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Quality and Shelf Life of Quail Carcasses in Refrigerators with Different Packaging

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A B S T R A C T

Quail meat is a valuable source of animal protein, but its perishable nature requires proper storage methods to prevent spoilage. This study examined the effects of storage time and packaging type on quail carcass quality. A completely randomized design with a factorial pattern was used, focusing on two factors: storage time and packaging type, including polypropylene (PP), polyethylene (PE), and plastic wrap. Variables observed were color, pH, water holding capacity, protein content, and total microbial count. Data were analyzed using ANOVA, followed by the Duncan test for significant results ($P < 0.05$). The results showed that quail carcasses packed with PP plastic had the best quality after 9 days of cold storage, with a pH of 6.22, water holding capacity of 51.45%, protein content of 20.59%, and microbial count of 1.2×10^6 cfu/gram. PP plastic, with a thickness of 0.8 mm, proved more effective than PE plastic (0.3 mm) and plastic wrap (0.2 mm) in preventing contamination, as thicker packaging provides a tighter seal, reducing air gaps that could allow bacteria to enter. Thus, PP plastic packaging is more effective in preserving quail carcass quality during storage, offering better protection against spoilage.

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INTRODUCTION

The potential for developing quail farming in Indonesia is still quite large as one of the sources of new growth in the local resource-based economy. The direct impact of quail farming development on Indonesian society cannot be separated from the basic function of livestock farming in meeting the food and nutrition needs of the Indonesian people, especially the need for animal protein. Quail farming as a producer of eggs and meat can be an alternative in an effort to meet the increasing demand for animal protein sources in order to improve the quality of human resources. Quail is one of the most sought-after types of poultry today because its egg production capacity is relatively fast and high (Hafid et al, 2011). Based on the Performance Report of the Directorate General of Animal Husbandry and Animal Health in 2022, the average quail population for the period 2020-2022 experienced positive growth of 4.06%, slightly below the average growth of broiler chickens (4.31%). The nutritional quality of quail meat is quite good, containing 13.1% protein and 11.1% fat, while broiler meat contains 12.7% protein and 11.3% fat. However, one of the weaknesses of meat is its perishable nature (Hafid et al, 2017). Most of the damage is caused by poor handling so that rotting microbes have the opportunity to grow so that they can reduce the quality and shelf life of the carcass (Soeparno, 2009).

Prevention of the growth of spoilage microbes can be done by immediately storing the carcass in the refrigerator. Storage should be done in a protected condition by wrapping because it can affect the shelf life and prevent a decrease in carcass quality during storage in the refrigerator (Hafid et al, 2017). Carcass or meat wrappers made of different types of plastic are often used because they are cheap, easily available on the market, and have low absorption of water vapor. Efforts to maintain carcass quality as described above apparently cannot prevent several events that occur naturally.

Quail meat storage at refrigerator temperature is better than storage at room temperature, because storage for too long can reduce the quality of the meat (Santos et al., 2019). Storing quail meat at cold temperatures extends the shelf life of the meat. The shelf life of quail meat at refrigeration temperature (6-8°C) for 24 hours, then storage at room temperature (24-26°C) for 6 hours (Nasution et al., 2021). In cold and wrapped storage conditions, chemical reactions occur in cells and muscle tissue that affect color, pH, water binding capacity, protein and total microbes, all of which are physical and chemical properties that affect meat quality (Heinz and Hautzinger, 2007). During storage, the aging process takes place which affects the quality of the meat. However, there can be a decrease in meat pH due to the anaerobic glycolysis process which will cause a lower water binding capacity, thereby accelerating the liquid out of the meat (Hafid Syam, 2007). Meat with a weak water binding capacity will result in relatively large weight loss during cooking. One way to maintain the quality of quail carcasses is through packaging.

LITERATURE REVIEW

Quail Carcass

Quail is one type of poultry that has undergone a domestication process, one type of quail that has undergone a domestication process is the Japanese

quail (*Coturnix coturnix japonica*). This type of quail is very popular among the public because it has good resistance to disease, has high egg productivity and good meat, and has a short life cycle so that the maintenance period is very short (Subekti and Hastuti, 2013).

Coturnix-cortunix japonica quail is widely farmed by the community because it has many advantages, including good breeding ability within 42 days it is able to produce eggs and within one year can produce three to four offspring, Egg production can reach 250 - 300 eggs / head / year (Sudrajat et al., 2014). Another advantage of female quail is that when it has entered the retirement period, the quail can be used as meat quail (Sunarno, 2004) (Tiwari and Panda, 1978).

