EFFECT OF CARCASS AGING LENGTH ON PHYSICAL AND MICROBIOLOGICAL QUALITY OF BALINESE PORK

N.L.P. Sriyani*, N.L.G. Sumardani and I.G. Suarta

Faculty of Animal Husbandry, Udayana University, Denpasar, Indonesia.

Abstract

The purpose of this study was to look at the effect of aging carcasses at different times on the physical and microbiological quality of Balinese pork. This study used a *completely randomized design* with four treatments and six replications namely P0 = fresh carcass without wilt, P1 = carcass aging for one day, P2 = carcass aging for two days, P3 = carcass aging for three days. Meat samples taken for physical and microbiological quality testing of meat are in the *longissimus dorsi* muscle. The variables observed were the pH value of meat, cooking loss, water holding capacity and drip loss, TPC content, coliform and *E-Colli*. The results showed the highest meat pH value on the third day aging (P3) was 5.7 statistically significantly different (P <0.05) compared to treatments P0, P1, P2, but the pH value of the four treatments was still within the threshold. The pH of the meat ultimate is 5.4-5.8. The lowest cooking loss value in the second day aging treatment (P2) was statistically significantly different (P <0.05) compared to P0, P1, P3. The lowest drip loss value on the second day aging (P2) is significantly different from P0 but not significantly different from P1 and P3. The water holding capacity of meat water in the second day aging treatment (P2) was statistically significantly different (P <0.5) with P0, P1, P3. Total microbial/TPC of 3.22×10^7 cfu/g was statistically significantly (P <0.05) higher than the control (fresh meat without aging) of 1.76×10^7 cfu/g. The number of coliform bacteria in bali pork aging for three days was 7.25×10^5 statistically significantly higher (P <0.05) than the control of 8.68×10^4. While the population of Escherichia coli bacteria in both samples was good there was a control nor aging for three negative days. The conclusion of this study shows aging of the carcasses of Balinese pork for three days still produces a good or normal physical quality of meat. The best physical quality of meat produced from this study is the physical quality of meat aging for two days (P2). The TPC and *Coliform* content of pork which was aging for three days experienced a significant increase in population (P <0.05). The content of TPC and Coliform bacteria both in fresh (control) meat and aging meat for three days is above the SNI threshold (SNI 7388, 2009). While the content of *Escherichia coli* bacteria in Balinesepork either fresh (control) or aging for three days was negative.

Key words: Bali pork, meat quality, aging.

Introduction

Bali Island in general most people consume pork. This can be understood because most of the people are Hindus who do not forbid pork for consumption. Porks circulating in traditional markets generally come from pork from cross-breed landrace pigs. Very little is found, even almost no pork is found from bali (local) pork breeds. But people on the Bali island, in general, prefer meat from bali pork, especially for rolled pork products because it is considered to have a more savory taste than other pork (Suandana, 2016). Bali pig features a rather coarse black feather color, there is also a white striped abdomen, curved back and erect ears. Bali pigs have higher fatty meat compared to landrace pigs because genetically the

Balinese pigs are included in the lard type. Bali pigs are usually raised with makeshift food in the form of banana stems, rice bran as the main feed and kitchen waste as additional feed (Budarsa, 2016).

Suandana, (2016), stated the texture of Bali pork is tougher than landrace pork or Bali pork has a lower tendency than landrace pork. Therefore, business efforts need to be made to improve the tenderness quality, one of which is to apply meat aging techniques after cutting. Aging is the handling of fresh meat after slaughter by hanging or storing for a certain time at low temperatures (0-5°C) and high temperatures 20-43°C (Soeparno, 2009). During aging, enzyme activity occurs that can decompose the connective tissue of the meat. Aging can increase meat tenderness and increase the meat flavor to be

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*Author for correspondence : E-mail: sriyaninlp@unud.ac.id

stronger. To improve the physical quality of bali pork, it is also necessary to test the content of pathogenic bacteria in pork that has been aging to determine aspects of food safety to be fit for consumption by consumers. Referring to the aforementioned problems, this study was conducted to look at the effect of length of aging on the carcass on the physical quality and content of pathogenic bacteria in Bali pork.

