



Animal Welfare Practices at Duck Slaughter Facilities and their Relationship to the Microbiological Quality of the Meat in Bogor City

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Abstract | Poultry slaughtering is recommended to be carried out in slaughterhouses so that animal welfare practices can be observed. However, duck slaughtering in Bogor City is still carried out in traditional markets causing the animal welfare practices are not yet known. Several studies indicate that animal welfare effects the organoleptic quality of meat, but there are still few studies of it effects the microbiology quality of meat including duck meat. This research was conducted to find out the relationship animal welfare practices towards the microbiological quality of meat in traditional markets in Bogor City. This research uses survey method at all slaughter facilities in Bogor City, which all located at traditional markets. Animal welfare practice data was collected by observation using checklist in the Animal Welfare Development Guidelines Assessment Checklist for Animal Product Business Units 2023, while the microbiological quality of meat, namely total bacteria, Enterobacteriaceae, *Salmonella* and *Staphylococcus aureus*, was tested using microbiology testing method written on SNI 2008 and ISO 21528-2:2017. The correlation of animal welfare practice and the microbiological quality of meat was analysed using the Spearman rho correlation test. Based on the results obtained, most of animal welfare practice at traditional market in Bogor City category as moderate and it had a significant effect ($p < 0.05$) on Enterobacteriaceae and *Staphylococcus aureus* on meat. This implied that animal welfare practice might as well affect the presence of microorganisms on meat.

Keywords | Animal welfare practice, Ducks, Meat, Microbiological quality, Slaughter facilities

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INTRODUCTION

Ducks are one of the waterfowl that are raised to produce meat to fulfil protein needs. According to Erat-alar *et al.* (2022), ducks are easy to raise because they are more resistant towards cold, hot, and humid environments than other poultry such as chicken. The duck meat itself having a distinctive taste that increases people's interest in consuming it. The more people interest in consuming the

duck meat, the more people demand their having the best quality meat. One that can affect the meat quality, namely meat is 'safe' to be consume— is by how animal welfare practice is carried on for ducks that will be slaughtered. Poor animal welfare will affect the resulting products and increase animal susceptibility to disease. Meat quality can decrease due to livestock experiencing stress if the animal welfare is unmet (FAWC, 2012). Poor animal welfare can also increase microorganisms inside the body, especially in

digestive tract. Although they are present inside the body, these microorganisms can contaminate the meat if it is not handled properly or if damage occurs during the removal of the innards.

The formulation of animal welfare has begun to be socialized in Indonesia because it can be an important point for food quality. Law of the Republic of Indonesia Number 18 of 2009 (Indonesia Government, 2009) regulates that livestock slaughter must be carried out in a slaughterhouse with a slaughtering method that meets animal health standards, and the animal welfare practice can be monitored. In Bogor City, duck meat production reaches almost 1 ton per year (Department of Food Security and Livestock, 2022) and most of it comes from slaughter facilities in traditional markets. Slaughtering outside the slaughterhouse, not just the animal welfare practice is not yet known– it can also increase the risk of microbial contamination on meat.

While many studies have been shown the impact of animal welfare practice on meat organoleptic such as colour and texture, there is still a gap in understanding its effect on meat microbiology quality. This study was designed to fill this gap and provide a comprehensive evaluation of animal welfare practices and the microbiological quality of duck meat in traditional markets in Bogor City. The findings of this study can serve as a crucial resource for the Department of Animal Husbandry and Animal Health, guiding them in formulating policies to enhance animal welfare and improve animal slaughtering practices in traditional markets.

MATERIALS AND METHODS

RESEARCH AREA

This research was carried out in May–December 2023. This research uses a survey method of all duck slaughter in Bogor City, where all slaughter located at the traditional markets. Animal welfare practices were collected and assessed using a checklist, while the microbiological quality of duck meat was checked using laboratory testing at Animal Product Quality Testing and Certification Center of the Ministry of Agriculture in Bogor City.

ETHICAL APPROVAL

Animals in this research, ducks, are sold at slaughter facilities at the traditional market and ready to be slaughtered and purchased. Microbiological laboratory testing using meat, that has been slaughtered based on applicable terms and conditions, so this research doesn't need any ethical approval from any department or any party.

