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EFFECT OF HARVESTING AGE ON WALKING ABILITY, PODODERMATITIS, CARCASS PERCENTAGE, ABDOMINAL FAT PERCENTAGE, AND REVENUE/COST RATIO OF BROILER CHICKENS

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ABSTRACT

This study was conducted to evaluate the effect of harvesting age on walking ability, pododermatitis, carcass percentage, abdominal fat percentage, and revenue/cost (R/C) ratio in broiler chickens. Three groups of five thousand Cobb chickens were reared until slaughter at ages 21 days (T1), 28 days (T2), and 35 days (T3), specifically for animal welfare and carcass quality variables using a sample of 15 chickens. The different harvesting ages did not show a different effect on the ability to walk broiler chickens which was marked by the acquisition of a score of 0, namely the chickens walked normally without detectable abnormalities in all treatments. Different harvesting ages had a highly significant effect ($P < 0.01$) on pododermatitis, carcass percentage, and abdominal fat percentage of broiler chickens. Pododermatitis score of T1, T2, and T3 was 1.00 ± 0.00, 1.20 ± 0.45, and 2.40 ± 0.55, respectively. Carcass percentage of T1, T2, and T3 was 65.26 ± 3.30%, 71.30 ± 17.00%, and 76.54 ± 3.00%, respectively. Abdominal percentage of T1, T2, and T3 was 1.34 ± 0.05%, 1.58 ± 0.22%, and 2.18 ± 0.08%, respectively. As for the R/C ratio obtained by each treatment sequentially 1.06, 1.16, and 1,09 for T1, T2, and T3, respectively. It could be concluded that harvesting ages have an impact on several factors such as pododermatitis, carcass percentage, abdominal fat percentage, and R/C ratio, but have no impact on the walking ability of broiler. The highest score of R/C ratio is obtained by T2 which shows that the greatest profit is obtained in harvesting chickens aged 28 days.

Keywords: Broiler; carcass percentage; abdominal fat; animal welfare; revenue/cost ratio.

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INTRODUCTION

Livestock farming is an activity of raising animals with the aim of obtaining results and income from that business activity. Initially, livestock businesses were only limited to rural efforts, but with the rapid development of time, society has become aware of the importance of animal protein from livestock. The opening of society's awareness of the need for animal nutrition has led to an increasing demand for meat, as broilers have become an alternative source of protein for the community besides beef. The Center for Agricultural Data and Information Systems in 2022 stated that the average consumption per capita of broiler meat for households from 2018-2023 was 6.10 kg/capita/year. The projected consumption of broiler meat per household for 2019 was 5.80 kg/capita, for 2020 it was 6.03 kg/capita, for 2021 it reached 6.22 kg/capita, and for 2023 it reached 6.57 kg/capita. This consumption only represents household consumption; if non-household consumption is added, the total consumption for 2019 is estimated to reach 11.96 kg/capita/year. Meeting the demand for broiler meat is inseparable from the ongoing development of poultry farming in Indonesia.

Broilers are one of the most popular food sources because chicken meat has become a staple food for the Indonesian people. Broilers are a high-potential livestock product because they can be produced more quickly than other livestock products, meeting market demand. This type of chicken grows rapidly and can be harvested in 4 - 5 weeks (Nuryati, 2019). The harvesting period for broilers is becoming shorter with the development of time. The shorter harvesting time for broilers may be due to the continuous development of technology and the continuous improvement in genetic quality over time.

The increasing demand for broiler carcass meat has resulted in farmers producing broilers with high live weights. Broiler farming has aimed to produce chickens with high harvest weights, as farmers believe that larger harvest weights lead to greater profits compared to harvesting at smaller weights or younger ages. The age at harvesting affects profitability, product quality, and animal welfare. This is supported by the opinion of Astuti and Elisabeth (2019) that longer rearing periods result in larger chickens.

The age at harvesting also affects several aspects of broiler welfare such as walking ability and pododermatitis. Although the effects of age on behavior and some aspects of welfare are known, this is still not well studied, especially for broilers production in the tropical region, and there is still very little research conducted. Previous research by Baeza et al. (2013) showed that producing broilers with high body weights with an increase in harvesting age is efficient for producing chicken meat with high weights but leads to a significant decline in animal welfare due to the increase in age. Based on this, further research is needed to evaluate the effect of broiler harvesting age at 21 days, 28 days, and 35 days on walking ability, pododermatitis, carcass percentage, abdominal fat percentage, and revenue/cost ratio (R/C ratio).