According to (Soeparno, 2011), meat is all parts of the livestock body except bones, legs, nails and feathers. In general, meat is composed of several 15 muscle tissues including smooth muscle tissue, special muscle tissue and transverse muscle tissue. Some animals that produce meat include quail meat. Quail meat is one of the food ingredients derived from animal protein that has high nutritional value and is low in fat.

Retired quail is known to produce meat with a fairly high proportion of 42.17 ± 6.72 gr (Hasan et al., 2003). In general, the chemical composition of meat consists of 70% water, 20% protein, 9% fat and 1% ash. However, retiring quail meat has a high nutritional value and is also low in fat. According to (Ribarski and Genchev, 2013), retiring quail meat has a water content of 72.5-75.1%, protein of 20-23.4%, fat of 1.0-3.4% and mineral content of 1.2-1.6%.

Carcass/Meat Storage

Carcasses/meat are easily damaged due to contamination by germs originating from feathers, skin, chicken digestive tract or the slaughtering process until ready for consumption. Germ contamination can cause changes in the quality of carcasses/meat, both physical quality, chemical quality, and microbiological quality (Pestariati, 2000). The number of germs in carcasses/meat will increase with the length of storage. In cold and wrapped storage conditions, chemical reactions occur in cells and muscle tissue that affect their physical properties such as water holding capacity, cooking loss, pH and changes in texture, aroma, and color of carcasses/meat.

Most of the damage is caused by poor handling, which provides an opportunity for the growth of rotting microbes and has an impact on the decline in quality and shelf life of the carcass. Carcasses/meat should be immediately put into the refrigerator to prevent the growth of rotting microbes. Carcasses that will be stored at cold temperatures should also be protected by wrapping because this treatment can affect shelf life and prevent a decline in carcass quality during storage in the refrigerator (Risnajati, 2010).

Refrigeration at refrigerator temperature is the simplest and most frequently used method to preserve and extend the shelf life of carcass/meat. Refrigeration can inhibit the growth of germs, because cold temperatures will reduce the kinetic energy of all molecules in the system, thereby reducing the rate of chemical reactions including the metabolic activity of germ cells. However, in

cooling or storage in the refrigerator, certain germs can still survive. The storage period of carcass/meat in the refrigerator for up to six days showed a decrease in pH to 5.70, an increase in the percentage of cooking loss of 34.48%, a change in color to reddish white, the aroma tends to be rotten and has a soft texture (Kasih, 2012.). It is suspected that with the use of packaging, the shelf life will be longer than 6 days.

Plastic Packaging

Preventive measures that can be taken by traders in traditional markets to increase the durability of carcasses/meat are to cover or pack the meat with plastic. Meat packaging plays an important role in preventing or reducing damage by microorganisms and physical disturbances. Another effect of plastic packaging is to protect the product from changes in water content because the packaging material can inhibit the absorption of water vapor from the air.

The types of plastic that are popularly used for meat packaging are PE (polyethylene) and PP (polypropylene), because these two types of plastic are not only cheap, easy to find on the market, but also have almost the same general properties (Yanti, 2008), while Wrap plastic is widely used to wrap frozen meat, cheese and fruit. The use of plastic as a packaging material has advantages over other packaging materials, including being easy to shape, non-corrosive, practical, low O2 permeability and resistance to the packaged material. Based on the results of previous studies conducted, the use of plastic as beef packaging, especially the use of PP plastic, is better at preventing bacterial contamination (Yanti, 2008).

METHODOLOGY

Time and Place of Research

The research was conducted in the Basic Sciences laboratory of the Faculty of Agriculture, Warmadewa University, located in Tanjung Bungkak, Sumerta Village, East Denpasar District, Denpasar City. The research period starts from May - December 2024.

Research Tools and Materials

This study used 50 grams of quail breast carcass. The materials used were distilled water, petreleum benzene and filter paper. The tools used were knives, plastic, cutting boards, basins, stoves, pans, pH meters, beaker glasses, scales, thermometers, stirring rods, porcelain cups, ovens, chromameters.

Research Design

This study used a completely randomized design (CRD) experimental method with a factorial model consisting of 2 treatment factors, namely storage time (factor A) and type of packaging (factor B). The storage time treatment consisted of 3 treatments, while the packaging type treatment consisted of 3 treatments. Each treatment was repeated 3 times. The treatments in this study were:

Storage Time Factor:

P1 = storage for 1 day

P2 = storage for 3 days
P3 = storage for 6 days
Packaging Type Factors:
PE = using PE packaging
PP = using PP packaging
PW = using plastic wrap packaging

Observed Variables

a. pH value (AOAC, 2005)

