from the difference in the area of the outer and inner circles on the filter paper. Free water is considered as part of the total water content released by pressing against the meat under controlled conditions. The results of measuring the wet area of pork that was slaughtered without stunning and using the stunning technique captive bolt can be seen in Figure 1.

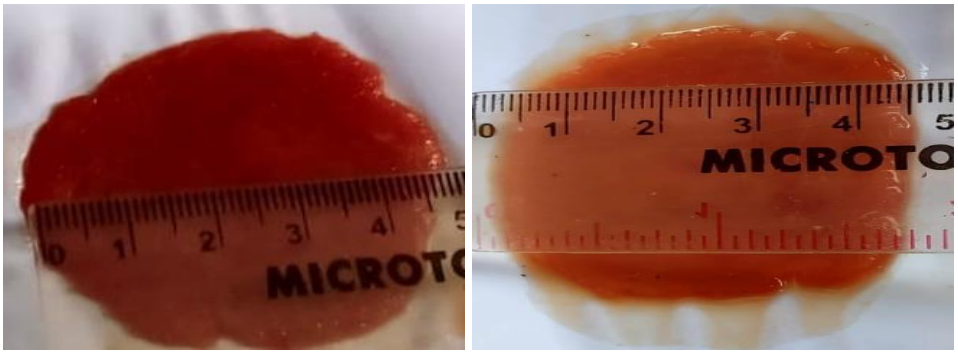

Figure 1. Wet area of pork without stunning (left); Wet area of pork with stunning (right).

Descriptively the average score of the area of the meat grinder that was slaughtered without stunning (5.18 ± 0.51) with 95% conf. the interval is in the range of 4.5-6.5; Average wet area score on meat slaughtered by stunning captive bolt shows the value (5.5 ± 0.94) with 95% conf. the interval is in the range of 4.5-8.5. The following are the results of the wet area test on pork slaughtered without stunning and using the stunning technique captive bolt presented in Table 2 below.

Table 2. The results of the wet area test of pork with captive bolt stunning and without stunning.

Variable	Non stunning	Stunning with *captive bolt*	p- Value
	Mean ± SD	Mean ± SD	

wetted area	5.18 ± 0.51	5.5 ± 0.94	0.307

Based on the test results in Table 2 shows that statistically the treatment group with the stunning technique captive bolt and the treatment group without stunning was not significantly different (P>0.05) with respect to the wet area, which means that the difference in stunning technique in pigs did not significantly affect the wet area value for pork.

Cooking Loss Test

Cooking loss (cooking loss) namely the weight of the meat sample lost during cooking or heating, fluid retention, and the pH of the meat also determine the quality of the meat. Cooking loss is an indicator of the nutritional value of meat related to the water content of the meat, i.e. the amount of water bound in and between muscles. High water holding capacity (WHC) will result in low cooking loss values [3]. The following is the result of shrinkage cook on pork butchered without stunning and using stunning technique captive bolt presented in Table 3 below.

Table 3. Results of the wet area test of pork with captive bolt stunning and without stunning.

Variabel	**Non stunning**	**Stunning with *captive bolt***	**p- Value**
	Mean ± SD	**Mean ± SD**	
Cooking loss	37.38 ± 3.82	40.7 ± 3.13	0.004*

Note: *significantly different (P<0.05)

Descriptively the mean cooking loss score of meat slaughtered without stunning (37.38 ± 3.82) with 95% conf. the interval is in the range of 35.59-39-17 while the cooking loss in meat slaughtered by stunning captive bolt shows the value (40.7 ± 3.13) with 95% conf. the interval is in the range of 39.23-42.16. Based on the test results in Table 2, it shows that statistically the pork is stunned by the stunning technique captive bolt and meat without stunning was significantly different (P<0.05), which means that the difference in stunning technique in pigs had a significant effect on the cooking loss value of pork.

In this study the results of the cooking loss test of meat slaughtered by stunning captive bolt showed a higher value compared to the cooking loss of meat slaughtered without stunning, which means that the difference in stunning technique in pigs has a significant effect on the cooking loss value of pork. This happens because of the value of the

water holding capacity of the flesh with stunning captive bolt low, the area of wet meat is high so that the cooking loss value of the meat is high. If the water holding capacity is high, the cooking loss will be low. On the other hand, if the water holding capacity is low, the cooking loss will be high, the increase in water holding capacity during withering is caused by a change in the relationship between protein and water, namely an increase in charge through the absorption of K+ ions and the release of Ca++, or due to weakening of myofibril bonds (actin and myosin) [3].

Improper stunning process can also cause excessive movement or thrashing movements in animals which can affect glycogen reserves in muscles and animals will experience stress. Stunning can cause stress if done incorrectly, such as due to operator (stunner) who are poorly trained, use of inappropriate tools or tools stunning which doesn't work well [2]. The slaughter method plays an important role in determining the quality of meat and can affect post mortem muscle metabolism [5][6].

It is very important for livestock to be free from stress, starting from the capture process to slaughtering, so that there is no loss of glycogen in livestock muscles which can reduce the quality of the meat produced. If the animal is stressed, the glycogen reserves will be drastically reduced, the lactic acid formed will have little meat quality such as the texture, consistency and color of the meat will be pale with a bad aroma [11].

When animals are stressed, the pH will drop drastically, there is a surplus of negative charge which results in the rejection of the myofilaments and gives more space for water molecules, lactic acid increases so that the water holding capacity of the meat tissue is not able to hold water properly and causes a lot of water to come out. so that the cooking loss value of the meat becomes high. Other factors that influence the value of cooking loss are the water-holding capacity of the meat tissue itself and the fat content in the muscle or surface of the meat, as well as the translocation of the meat fat [3]. Muscles that have high intramuscular fat have a highwater holding capacity so that when cooked, the cooking loss is small. Meat with a lower cooking loss has a relatively better quality than meat with a higher cooking loss, because the loss of nutrients during cooking will be less. Cooking loss is related and inversely proportional to water holding capacity, a high cooking loss value followed by low water holding capacity indicates that meat cooking loss is influenced by water holding capacity and moisture content. The higher the water

holding capacity, the lower the water content of the meat. This was followed by a decrease in the percentage of cooking loss of meat. A high cooking loss value followed by a low water holding capacity indicates that meat cooking loss is influenced by water holding capacity and moisture content. The higher the water holding capacity, the lower the water content of the meat. This was followed by a decrease in the percentage of cooking loss of meat. A high cooking loss value followed by a low water holding capacity indicates that meat cooking loss is influenced by water holding capacity and moisture content. The higher the water holding capacity, the lower the water content of the meat. This was followed by a decrease in the percentage of cooking loss of meat.

IV. CONCLUSION

The results showed that the value of water holding capacity and wet area of meat without stunning and with captive bolt stunning showed no difference, while the cooking loss of meat without stunning and with stunning had differences.

V. SUGGESTION

The results of this study the authors suggest that there is a need for training or improvement of the stunning method captive bolt in order to reduce the movement of the animal. Further research needs to be done on the right method that can reduce the movement of animals when slaughtered to make it easier for butchers.

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