Materials and Methods

Research Materials

The research material uses Balinese pigs aged ± 3 months body weight ± 25 kg where the weight of pigs in this range is very often used as a rolled pork product. Pigs used are pigs that are kept in an extensive system or offered with an adequate feed by breeders. These pigs are then slaughtered at traditional slaughterhouses. After slaughtering the Bali pig carcass is carried out with a low-temperature aging process by hanging on the feet (*thendo archiles*) in the aging room with a temperature of 0°C. Meat samples taken for physical and microbiological quality tests are on the muscle part of *Longisimus dorsi* (LD).

Research Design

The design used in this study was a *Complete Randomized Design* with four treatment periods with each treatment consisting of six carcass replications. The duration of aging that will be tried in this study is the control carcass (fresh)/not aging, carcass with one day aging, carcass with aging two days and carcass with aging three days, namely:

Treatment 1 (*control*) : Fresh carcass

Treatment 2 : Carcass aging for 1 day

Treatment 3 : Carcasses aging for 2 days

Treatment 4 : Carcasses aging for 3 days

Variables

• Meat pH:

The degree of acidity or pH of fresh meat is determined using a pH meter. Samples weighed 25 g were crushed and diluted with 25 ml *aquadest*. Then the pH is measured after calibration with a buffer solution for standard 7. The electrodes are washed and dried then put into the extract, after that the switch is turned on and the number shown is the pH of the meat extract.

• Cooking loss:

Before cooking the meat sample is weighed as much as 50 g, as initial weight, then boiled in boiling water. Then the cooked meats are placed and left open on flat plates of frosted paper in the room so that the meat can

evaporate freely and partly is absorbed by the base. While the meats have evaporated and the temperature decreases, weighing is done several times until the weight is relatively constant so the final weight of the meat can be determined. Weight loss percentage for meat is calculated as follows:

$$\% \text{ cooking loss} = (\text{initial meat weight - final meat weight}) \times 100$$

• Water Holding Capacity (WHC):

Measurement of water holding capacity is carried out using the Clement 2000 centrifuge. 1.5-2.5 meat are crushed, then weighed, as initial weight. Furthermore, the meat is wrapped in *Whatman* 41 filter paper, the meat wrap is then put into a centrifugation device and high speed rotating is carried out at 36,000 rpm for 60 minutes. Percentage (WHC) is calculated using the formula:

$$\text{WHC } (\%) = \frac{\text{Weight of meat residue}}{\text{Sample weight}} \times 100$$

• Drip loss of Meat:

Driploss is determined by weighing meat samples with a thickness of 2.0 cm without fat and connective tissue as initial weight. Furthermore, the meat is tied to a rope and hung tightly wrapped. Meat should not touch plastic bags. Hang meat at room temperature for 24 hours as the final weight. Before weighing, the meat is wiped dry and then weighed. *Driploss* value is calculated as weight loss according to the formula:

$$\% \text{ drip loss} = \frac{\text{Initial meat weight - Final weight}}{\text{Final weight}} \times 100$$

• Total plate count (TPC):

TPC is a technique to count the total number of microbes present in meat using PCA (*Plate Count Agar*) media for *total plate count* analysis in the following way, namely, as much as 10 grams of meat is put into an *Erlenmeyer* tube that contains 0.1% peptone water solution sterile as much as 90 ml, so that a 10-1 dilution is obtained. This 10-1 dilution is homogeneous and diluted again by taking 1 ml with a pipette then put into a test tube containing 9 ml of telephone solution to obtain a 10-2 dilution and so on so that a 10-6 dilution is obtained. Then the planting is done by the pouring method (Jenie and Fardiaz, 1989). This planting is carried out in a sterile room and adjacent to the bunsen fire, it aims to avoid contamination from the outside environment, by taking dilution levels of 10-5, 10-6 and 10-7 with pipettes each poured with PCA media (temperature ± 45°C) into 20 ml *Petri dishes* and closed again. Furthermore, it is homogeneous by carefully moving the petri dish, leaving it until the media solidifies. Planting is made in duplicate into an incubator at 37°C in reverse conditions and yields can be calculated 24-48 hours.