The pH value was measured using a pH meter and calibrated with a buffer solution with pH values of 4 and 7. The pH meter cathode was inserted into the sample and left until the numbers listed on the digital measurement did not change anymore. The pH meter cathode was rinsed with distilled water and dried before being used again.

b. Water Binding Capacity (DMA) (Honikel, KO and R. Hamm.1994)

A 0.3 kg meat sample is placed on the filter paper between two stainless steel plates, then given a load of 35 kg for 5 minutes. On the filter paper, an area will be seen covered by the meat sample that has become flat and wet around it. The wet area is obtained by the area of the two areas covered by meat from the total area that includes the wet area on the filter paper. DMA is calculated based on the percentage between the wet area and the total area

$$\text{MgH2O} = \frac{\text{area basah } (\text{cm}^2)}{0.0948} \text{ x } 8.0\ \%$$

c. Protein content

Analysis of dissolved protein levels using the Lowry-Follin Chiocalteau Phenol method (Apriyantono, 1989) with the formula:

x = (y – a) / b
y = sample absorbance
a and b = the determination of the standard curve created

% Dissolved Protein = (x[mg/ml]× fp × 100 %) / [mg/ml]) sample

d. Total Microbes

A total of 10 g of chicken meat sample was placed in a sterile heat-resistant Erlenmeyer flask. A total of 90 mL of sterile diluent solution was added to the aseptic Erlenmeyer flask. The sample was then crushed with a Stomathcer for 120 seconds, resulting in a sample with a dilution of 10-1. The sample solution was taken aseptically as much as 1 mL with a pipette, then put into a test tube containing 9 mL of sterile diluent solution to produce a dilution of 10-2, then 1 mL of the 10-2 dilution was taken and put into a test tube containing 9 mL of sterile diluent solution to produce a dilution of 10-3 to a dilution of 10-6. Each selected dilution was pipetted aseptically as much as 1 mL of sample to be put into a sterile petri dish in duplicate and sterile PCA (Plate Count Agar) media

was added as much as 10-15 mL. After the agar media solidified, the petri dish was incubated in an inverted position in an incubator at 37°C for 2 days.

Data analysis

The data obtained were analyzed using ANOVA analysis of variance, if there were results that had a significant effect (P<0.05) then continued with Duncan (Stell and Torrie, 1993).

RESEARCH RESULT

The results of the study showed that there was a significant to very significant effect of the type of plastic packaging, storage time and its interaction on pH, protein content, and total microbes of quail carcasses during storage, but had no significant effect on the water binding capacity of quail carcasses. The research data can be seen in Table 1.

Table 1. Physical, chemical and microbiological quality of quail carcasses due to the influence of packaging with plastic packaging types during storage

Treatment	pH		Protein Content (%)		TPC Logs		Water Holding Capacity		Color
PWH3	6,137	ef	18,776	with	5.243	b	52,708	a	Dark red
PPH3	6,210	cd	21,778	b	5.260	b	48,222	a	Dark red
PEH3	6,073	f	19,914	c	5.318	b	52,504	a	Dark red
PWH6	6,510	a	18,140	e	5,717	b	47,160	a	Dark red
PPH6	6,290	b	25,539	a	6.030	b	51,771	a	Dark red
PEH6	6,253	bc	23,886	a	5.116	b	50.135	a	Dark red
PWH9	6,210	cd	19,906	c	5,812	b	54,069	a	Pale dark red
PPH9	6,220	bcd	20,589	c	5.626	b	51,427	a	Pale dark red
PEH9	6,150	def	19,824	CD	7,042	a	51,244	a	Pale dark red

Information:

1. Mean values followed by the same letter in the same column indicate no significant difference in Duncan's 5% test.
2. PE = using PE packaging
   PP = using PP packaging
   PW = using plastic wrap packaging
   P1 = storage for 1 day
   P2 = storage for 3 days
   P3 = storage for 6 days

DISCUSSION

Statistical analysis showed that the treatment of plastic packaging type and storage time had a very significant effect (P<0.01) on the pH value of quail meat. The pH value of quail meat ranged from 6.137-6.510. The highest pH value was obtained in the storage treatment with plastic wrap on the 6th day of

observation, which was 6.510. The study showed that the pH value of quail meat in all types of packaging increased on the 6th day and then decreased on the 9th day. The increase in the pH value of meat can be caused by the activity of microbes that deaminate amino acids in meat, resulting in alkaline compounds such as ammonia or NH4 (Arizona et. al., 2011) (Ginting et. al., 2014) Meanwhile, on the 9th day, there was a decrease in pH due to microbial activity which caused the glycolysis process to produce lactic acid. The accumulation of lactic acid in meat causes an increase in muscle acidity (Silvia, et.al., 2022) (Wowor, et. al., 2014) (Harmoko, et.al., 2021).