DATA AND SAMPLE COLLECTION

Data collection was carried out at all seven duck slaughtering locations in three traditional markets in Bogor City. Each considering facilities was considered as sample for the

research. Data regarding animal welfare practices was collected through observation and assessment using a checklist. Meat microbiological examination samples were taken from all slaughter facilities, with a total of 21 duck meat examination samples due to the triplicate test.

ANIMAL WELFARE PRACTICE ASSESSMENT

Data collection regarding animal welfare practices was carried out through observation and assessment using the assessment checklist in the poultry welfare guide, "Guidelines for Animal Welfare Development in Animal Product Business Units 2023" (Latif *et al.*, 2023). There are 38 components grouped into 12 aspects. Each statement is filled with 'suitable and non-suitable' for the implementation of duck welfare. The components of the aspects assessed are presented in Table 1.

Table 1: Assessment of animal welfare aspects at duck slaughtering in Bogor city.

Aspects	Number of components of assessment aspects
Aspects of Transportation Equipment	1
Aspect of Resting Place	5
Aspects of Demotion and Suspension	3
Aspects of the Hanging	2
Aspects of Slaughter Equipment	3
Aspects of the Arrival	1
Aspects of Poultry Resting	6
Aspects of Removal from baskets and Restraints	8
Aspect of the Stunning	2
Aspects of the Slaughter	3
Aspect of Human Resources	2
Aspects of Emergency Planning	2
Total of components	38

The percentage of duck slaughter assessment for each aspect is categorized into 3 levels, namely good, moderate, and poor based on calculations by Arikunto (2013) with the formula;

$$\frac{\text{Score obtained}}{\text{Maximum total score}} \times 100\%$$

The overall results of animal welfare at each duck slaughter are generally categorized based on the number of aspect components that are appropriate referred to the distribution of Veterinary Control Number assessments in the Regulation of the Minister of Agriculture of the Republic of Indonesia (Minister of Agriculture of the Republic of Indonesia, 2020). The division of assessment categories is presented in Table 2.

Table 2: Animal welfare assessment categories.

Category	Assessment of animal welfare aspects ^a	Animal welfare assessment as per slaughter ^b
		Sesuai
Good	> 67%	≥ 26
Moderate	33–66%	13–25
Poor	0–32%	≤ 12

Key: a referring to the formula of Arikunto (2013); b refers to the division of veterinary control number categories in the regulation of the minister of agriculture of the republic of indonesia (2020).

MICROBIOLOGICAL TESTING OF MEAT

The bacteria that were tested in this research are standard meat microbiology assessment in Indonesia based on Indonesian National Standardization Agency 2023, such as total plate count (for total bacteria), *Salmonella* spp., *Staphylococcus aureus* and Enterobacteriaceae. A total of 25 g of sample was weighed crushed using stomacher and continued with the appropriate testing procedure. Testing methods for total bacteria, *Salmonella*, and *Staphylococcus aureus* follow the test procedures listed in the Indonesian National Standards 2897:2008 — Testing Methods For Microbial Contamination In Meat, Eggs And Milk, and Their Processed Products (SNI, 2008), while testing methods for Enterobacteriaceae follows the (ISO 21528-2, 2017) Microbiology of The Food Chain — Horizontal Method For The Detection and Enumeration of Enterobacteriaceae — Part 2: Colony count technique (ISO 21528-2, 2017).

DATA ANALYSIS

The percentage of animal welfare practice data was processed using Microsoft Excel 2010®, while the amount of microbiology in duck meat that had been calculated referred to the standard on the maximum microbial limit Indonesian National Standardization Agency, (2023) in poultry meat in Indonesia for total bacteria, *Salmonella* spp., and *Staphylococcus aureus* and the reference standard of the International Commission on Microbiological Specification for Food (2016), poultry meat for Enterobacteriaceae. The relationship between animal welfare practices and the microbiological quality of the meat produced was analysed using the Spearman rho correlation test using SPSS statistic v.22.

RESULTS AND DISCUSSION

ANIMAL WELFARE PRACTICE ASSESSMENT

The percentage of animal welfare assessments at duck slaughter facilities in Bogor City based on twelve aspects of duck slaughtering is presented in Figure 1.