MATERIALS AND METHODS

Experimental Design

This research was conducted at a broiler farm located in Sukodadi Village, Wagir Sub-District, Malang Regency. The study used 5,000 Cobb broilers. Evaluation of animal welfare variables and carcass quality was performed using 15 unsexed broilers divided into 3 treatment groups: T1 with a harvesting age of 21 days, T2 with a harvesting age of 28 days, and T3 with a harvesting age of 35 days. Each treatment was replicated 5 times. Each replication consist of 1 bird. Each group of chickens was placed in the same cage, provided with the same feed and water, and raised under the same management. At the time of harvesting, samples were taken from each treatment group, marked accordingly, to

determine walking ability, pododermatitis, carcass percentage, abdominal fat percentage, and R/C ratio for each different harvesting age. The research utilized a complete randomized design model with 3 treatments and 5 replicates. Treatments were differentiated based on the age of the chickens at harvest to observe and analyze the differences in harvesting age on walking ability, pododermatitis, carcass percentage, abdominal fat percentage, and R/C ratio.

Variables

The variables observed in this study were walking ability, pododermatitis, carcass percentage, abdominal fat percentage, and R/C ratio.

Walking ability

The assessment of walking ability used the 5-score walking ability assessment method, by selecting chickens and having them walk in the cage, then assessing them based on the scoring table according to Kestin et al. (1992). A score of 0 was associated with poultry walking normally without detectable abnormalities, a score of 1 for poultry with minor limb defects, a score of 2 for poultry with definite limb defects that can be identified but do not hinder their movement or competition for feed, a score of 3 for poultry with clear limb defects that affect their ability to move, and a score of 4 for poultry with severe limb defects, capable of moving but with difficulty.

Pododermatitis

Pododermatitis was assessed by randomly selecting chickens and evaluating one leg using a 3-point scoring system based on lesion scoring according to Allain et al. (2009). Score of 1 was for chicken legs without lesions and no change in skin color, a score of 2 for skin color changes to brown or erosion or both, and a score of 3 for black skin color changes, presence of lesions, split epidermis, or a combination of all three.

Carcass percentage

The calculation of carcass percentage was done by weighing chickens after removing blood, feathers, feet, head, neck, and all internal organs except for the lungs and kidneys. The carcass percentage is calculated as follows:

$$Carcass\ percentage\ (\%) = \frac{Carcass\ Weight\ (g)}{Live\ Weight\ (g)} X100\%$$

Abdominal fat percentage

The abdominal fat percentage was obtained by weighing the fat adhering to the inside of the chicken's abdomen, which includes the heart, gizzard, abdominal wall, kidneys, and cloaca. The abdominal fat percentage is calculated as follows:

$$Abdominal\ fat\ percentage\ (\%) = \frac{Abdominal\ fat\ weight\ (g)}{Live\ weight\ (g)} X100\%$$

Revenue/Cost Rasio

Data was calculated and analyzed descriptively to depict the composition or structure of production costs, revenue, and income. All expenses of the production process are the result of adding fixed costs and variable costs. Systematically, the cost formula can be written as follows:

$$TC = TFC + TVC$$

TC = Total Cost (IDR/period)
TFC = Total Fixed Cost (IDR/period)
TVC = Total Variable Cost (IDR/period)

Revenue was obtained from the production volume multiplied by the agreed-upon price of the product between the producer and the buyer or consumer (Suratiyah, 2015). Revenue was depicted by the following formula:

$$R = P \times Q$$

R = Revenue (IDR/period)
P = Products Price (IDR/kg)
Q = Total Products (kg/period)

Income was the difference between the total costs (fixed costs and variable costs) incurred and the revenue obtained. Income was depicted by the following formula:

$$\Pi = TR - TC$$

Π = Income (IDR/period)
TR = Total Revenue (IDR/period)
TC = Total Cost (IDR/period)