The protein content of quail meat ranges from 18.776% -25.539%. The results of the analysis of variance showed that the treatment of plastic packaging type and storage time had a very significant effect ($P < 0.01$) on the protein content of quail meat. The highest quail meat content was obtained in the PP plastic packaging treatment on the 6th day of 25.539% which was not significantly different from quail meat packaged with PE plastic with a protein content of 23.886%. The results showed that on the 6th day there was an increase in protein content. This is likely due to a decrease in the water content of the meat during storage so that the protein ratio increases. If the water content decreases, the total weight of the meat will decrease, but the protein content remains the same, so that the protein ratio increases. Meanwhile, on the 9th day, there was a decrease in the protein content of the meat. This is due to microbial activity that occurs during storage which can cause a decrease in protein content. Microbes can break down protein into smaller components, so that the total protein content decreases (Rahmadani, 2023).

Diversity analysis showed that the treatment of plastic packaging type and storage time had a significant effect ($P<0.05$) on the total microbes of meat. The highest total microbes were obtained in meat with PE packaging on the 9th day with a log TPC value of 7.042. On the 3rd and 9th days, there was no significant difference between the total microbes of quail meat in the three types of packaging. In general, during storage there was an increase in the total microbes of quail meat. Storing meat at cold temperatures (usually below 4°C) can inhibit microbial growth, but does not kill it. Therefore, microbes can still grow and develop, causing an increase in the number of microbes [9]. Contamination of meat with bacteria can occur during meat cutting and processing. This contamination can increase the number of microbes in meat, which then develop during storage (Hernando, et. al., 2015).

Statistical analysis shows that the analysis of diversity shows that the treatment of plastic packaging type and storage time has no significant effect ($P>0.05$) on the water binding capacity of meat. Factors that affect water binding capacity are collagen that dissolves in water can increase water binding capacity. The more collagen that dissolves, the higher the water binding capacity of meat. Protein also plays a role in binding water, so the composition of protein in meat greatly affects water binding capacity (Risnajati, 2010).

The color of quail meat is dark red. The longer the storage, the more visible the color change of quail meat becomes paler. Changes in meat pH during storage

can also affect color. Meat with a lower pH tends to have a paler color due to changes in collagen and protein structure (Jaelani, et. al., 2016). The longer the meat is stored, the more water comes out of the meat, so the meat becomes soft and wet. This can cause the color of the meat to become pale due to a significant decrease in water content (Liur, 2020)

Quail carcasses packed with PP plastic had the best quail carcass quality during 9 days of storage at cold temperatures. Quail carcasses packed with PP plastic on the 9th day had the following characteristics: a pH value of 6.22; a water binding capacity of 51.45%; a protein content of 20.59%, reddish white meat color and a total microbe of 1.2 x 106 cfu/gram. PP plastic has a higher thickness than PE plastic and plastic wrap. The thickness of PP plastic is 0.8 mm, the thickness of PE plastic is 0.3 mm and the thickness of plastic wrap is 0.2 mm. Thicker plastic packaging can be more effective in preventing contamination of pathogenic bacteria. This is because the thicker thickness can make the packaging tighter and there are no air gaps that can allow bacteria to enter the meat (Triyannanto, et al., 2021).

CONCLUSIONS AND RECOMMENDATIONS

Quail carcasses packed with PP plastic had the best quail carcass quality during 9 days of storage at cold temperatures. Quail carcasses packed with PP plastic on the 9th day had the following characteristics: pH value of 6.22; water binding capacity value of 51.45%; protein content of 20.59%, and total microbes of 1.2 x 106 cfu/gram. PP plastic has a higher thickness than PE plastic and plastic wrap. The thickness of PP plastic is 0.8 mm, the thickness of PE plastic is 0.3 mm and the thickness of plastic wrap is 0.2 mm. Thicker plastic packaging can be more effective in preventing contamination of pathogenic bacteria. This is because the thicker thickness can make the packaging tighter and there are no air gaps that can allow bacteria to enter the meat.

ADVANCED RESEARCH

For future advanced research, it would be valuable to explore the combined effects of different packaging materials and varying refrigeration temperatures on the quality and shelf life of quail carcasses. Investigating the role of active packaging technologies, such as antimicrobial or oxygen-absorbing films, could further enhance preservation. Additionally, extending the study to include sensory evaluation (e.g., texture, flavor) and nutritional changes over time would provide a more comprehensive understanding of how packaging impacts consumer acceptability. Finally, analyzing the economic feasibility and environmental impact of using thicker or advanced packaging materials like PP in large-scale food industries would offer insights into practical applications and sustainability considerations.

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