The assessment results show that most of the duck slaughtering in Bogor City needs to comply with the established

criteria fully. Most assessment aspects are still below 50%. Aspects that are not appropriate (0%) are aspects of transportation equipment, arrival of birds, hanging birds, stunning, and human resources. Aspects that are not yet appropriate (21–75%) are aspects of lowering, resting areas, resting birds, removing birds from baskets and restraints, and emergency plans. Aspects that have been adjusted (95%) are aspects of slaughtering and slaughter equipment.

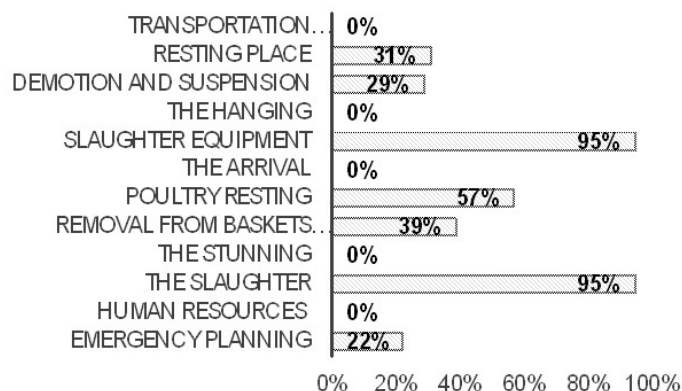


Figure 1: Percentage of total assessment of animal welfare aspects.

The means of transport used to bring the ducks to the slaughtering area are motorbikes and open trucks without covers. The use of this transportation is still conventional in Indonesia due to several factors such as the relatively close distance between breeders and slaughter facility and the lack of cost of having a proper vehicle. The provisions for vehicles transporting poultry are written in the “Guidelines for Animal Welfare in Transporting Animals” which states that a good vehicle for transporting poultry is to use a truck, a pickup truck equipped with a cover, and a motorized vehicle equipped with a box (Ma’arif *et al.*, 2020). However, the transportation of ducks was not appropriate, making them stress out, so it this aspect was not fulfilled. This aspect quite crucial because many poultry deaths occur due to stress caused during the transportation process, as it state by Nur’aini (2019).

The health and welfare of ducks arriving at the slaughter facility must be ensured to prevent the spread of disease. The human resources who carry out the examination are authorized medical personnel (Government Regulation of the Republic of Indonesia, 2017). However, these human resources are not available at the slaughter facility, so the ducks have no health or welfare status checks. The physical condition of the ducks that arrives is only checked briefly by the employee, and the ducks are put in a cage or left in the transport vehicle to rest. Meanwhile, the aspect of hanging and stunning poultry is not carried out because slaughtering still carried out traditionally, as written in the Government Regulation of the Republic of Indonesia 2009 (PPRI, 2009). The limited area is an obstacle to not imple-

menting these two aspects. It is recommended that poultry slaughter facilities also need a poultry hanging device, as it stated in Minister of Agriculture law 1976 (Minister of Agriculture, 1976), to make slaughter easier, speed up bleeding, and reduce discomfort in ducks.

The resting area, poultry resting, and the holding and restraining are one assessment unit because they are in the same place. The resting area used is the shelter cage. The shelter cage is protected from direct sunlight and rain but is not equipped with temperature and humidity settings which can cause heat stress on the ducks. Heat stress can affect animal growth conditions because it inhibits the electrolyte balance in growth and later affects meat quality (Nova and Zein, 2020). Apart from it, each slaughtering area is still close to a noise source which can cause the ducks to become stressed. In general, birds are sensitive to sound, so that a source of noise that is too close can disturb the comfort of the ducks and their resting will not be optimal. Meanwhile, aspects of the emergency plan, namely emergency slaughtering procedures and emergency procedures, are not yet available at all duck slaughtering facilities.

Some slaughter facilities have emergency slaughtering procedures in accordance with the provisions of the Republic of Indonesia Government Regulation (Government Regulation of the Republic of Indonesia, 2009), in which the employee or officers prioritizing slaughtering animals that are weak or disabled. However, none of the facilities have emergency procedures such as emergency guide machine or emergency guide if the electricity is shut off, considering the slaughter are still carried out traditionally.

Table 3: Number of appropriate assessment aspect components for each duck slaughter facility.