Revenue Cost Ratio (R/C Ratio) was the ratio of revenue to costs, indicating how much revenue can be obtained from every unit of cost used in production (Muzizat and Rosa, 2020). It explained that the R/C was used to compare revenue and costs (Suratiyah, 2015). The R/C ratio can be used to measure the relative profitability level in a business activity. The value of the R/C ratio was used to determine whether the business is profitable or not. This formula can be written systematically as follows:

$$\text{R/C Ratio} = R/C$$

R = Revenue (IDR/period)
C = Cost (IDR/period)

Decision criteria:
R/C > 1 Broiler farming is profitable
R/C < 1 Broiler farming is not profitable
R/C = 1 Broiler farming reach breaks even point

Data Analysis

The data on walking ability, pododermatitis, carcass percentage, and abdominal fat percentage were analyzed using analysis of variance, while the R/C ratio was analyzed descriptively. This method was done to determine the most optimal harvesting age to achieve the best walking ability, pododermatitis, carcass percentage, abdominal fat percentage, and R/c ratio using a complete randomized design research model.

RESULTS AND DISCUSSION

Effect of harvesting age on walking ability, pododermatitis, carcass percentage, abdominal fat percentage, and revenue/cost ratio of broiler chickens is presented on Table 1.

Table 1. Effect of harvesting age on walking ability, pododermatitis, carcass percentage, abdominal fat percentage, and revenue/cost ratio of broiler chickens

Variables	T1	T2	T3	*P* value
Walking ability	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	> 0.05
Pododermatitis	1.00^{a} ± 0.00	1.20^{a} ± 0.45	2.40^{b} ± 0.55	< 0.01
Carcass percentage (%)	65.26^{a} ± 3.30	71.30^{b} ± 17.00	76.54^{b} ± 3.00	< 0.01
Abdominal fat percentage (%)	1.34^{a} ± 0.05	1.58^{a} ± 0.22	2.18^{b} ± 0.08	< 0.01
Revenue/cost ratio	1.06	1.16	1.09	NA

NA: Not Analyzed

Walking Ability

Results indicated that the treatment did not have a significant effect ($P > 0.05$) on the walking ability of broiler chickens, as shown by the score of 0 obtained in all treatments (Table 1). Physical ability is a dominant determining factor for walking in poultry. Furthermore, the heavier the chicken, the more it affects the physical proportions of the chicken, resulting in differences in how chickens walk. In this study, the weight of the chickens in the age range of 21–35 days was still considered normal according to the standard of 900 – 2,000 g, so the physical proportions of the chickens are still ideal and normal, thus not affecting the way and ability of the broiler chickens to walk. Bokkers and Koene, (2004) that physical ability is the dominant determining factor for walking in birds, apart from that the heavier the chicken, the more physical proportions the chicken will have, so the way the chicken walks will also change slightly. This is supported by the statement of Baeza, et al., (2011) which stated that the different physical proportions of broilers cause the way they walk to change in order to maintain their center of gravity during locomotion.

Pododermatitis

The genetic engineering carried out has resulted in an increase in production capacity to the maximum and very well, but the increase in production is not matched by an increase in livestock welfare and the livestock often feel stressed and uncomfortable. Like humans, poultry also need welfare/comfort (animal welfare) in living their lives before being used by humans (Sunarti, and Sugiarto, 2015). The comfort conditions of birds can be seen by their daily behavior. Poultry that is able to show normal behavior in daily life indicates that the bird is in good health and prosperity.

Walking ability was evaluated on 5 chickens per treatment (15 chickens in total). The walking ability assessment used the walking ability assessment method with 5 scores. By selecting the chicken and making the chicken in the cage walk, the procedure is repeated 3 times, the bird is given a score from 0 to 4 according to the condition of the chicken's walking ability. Kestin et al., (1992) explained that in short, a score of 0 corresponds to birds that walk normally without detectable abnormalities, a score of 1 for birds that have a slight locomotor defect, a score of 2 for birds that have definite and identifiable locomotor defects but there are no problems in moving or competing for food, a score of 3 for birds that have obvious movement defects affecting their ability to move, and a score of 4 for birds that have severe movement defects, able to move but having difficulty.