• Testing for Coliform and Escherichia coli bacteria:

The method used to obtain the total bacteria *Escherichia coli* and *Coliform* is the scatter method (Fardiaz, 1992) using EMBA media which is as much as 5 grams of meat put into the *Erlenmeyer* tube containing 0.1% *peptone water* solution with a volume of 45 ml so that it is obtained 10^{-1} dilution. This 10^{-1} dilution is then homogenized and diluted again by taking 1 ml through a pipette and then put into a test tube containing 9 ml of peptone solution so that a 10^{-2} and 10^{-3} dilution is obtained. From 10^{-1} dilution taken using a 0.1 ml sterile pipette then poured on the surface of the solid EMBA media into a petri dish then incubated at 37°C in reverse and results can be calculated after 24-48 hours. Planting at a rate of dilution of 10^{-1}, 10^{-2} and 10^{-3} to count the growing bacterial colonies using the cup count method is to choose the number of colonies growing in *Petri dishes* ranging from 30-300 colonies (Jenie and Fardiaz, 1989). Formula:

$$\text{Colony/gram} = \frac{1}{\text{diluent factor}} \times \text{Number of virgin colonies}$$

Data Analysis

Data obtained were analyzed by variance, for microbiological data before being analyzed it was first transformed into logarithmic form. If there were significant differences between treatments (P <0.05) then the analysis was continued with Duncan's Multiple Range Test (Steel and Torrie, 1980).

Results and Discussion

Physical Quality of Meat

The pH value of Bali pork which is not aging P0 (control) is 5.51 while the pH value of Bali pork which is aging for days (P1) 5.40, aging 2 days (P2) 5.42 and aging three days (P3) 5.70. The PH value of meat from control until two days of aging was not statistically significantly different while the pH value of meat on the third day aging experienced a statistically significant difference P <0.05. The value of cooking loss meat on day 2 aging (P2) decreased and then on with day 3 with a statistically significant increase (P <0.05). The smallest drip loss value is also on the second day aging (P2) then on the third day has increased. The value of the largest holding capacity of water on the second day aging, while the value of the smallest holding capacity of water in control meat (P0).

The pH value of meat on aging days 1 and 2 did not change significantly, this is because in this period the change in pH was still influenced by the post-mortem glycolysis process. Soeparno, (2009), stated after

rigormortis the lowest pH reached by meat or what is called an ultimate pH is 5.4-5.8. In this process changes of glycogen to lactic acid and continue until the glycogen in the meat tissue is used up. According to Aberle *et al.*, (2001) and Lawrie, (2006), meat pH can decrease rapidly to reach 5.4-5.5 for several hours after cutting. The pH standard for healthy, sufficiently rested animal meat is 7-7.2 and will continue to decline for 24 hours. The decrease in pH is not the same for all tendons from an animal and between animals is also different. The postmortem pH value will be determined by the amount of lactic acid produced from glycogen during the anaerobic glycolysis process. The pH value will be lower in animals that experience stress before cutting and will produce pale, soft and exudative meat (*pale, soft, exudative = PSE*). On the 1st and 2nd days aging in this study, it was suspected that muscle glycogen reserves were still present to form lactic acid so that the pH value of the meat was low. But on the third day aging, the pH value of meat has increased significantly. There is a possibility that aging day 3 the muscle glycogen reserves will begin to decrease, so the process of forming lactic acid will decrease, causing the process of neutralization by alkaline compounds from the results of microbial metabolism, so that it will be followed by an increase in meat pH.