Slaughter-facility Code	Percentage (%)	Number of accordance aspect components	Category
PAP1	26,31	10	Poor
PAP2	44,73	17	Moderate
PJDP1	36,82	14	Moderate
PJDP2	42,10	16	Moderate
PJDP3	39,47	15	Moderate
PBP1	39,47	15	Moderate
PBP2	31,57	12	Poor

Officers or employees carry out this traditional slaughter following the provisions for halal slaughter based on applicable provisions and by shari'a (Islamic slaughter) (LP-POM MUI and Nadha, 2018). However, the assessment did not reach 100% because a small number of employees or traders still slaughtered incorrectly below the jaw, and the knife used was less than four times the width of the

neck of the duck being slaughtered. The purpose of this knife length is to ensure perfect slaughter, and the knife does not get stuck when slaughtering. Another provision regarding the length of the slaughter knife put forward by Kustiningsih and BBPKH Cinagara Bogor is 1.5 times the width of the neck of the animals to be slaughtered with a minimum size of a poultry slaughter knife of 10 cm (Kustiningsih and BBPKH Cinagara Bogor, 2020). A small number of traders still have not complied with these statements and the criteria for assessing aspects.

The number of Aspect components for each trader in implementing animal welfare practices in duck slaughter at traditional markets in Bogor City is shown in Table 3.

The results obtained show that PAP1 and PBP2 are in the poor category because the appropriate aspect components are only 10–12 components, while the other duck slaughter facilities are in the moderate category with the appropriate number of 14–17 components and there are no duck cuts in the good category. Even though the implementation of animal welfare in duck slaughter in Bogor City is in the moderate category, the percentage of compliance assessed is still less than half. These results indicate that many applications still need evaluated in completing animal welfare at duck slaughter. Handling the slaughter of ducks and other poultry is very important because apart from minimizing pain in the poultry, it also maintains the quality and value of the meat produced (Islahuddin, 2009). This matter cannot be separated from the traders' experience in attending animal welfare education, so that they know the importance of implementing animal welfare. However, traders or duck slaughter employees said they never received counseling or information regarding the welfare of the animals, which caused the level of animal welfare at duck slaughter in Bogor City not to be optimal.

MEAT MICROBIOLOGY QUALITY

A total of 21 samples of duck meat from the slaughter facilities were tested for microbiological quality, each for total bacteria, Enterobacteriaceae, *Salmonella*, and *Staphylococcus aureus*. The test results of the four microorganisms are listed in Table 4.

Based on the results, the total plate count– which describes total bacteria in duck meat, does not exceed the maximum microbial limit set by the Indonesian National Standardization Agency (BSNI, 2023) with an average microbial count of 2.45×10^5 CFU/g. The maximum limit set is 1×10^6 CFU/g. Therefore, if the number of microbes found is less than the maximum limit, the meat is safe for consumption.

The Indonesian National Standardization Agency has not set a maximum microbial limit for Enterobacteriaceae on meat, however, The International Commission on Microbi-

ological Specification for Food or ICMS for short, sets the maximum limit for Enterobacteriaceae in meat as $< 1 \times 10^2$ (Compendium of microbiological criteria for food, 2016). Based on the results, only 9.52% of duck meat samples met distribution requirements. However, the ICMS also sets exceptions that can be accepted in several countries, namely 10^2 – 10^4 CFU/g (Da Costa, 2022). Referring to these provisions, 100% duck meat is categorized as safe for consumption because it is still below 10^4 CFU/g with an average count of 1.21×10^3 CFU/g.

Table 4: Microbiological test results of duck meat.

Microbes Test	Frequency of meeting re-quirements (%)	Average number of microbes (cfu/g)	Provision
Total Plate Count	100	$2,45 \times 10^5$	< MLM
Enterobacteriaceae	9,52	1×10^2	< ICMS
	100	$1,21 \times 10^3$	< ICMS ^a
<i>Salmonella</i> spp	52,3	-	< MLM
<i>Staphylococcus Aureus</i>	90,48	$1,14 \times 10^2$	< MLM

MLM: Maximum Limits of Microbial (BSNI, 2023); **ICMS:** International Commission on Microbiological Specification for Food; **a:** International Commission on Microbiological Specification for Food with maximum hose 10^2 – 10^4 (Compendium of microbiological criteria for food, 2016); **cfu:** colony forming units.