Lesions on the feet or bumblefoot are often also called pododermatitis, namely local wounds on the feet and pads of the chicken's feet due to continuous physical trauma (Fadilah, 2011). Symptoms of pododermatitis include thickening of the skin (hyperkeratosis), festering wounds, and chronic skin lesions on the chicken's foot pads. Pododermatitis was assessed by randomly selecting chickens by assessing one foot per bird (always the same side of the foot) using a 3 point scoring system, Welafare Quality., (2009) explained that a score of 1 is for chicken feet that have no lesions and no changes. skin color, score 2 for brown skin discoloration or erosion or both, and score 3 for black skin

discoloration, deep lesions, split epidermis, or a combination of the three.

This study showed that harvesting age had a highly significant effect ($P < 0.01$) on the pododermatitis score of broiler chickens (Table 1). The highest pododermatitis score was found in T3 or at 35 days of age, with an average value of 2.40. While the lowest pododermatitis score was obtained in T1 (21 days) with an average value of 1.00. This result probably due to the contact between the chicken's feet and litter, which has low quality due to poor maintenance.

Pododermatitis was not found in T1 or 21 day old chickens, all chickens were 21 days old gets a score of 1, which means there are no lesions and no changes skin color on the chicken's feet, but at T2 or 28 days old there was 1 chicken that was has a score of 2, namely there is a change in skin color to brown or erosion or both on chicken feet. In treatment 3 or 35 days of age, a case of pododermatitis occurred which is quite serious where there are 3 chickens with a score of 2 (U2, U4 and U5) and 2 chickens with a score of 3 or there is a black discoloration of the skin, there are deep lesions in the epidermis split, or a combination of the three on the chicken feet found on (U1 and U3).

Moderately severe pododermatitis was found in T3 or at 35 days of age, as the litter was found to be mixed with manure and water droplets from the nipple, resulting in a wet litter condition with relatively high ammonia content. This condition can exacerbate the level of pododermatitis in chickens because their feet rub against the wet litter and the heat caused by ammonia leads to lesions on the foot pads.

Mayne (2005) states that humidity is one factor that influences the rate of occurrence
pododermatitis in poultry, quite severe pododermatitis at T3 or 35 days of age It was also influenced by poor litter quality, which was found in research cages. This litter has been mixed with dirt and water from the nipple so that the litter condition is damp and contains quite high ammonia, this condition can worsen the level pododermatitis in chickens due to chicken feet rubbing against damp litter as well heat due to ammonia which causes wounds on the soles of the chicken's feet, this is strengthened by the statement of Baeza, et al., (2011) that this high rate of pododermatitis is caused contact between the soles of the chicken's feet and litter whose quality has deteriorated.

Carcass percentage

Bone is one of the factors that influences the final carcass percentage results. Carcass percentage is closely related to bone proportion. Bone growth develops rapidly at the beginning of rearing, but during the finisher period, the rate of bone growth decreases and the rate of growth of muscle, meat and fat increases, and affects the weight and proportion of the carcass, this is confirmed by the results of research by Patriani and Hafid (2019) which states that Chickens with weights ranging from 851 to 1050 g, had the highest bone percentage of 30.27%. and the lowest bone percentage was at a weight of 1,451 to 2,000, namely 21.49%.

Muscle growth will increase rapidly when the chicken enters the finisher phase, after bone growth decreases. Muscle tissue growth is caused by an increase in muscle size. An increase in muscle size is caused by an increase in the thickness or diameter of muscle fibers and an increase in the amount of tissue such as blood vessels or connective tissue around the muscle (Wahyunighasti, 2017). Factors that influence muscle growth can be divided into internal and external factors. Internal factors include physical activity, gender, age and hormones, while external factors include food. The formation of muscle mass is also supported by nutrients. Muscle mass is influenced by adequate levels of energy and protein. Amino acid supplementation affects muscle mass by increasing protein synthesis. An increase in protein synthesis will slowly cause muscle hypertrophy (Setiowati, 2013). As can be seen in Table 1, this study indicated that harvesting age had a highly significant effect ($P < 0.01$) on carcass