The water holding capacity value increases significantly with days 1 and 2. Aging can increase the holding capacity of water at various pH levels due to changes in the water-protein relationship, namely an increase in charge through absorption of K ions and liberation of Ca ions, but prolonged storage will decrease the water binding capacity and changes in muscle structure. Aging on the third day has shown a decrease in the water holding capacity. It is suspected that on the 3rd day microbial growth has started. Conditions like this can be seen in the increase in pH value on day 3, this will continue and will achieve the ideal pH for microbial growth, namely at neutral pH because most bacteria will grow at neutral pH (Forrest *et al.,* 1975; Levie, 1977). The same thing was stated by Jay, (1978), the ideal pH for bacteria is in the pH range of 6.6 to 7.5. According to Thornton, (1957), that if the pH of the meat reaches 6.8 or higher there will be a significant protein decomposition, namely changes, colors and textures and conditions like this reduce the power of water value capacity by meat protein. Decrease in the holding capacity of water on the third day aging is also thought to be caused because on the third day there has been a denaturation of meat protein. During storage changes in ions are bound by meat protein or protein denaturation. Soeparno, (2009), stated the presence of muscle protein denaturation results in changes in the structure of meat protein so that free water between

Table 1: Effect of carcass agingperiod on the physical quality of pork at different times.

Variable	Treatment				SEM
	P0	P1	P2	P3	
pH	5.51[a]	5.40[a]	5.42[a]	5.70[b]	0.027
Water Holding Capacity	19.59[a]	27.42[b]	31.76[c]	27.71[b]	0.810
Cookingloss	41.72[b]	40.51[b]	38.29[a]	40.55[b]	0.297
Drip loss	18.59[b]	13.32[a]	12.44[a]	13.69[a]	0.580
P0 = Fresh Carcas/pig carcass without aging; P1 = Pig carcass aging for 1 day; P2 = Pig carcass aging for 2 days; P3 = Pig carcass aging for 3 days; SEM = Standard Error of the Treatment Means					

protein molecules decreases and results in a decrease in the binding capacity of the meat water. The binding capacity of water by meat protein or called the *Water Holding Capacity* (*WHC*), is defined as the ability of meat to hold water or water added as long as there is an influence of strength, such as cutting meat, heating, grinding and pressure. Meat also can absorb water spontaneously from environments that contain liquid (*water absorption*). The decrease in water binding power can be seen by the exudation of a liquid called drip in raw meat (Soeparno, 2011).

The value of cooking loss meat decreased significantly on day 2 aging, due to the trend of the value of water holding capacity increased on days 1 and 2. Cooking losses are an indicator of the nutritional value of meat-related to meat moisture content, namely the amount of water bound in and between muscle. High water holding capacity (WHC) will result in low cooking losses. This is indicated by the results of research, the increased water holding value is followed by a low cooking loss value in aging 1 and 2 and vice versa the decrease in the water holding capacity in the 3 days aging treatment is followed by an increase in cooking shrinkage value. Low cooking loss meat has a relatively good quality compared to large cooked meat because the risk of losing nutrients

during cooking will be less. Soeparno, (2009), stated, in general, the value of cooking loss meat varies between 1.5-54.5% with a range of 15-40%.

The value of drip loss also decreased from the control until aging days 1 and 2. This trend is inversely proportional to the trend of the value of the holding capacity of meat water which has increased. But on the 3rd day aging the value of drip loss has increased due to the decrease in the value of the holding capacity of meat water on the 3rd day aging. The decrease in the binding power of water can be known by the existence of liquid exudation called drip on raw meat (Soeparno, 2011).

Quality of Meat Microbiology

Based on the results of the study that the bali pork aging for three days produced a total microbial/TPC of 3.22×10^7 cfu/g which was statistically significantly (P <0.05) higher than the control (fresh meat without aging) of 1.76×10^7 cfu/g. The number of coliform bacteria in bali pork aging for three days was 7.25×10^5 statistically significantly higher (P <0.05) than the control of 8.68×10^4. While the population of *Escherichia coli* bacteria in both samples was good there was a control nor those aging for three negative days in table 2.