Salmonella spp. can be found in a various place, including soil, water, air, human and animal waste, and food. The result showed that 52.3% of duck meat was negative for *Salmonella* spp. while the rest duck meat is positive. The presence of *Salmonella* spp. in food products has a negative value because this bacteria is responsible for causing gastroenteritis which causes 11–20 million people worldwide to be infected and around 161,000 die (Liur, 2020). Thus, by this result, it implies that the duck meat needs to cook properly before ready to serve or to eat.

The number of *Staphylococcus aureus* obtained showed that

90.48% of duck meat was below the maximum limit of microbial set by BSNI (2023), namely 1×10^2 . Even though the average number of all samples was 1.14×10^2 , it still considering save because only 9.52% the bacteria remain can be remove by proper cooking. *Staphylococcus aureus* usually found on meat and the result quite high, if the meat contact with other object such as butcher's or consumer's hand and sales table (Ibrahim *et al.*, 2017). Because duck having less contact of these, *Staphylococcus aureus* was less found on the meat.

CORRELATION OF ANIMAL WELFARE ON THE MICROBIOLOGICAL QUALITY OF DUCK MEAT

The animal welfare practice assessment categories and the average microbiological count of duck meat at each slaughter facilities are presented in in Table 5.

Animal welfare practice assessment and microbiological count, which has been researched, are being compared to each other to see the differences between them. It shows that there is a difference in the average bacteria in the implementation of animal welfare in the moderate category and in the poor category. Enterobacteriaceae and *Staphylococcus aureus* in moderate animal welfare category had an average of more bacteria that met the requirements than those in poor animal welfare category. Meanwhile *Salmonella* spp. still found in several meat in the moderate category, and some total bacteria are still higher than the poor category. This comparison illustrates that animal welfare can influence the presence of bacteria in duck meat. This is in accordance with the statement of Kholbi (2023) that said improving animal welfare will improve animal health, food safety and food security. Chen *et al.*, (2022) added that implementing good animal welfare will result in a positive immune response, optimal health status, the result in the form of superior food ingredients, and balanced intestinal microbiology.

By calculating using Spearman rho correlation test, the results of the relationship between animal welfare and the microbiological quality of duck meat are presented in Table 6.

Table 5: Animal Welfare Assessment and Average Meat Microbial Result.

No	Slaughter facility code	Animal welfare assessment result	Average Meat Microbiology Results (cfu/g)			
			TPC (1×10^5)	Enterobacteriaceae (1×10^3)	<i>Salmonella</i> spp.	<i>Staphylococcus aureus</i> (1×10^2)
1	PAP1	Poor	3.50	2.03	Positive	1.47
2	PAP2	Moderate	2.77	0.50	Positive	1.00
3	PJP1	Moderate	3.87	1.44	Negative	1.00
4	PJP2	Moderate	2.77	0.83	Negative	1.00
5	PJP3	Moderate	0.53	0.92	Negative	1.00
6	PBP1	Moderate	0.86	0.49	Positive	1.00
7	PBP2	Poor	2.27	2.08	Positive	1.57

PA: Anyar market; **PJ:** Jambu-Dua market; **PB:** Bogor market; **P1:** Facilities 1; **P2:** Facilities 2; **P3:** Facilities 3; **cfu:** colony forming units; **TPC:** Total plate count.

Table 6: Correlation between animal welfare and microbiological quality of duck meat.

			TPC	Salmonella spp	Enterobacteriaceae	Staphylococcus
Spearman's rho	Animal Welfare	Correlation Coefficient	-.257	-.294	-.800*	-.771*
		Sig. (2-way)	.578	.522	.031	.042

*The correlation is significant across levels $p<.05$.

Animal welfare has a negative correlation value with the four bacteria tested. The negative correlation value states that the greater the variable's value, the smaller the value of the other variables. In this case, the better the animal welfare practices, the fewer the number of bacteria found and vice versa. Animal welfare practices correlate ($p<.05$) with Enterobacteriaceae and *Staphylococcus aureus*, but animal welfare practices do not correlate ($p>.05$) with total bacteria nor *Salmonella* spp.