percentage of broilers. The highest carcass percentage was found in T3 or at 35 days of harvesting age with an average of 76.54%. On the other hand, the lowest carcass percentage was obtained by T1 or at 21 days of harvesting age with an average of 65.26%. The carcass percentage of broilers in this study was higher compared to those found by Akhadiarto (2010), which ranged from 57.39% to 60.08%, and consistent with the findings of Mahfudz (2009), which ranged from 65-75%. The high carcass percentage at 35 days of age is suspected to be caused by the increasing feed intake as the chickens age. This will be followed by an increase in the proportion of meat. Additionally, as the age of the chicken increases, the final weight will also increase, thus affecting the final carcass percentage. The carcass percentage is also influenced by the condition of muscle and bone growth. During the starter phase, the proportion of bones will increase rapidly, while during the finisher phase, bone growth will decrease and be replaced by rapid muscle and meat growth. The results of the analysis of variance in table 10 show that there is a significant increase in the percentage of broiler carcasses because as the age of the chicken increases, the weight of the carcass and the percentage of the carcass also increase, this is in accordance with the statement of Indra (2015) which states that the percentage of carcasses is influenced by the age of harvest. The carcass percentage will increase as the harvest age increases, so that the longer the harvest period, the higher the carcass percentage.

The increase in carcass weight is also influenced by feed consumption, the higher the feed consumption, the increase in body weight so that the carcass weight obtained is high and vice versa, this is in accordance with the statement of Anggitasari, et al., (2016) that feed consumption will continue to increase during the growth period thus causing the chicken's body weight to increase, apart from that increasing age also affects the nutritional needs for basic life and growth. The carcass percentage is also influenced by the proportion of bones, the proportion of bones increases at the start of rearing, in the live weight range of 851-1,050 g the proportion of chicken bones is 30.27% of its live weight, and the older and heavier the chicken, the proportion of bones will decrease, at weight range 1,451 – 2,000 g, the bone percentage is 21.49%, which means that the bone percentage during the finisher period has decreased along with rapid meat growth.

The results of the research have an average percentage of broiler carcass weight at age ranging from 65.3% - 76.5%, this figure is higher when compared to Akhadiarto's (2010) research, namely 57.39 - 60.08% and is in accordance with Mahfudz's research results (2009) which ranges from 65-75% of live weight. Carcass percentage is influenced by several factors, including breed of animal, feed consumption, age of animal, sex of animal, and weight of fat.

Abdominal fat percentage

The rapid growth of fat in broiler chickens is in line with the increase in feed consumption in animal, especially abdominal fat. Abdominal fat is the fat in the chicken's body that is located in the abdominal cavity. Abdominal fat deposits on the chicken's body occur because the energy resulting from the nutrient metabolism process that enters the chicken's body exceeds the chicken's needs, both for basic living and reproduction (Oktaviana *et al*., 2010). Excess abdominal fat can also be seen as a sign of wasting feed. Because abdominal fat is the part that is not consumed (Hidayat, 2015). Abdominal fat accumulation in broilers is influenced by several factors, including genetics, level of feed consumption, gender, age of rearing, and environmental factors (Tumuva and Teimouri, 2010). Abdominal fat comes from the lining of the digestive tract and fat near the cloaca. Abdominal fat is obtained by taking abdominal fat (near the cloaca) and digestive tract (Anwar *et al.,* 2019). Abdominal fat weight is determined by measuring the weight of fat attached to the

chicken's stomach, including the heart, gizzard, abdominal wall, kidneys and cloaca. The percentage of abdominal fat is determined by the amount of fat in the carcass (Dou *et a*l., 2009). Results indicated that harvesting age had a highly significant effect ($P < 0.01$) on abdominal fat percentage of broilers. The highest abdominal fat percentage was found in T_3 or at 35 days, with an average of 2.18%. On the other hand, the lowest abdominal fat percentage was found in T_1 or 21 days, with an average of 1.34%. This is can be speculated because as the age increases, the feed consumption also increases, leading to more energy being stored in the form of fat. Fat deposition in the chicken's body occurs because the energy resulting from the metabolism of nutrients entering the chicken's body exceeds the required level. The lower the abdominal fat percentage, the better the carcass quality. Abdominal fat develops rapidly in the late rearing period or in the finisher phase, in line with the development of muscle and meat in chickens.

Based on the data in Table 1. percentage of abdominal fat, different harvest ages from highest to lowest in sequence are T_3 (2.18b ± 0.08), T_2 (1.58a ± 0.22), T_1 (1.34a ± 0.05). This result is lower when compared to research by Setiawan and Sujana (2009) which shows that the percentage of abdominal fat at the age of 21-20 days is 2.24%, at the age of 27 days is 2.4%, and the largest at the age of 36 days is 3.41%.