Information on the total amount of microbial TPC, *Coliform* and *Escherechia coli* in meat is needed to determine food sanitation and state whether the food is suitable for consumption or not. This was confirmed by Soeparno, (2009) that the microbiological evaluation of meat aims to determine the pathogenic microbial profile related to food sanitation and safety. Based on the results of the study that the bali pork aging for three days produced a total microbial/TPC of 3.22×10^7 cfu/g which was statistically significantly (P <0.05) higher than the control (fresh meat without aging) of 1.76×10^7 cfu/g. Similarly, the population of coliform bacteria. The number of coliform bacteria in bali pork aging for three days was 7.25×10^5 statistically significantly higher (P <0.05) than the control of 8.68×10^4. This was because the process of aging can cause a decrease in the quality of meat, especially in the long aging. This is following the opinion of Ogunbowo and Okanlawon, (2006), the longer the shelf life of foodstuffs in the refrigerator, the lower the sensory receptivity (smell and general appearance) of foodstuffs with or without any treatment.

In this study, three days of aging in bali pork have indicated a decrease in quality. Also, having seen in sensory observations with the five senses of the flesh has changed color, slimy and has

Table 2: Effect of carcass aging period on the microbial quality of pork at different times.

Variable	Treatment				Standard SNI (SNI 7388, 2009)
	P0	P1	P2	P3	
TPC (cfu/g)	1.76×10^{7b}	1.83×10^{6a}	2.1×10^{7bc}	3.22×10^{7c}	1×10^6
Coliform (cfu/g)	8.68×10^{4b}	2.43×10^{4a}	2.83×10^{5bc}	7.25×10^{5c}	1×10^2
E coli (cfu/g)	-	–	–	-	1×10^1
P0 = Fresh carcass/pig carcass without aging; P1= Pig carcass aging for 1 day; P2 = Pig carcass aging for 2 days; P3 = Pig carcass aging for 3 days; Numbers with different superscripts on the same line show real differences.					

a somewhat smelly. The condition of the meat like this, especially the slimy conditions indicates that the holding capacity of the meat is decreased. The presence of water on the surface of the meat is an excellent medium for the growth of pathogenic bacteria in this case is TPC and *Coliform*.

While the *E. coli* bacteria in this study were negative. Calculation of the number of *Escherichia coli* bacteria in meat is very important because the presence of these microorganisms can be used as an assessment of the sanitation quality of meat and water (Suwansonthicai and Rengpipat, 2003). This bacterium can also be an indication that the food has been contaminated by human and animal feces so that in food microbiology it is referred to as an indicator of sanitation (Supardi and Sukamto, 1999). In this study, it can be interpreted that both bali pork control and aging for three days were not polluted by human or animal feces. Contamination usually often occurs when animals undergo the process of slaughtering especially when removing innards. Technical errors can cause the intestines to burst or leak which is very possible to contaminate the meat. So that the cutting process in this study goes well or there is no error in the issuance of innards (*episheraching*).

The content of TPC and *Coliform* bacteria from both samples is above the SNI threshold (SNI 7388, 2009). This is likely due to a lack of clean sanitation during cutting. Cutting tools for example knives, buckets, carcass slaughtering floors and even cutters can be contaminated media. It should be noted that in this study the cuts were carried out in the traditional slaughterhouse. In general, traditional abattoirs lack the *hygeinetas* standard. Therefore, it is necessary to appeal to traditional slaughterhouses to improve cleanliness at the place of cutting as well as tools used for cutting.

Conclusion

The maximum long duration of carcasses of bali pig to produce the physical quality of bali pork is for two days seen from the highest water holding value followed by cooking loss and drip values. Aging of meat for three days still shows the physical quality of normal meat but has begun to show signs of deteriorating physical quality of bali pork. The content of Bacteria TPC and *Coliform* of pork which aging for three days increased significantly. The content of TPC and *Coliform* bacteria both in fresh (control) meat and aging meat for three days is above the SNI threshold (SNI 7388, 2009). While the content of *Escherichia coli* bacteria in bali pork either fresh (control) or aging for three days was negative.

Acknowledgment

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