Animal welfare practices do not correlate with total bacteria because apparently the presence of bacteria come from the environment and humans, and it can re-contaminate the meat (Doron and Gorbach, 2008), even though the duck maintenance and meat handling have followed the procedures. Therefore, bacteria can still be found in moderate or poor animal welfare practices. This is in accordance with the results of the study by Cevallos-Almeida et al. (2021) which also found that animal welfare did not affect the presence of total bacteria in beef carcasses even though the assessment of the cattle slaughter management was categorized as poor. Because of this, the determination of bacterial contamination limits is needed to become a safe standard for meat to be distributed to the public (Mendonca et al., 2020).

The balance of bacteria including Enterobacteriaceae in the digestive system, must be maintained so that harmful genera do not dominate and cause disease in ducks. Stress is one factor that can affect the number of these bacteria. If the host is stressed, there will be an increase in harmful bacteria and a decrease in beneficial bacteria (Stress Management Society, 2023). Several factors as mentioned in the animal welfare assessment result, can trigger ducks to become stressed and this can increase harmful bacteria in the body. In addition, ducks in the slaughter facilitate are partially fasted, with a minimum fasting time of 6-8 hours. According to Agustina (2017), livestock intestines that are not empty due to lack of fasting time before it slaughtered, can contaminate the meat when the intestines are removed. These factors combined causes the Enterobacteriaceae found on duck meat. The strength of the correlation between animal welfare practice and Enterobacteriaceae is categorized as a very strong correlation, making the animal welfare practices during slaughter affect the presence of Enterobacteriaceae.

One of the Enterobacteriaceae genera also observed in this study, namely *Salmonella* spp., did not correlate with aspects

of animal welfare practice, although Enterobacteriaceae did. This is not in accordance with the results of the study by Iannetti et al. (2020), who concluded in their study that the implementation of low-welfare and high-welfare animal welfare correlated with the number of *Salmonella* spp. High-welfare implementation had a few *Salmonella* in the 0–7.5% range. This difference can occur because the implementation of hygiene in the study by Iannetti et al., (2020) was guaranteed and implemented so that the assessment of animal welfare was visible. Meanwhile, in this study, hygiene had not been fully implemented, which caused the presence of *Salmonella* spp. in duck meat to still be found.

Staphylococcus spp. bacteria are one of the causes of skeletal disorders such as lameness or paralysis, especially in meat-type livestock. Poor implementation of animal welfare is a trigger for the presence of *Staphylococcus* spp. which causes paralysis (Szafraniec et al., 2022). Sato and EL-Gazzar (2022), added that the genus *Staphylococcus aureus* enters the tissue and bloodstream through damaged skin or mucous membranes, and this way, it can contaminate or its presence on the meat. Based on the assessed animal welfare practice result, the ducks were treated well enough to minimize the occurrence of open wounds that became an entry point for *Staphylococcus aureus*. Taufik et al. (2022) also mention that blood is a growth medium for *Staphylococcus aureus*, so blood removal needs to appropriate. During the slaughter, blood was removed perfectly after, which caused minimum *Staphylococcus aureus* contamination in the meat. The strength of the correlation between animal welfare practices and *Staphylococcus aureus* is categorized as a strong correlation, indicating that animal welfare practices affect the number *Staphylococcus aureus*.

CONCLUSIONS AND RECOMMENDATIONS

This research concludes that animal welfare practices towards ducks in traditional markets in Bogor City are mostly categorized as moderate. Deviations in practice still occur in many aspects, except the aspects of slaughtering and slaughter equipment. All duck meat produced has a total number of bacteria that meets the maximum microbial limit standard. Animal welfare practices applied at the slaughter facilities are strongly correlated with the number of microorganisms in meat, especially Enterobacteriaceae and *Staphylococcus aureus*. The next research could be focus on the detail about of how each aspect of animal welfare practice affect specific microorganisms .

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NOVELTY STATEMENT

- This is the first time animal welfare practice assessment on duck slaughter.
- This is the first time Guidelines for Animal Welfare Development in Animal Product Business Units 2023 by Latief et al., 2023 have been use on research.
- This is the first time animal welfare practices have associated with meat microbiology in Bogor City and Indonesia

AUTHOR'S CONTRIBUTIONS

Ivania Farrah Nadhira contributed to collecting samples, researching, analysing data, and preparing the manuscript. Chaerul Basri and Trioso Purnawarman contributed to revising the manuscript and supervised the research.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

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