Revenue/Cost Ratio

R/C is a comparison between receipts or income and costs incurred during the production process until it becomes a product. A business is said to be profitable and worth continuing if it has an r/c value > 1, the greater the r/c value, the greater the profits obtained from the business, the r/c ratio obtained in this research can be seen in the Table 1.

Total cost is the total amount of fixed and variable costs incurred by a company to produce a product during one production period (Ali and Indrajit, 2022). The amount of fixed costs in this study is IDR 1,946,976. These costs are obtained from calculating depreciation of goods and equipment used for continuity production processes, such as feed bins, drinkers, cages and other equipment, the amount of fixed costs does not change even though the amount of production capacity increases at a certain time business, this is in accordance with the opinion of Arief (2018) that fixed costs are costs incurred regularly, the amount of which is fixed each production period and is not influenced by how much production volume or ongoing business processes during that period. Fixed costs are also defined as the minimum costs that must be incurred by a business to carry out a production process in the form of goods or services. The amount of variable costs is different for each treatment with the largest costs being in T3 (Rp. 179,177,000) followed by T2 (Rp. 113,536,000) and the smallest is T1 (Rp. 98,672,000), the amount of different variable costs with the same production capacity is influenced by the costs of feed, drinking water, vaccines, etc. and electricity and the operational costs incurred are different and continue to increase as the harvest age increases.

Revenue is the result of multiplying a number of production inputs with the applicable unit price. According to Hayati's opinion, et al. (2019) revenue is calculated by multiplying the number of chickens produced (kg) by the price (rupiah). Revenue data obtained based on harvest age shows that revenue comes from sales of chickens, sales of chicken manure, and FCR bonuses from partnerships, the largest total revenue in T3 (198,430,000) followed by T2 (Rp. 139,910,000), and the smallest is T3 (Rp. 101,803,500).

Income is the difference between total revenue minus all costs incurred during the maintenance/production period and is expressed in Rupiah (Rahmah 2015). The income obtained in this research is based on different harvest ages from highest to lowest in sequence, namely T2 (Rp. 24,427,000),

T3 (Rp. 17,306,000), and the lowest income is T1 (Rp. 1,184,500). The r/c ratio values at different harvest ages from highest to lowest respectively are T2 (1.2), T3 (1.1), and T1 (1.01). These results indicate that harvesting broilers at harvest age of 21 days to 35 days is feasible because of each treatment has an R/C value > 1, which means there is a profit. This is in accordance with the opinion of Marianne (2016) which states that a business or undertaking is declared feasible if the R/C ratio is > 0. If the R/C ratio is < 0, the business is declared unable to be carried out because it is experiencing a loss, and if the R/C ratio is = 0, the business activity is declared unprofitable but not detrimental either or it could be said break even. The higher the value of the R/C ratio, the higher the profit the producer obtains from one unit of production costs, and thus the more profitable it is company or business.

The highest production cost was found in T3 (IDR 181,417,500), followed by T2 (IDR 128,668,500), and the lowest production cost in T1 (IDR 96,204,500). The total production costs, although with the same production capacity, were influenced by different cost such as feed, water, medications, vaccines, chemicals, electricity, and operational cost, which vary and increase as the rearing age increases. The highest revenue was obtained in T3 (IDR 198,430,000). Revenue was obtained from the sale of chickens, manure, and bonuses from partnerships. The R/C ratio obtained in this study was 1.06, 1.16, and 1.09. This indicates that different harvesting ages affected R/C ratio.

The highest revenue was in T3, but the largest profit was in T2. This result because the total costs in T2 were not too high, thus yielding greater profits compared to other treatments. The R/C ratio for all treatments was still above 1, indicating that harvesting at ages 21-35 days was profitable.

CONCLUSION

It can be concluded that harvesting age has does not alter walking ability, but it affects pododermatitis, carcass percentage, abdominal fat percentage, and revenue/cost ratio. The results of this research are expected to be used as a guideline for farmers, especially for new farmers, to adjust the appropriate harvesting age so that harvesting can be done at the right time to maximize profits while still considering animal welfare. For further research, it is recommended to use more samples so that the data obtained regarding animal welfare conditions are more accurate.

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