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Fumigation-Based Agricultural Sanitation Technology in the Production Chain of Broiler Hatching Eggs

Pengaruh Pasang Surut terhadap Parameter Fisika-Kimia Air Laut pada Perairan di Pelabuhan Bitung

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Abstract. Broiler parent stock production units play an important role in the poultry agroindustry chain because they produce hatching eggs as the main source for day-old chick production. Hatching eggs are biological products that are highly susceptible to microbial contamination from the farm environment until they enter the hatchery. Therefore, the implementation of sanitation and fumigation is necessary to maintain hatching egg quality and strengthen the biosecurity system in poultry production. This study aimed to describe the application of fumigation as a biosecurity-based sanitation technology in a broiler parent stock production unit located in Mekarwaru Village, Gantar District, Indramayu Regency, West Java. The study was conducted from September to November 2024 using a descriptive qualitative method. Data were collected through direct observation, guided interviews, and field documentation. Observations focused on the fumigation of closed-house poultry houses, fumigation of hatching eggs in fumigation boxes, sanitation of egg transport vehicles, fumigation of hatching eggs in the egg storage room, the use of fumigant materials, and the application of personal protective equipment. The results showed that fumigation was applied in multiple layers at critical biosecurity points. Poultry house fumigation was carried out after sanitation procedures to reduce microbial contamination in the production environment and to interrupt the contamination cycle between production periods. Hatching egg fumigation was conducted in farm fumigation boxes and in the egg storage fumigation room to reduce the risk of eggshell contamination before the eggs were transported to the hatchery. Sanitation of egg transport vehicles supported the continuity of biosecurity between production units. The use of fumigants was adjusted according to room volume, fumigation duration, gas residue control, and worker safety requirements. In conclusion, fumigation applied in the broiler parent stock production unit in Mekarwaru Village functions as a biosecurity-based agricultural sanitation technology that supports hatching egg quality, microbial contamination control, and the sustainability of poultry production.

Keywords: biosecurity; broiler hatching eggs; fumigation; poultry farming; sanitation technology

INTRODUCTION

Modern agricultural systems do not only encompass crop production but also include the management of the livestock subsector as part of the provision of animal-based food. One important commodity in the poultry farming system is broiler chickens, as they contribute to the supply of animal protein, the strengthening of food security, and the support of agroindustrial economic activities. In the broiler production chain, parent stock farms hold a strategic position because they produce hatching eggs, which serve as the main source for day old chick production. Therefore, the success of broiler production is not only determined by broiler management at the final rearing stage but also by the quality of hatching eggs produced at the breeding level.

Hatching eggs are an important biological input in the poultry production system. The quality of hatching eggs determines hatchability, chick quality, early DOC health, and broiler production performance in subsequent phases. However, hatching eggs are highly susceptible to microbial contamination because the eggshell surface can be exposed to bacteria, fungi, dust, feces, litter, poultry house equipment, air, workers, and

transportation facilities (Pees et al., 2023). Contamination of hatching eggs can reduce hatchability, increase embryonic mortality, and increase the risk of microorganism transmission from breeding farms to hatcheries (Franco et al., 2023; Oliveira et al., 2022; Selby et al., 2023). Therefore, contamination control in hatching eggs is an important aspect of poultry agricultural technology.

Broiler parent stock farms generally apply intensive rearing systems using closed-house poultry housing. This system enables more controlled management of temperature, humidity, ventilation, stocking density, and production efficiency. Nevertheless, intensive rearing systems also carry high biosecurity risks if the cleanliness of poultry houses, equipment, eggs, workers, and distribution pathways is not managed consistently (Delpont et al., 2023; Islam et al., 2023; Tilli et al., 2024). In the context of applied agroecotechnology, poultry house environmental management is not only intended to maintain animal health but also to support production sustainability, input efficiency, product quality, and workplace environmental safety.

Biosecurity is a major component of modern poultry farming systems. The implementation of biosecurity aims to prevent the entry, survival, and spread of disease agents within the production environment. One of the biosecurity measures widely used in poultry breeding units is sanitation and fumigation. Sanitation functions to remove dirt, dust, organic matter, and growth media for microorganisms, whereas fumigation functions to suppress residual microorganisms on the surfaces of poultry houses, equipment, storage rooms, vehicles, and eggshells. Thus, fumigation can be viewed as an agricultural sanitation technology that plays a role in maintaining the quality of biological inputs, namely hatching eggs.

Fumigation using chemical agents such as formaldehyde remains widely used in the poultry breeding industry because it is considered effective in reducing microbial contamination on egg surfaces and production facilities (Pees et al., 2023; Santos et al., 2025; Selby et al., 2023). However, the use of formaldehyde also requires caution because this substance has the potential to pose risks to worker safety, embryo quality, and the environment if dosage, exposure duration, ventilation, and gas residue disposal are not properly managed (Oliveira et al., 2025; Özdemir et al., 2025). Therefore, fumigation practices in poultry farms cannot be assessed solely based on their effectiveness in eliminating microorganisms, but must also consider occupational safety, the sustainability of the production environment, and procedural compliance with the principles of sustainable agriculture.

Recent studies have shown that hatching egg sanitation technology continues to develop. In addition to formaldehyde, several alternative methods such as hydrogen peroxide, essential oils, plant extracts, ozone, UV-C radiation, peracetic acid, and hydroxyl radical processes have begun to be studied as safer and more environmentally friendly sanitation agents or methods (Al-Shammari et al., 2022; Bekhet & Khalifa, 2022; Vale et al., 2024). However, the application of these alternative methods at the commercial farm scale still requires adjustment to room volume, egg type, tropical environmental conditions, microbial contamination load, operational costs, and human resource readiness (Dhillon et al., 2025; Melo et al., 2026). This indicates that field studies on the application of fumigation in parent stock farms remain relevant, particularly to examine how sanitation technology is implemented under actual production conditions.

In the present study, fumigation was applied at several important points, namely

closed-house poultry houses, hatching eggs in farm fumigation boxes, egg transport vehicles, and the egg storage fumigation room. This treatment chain reflects an effort to control contamination in multiple layers, beginning from the poultry house environment to egg storage before delivery to the hatchery.

From an agricultural perspective, this practice is important to examine because hatching eggs represent the initial stage of the broiler production chain. If sanitation and fumigation are not properly implemented, microbial contamination may be carried from the poultry house to the egg storage facility and hatchery, potentially reducing hatching success and DOC quality. Conversely, the implementation of fumigation in accordance with proper procedures can support hatching egg quality, maintain embryo health, reduce the risk of cross-contamination, and strengthen the efficiency of poultry production.

Based on the above background, this study aimed to describe the application of fumigation as a biosecurity sanitation technology in a broiler parent stock farm in Mekarwaru Village. The study focused on the fumigation of closed-house poultry houses, fumigation of hatching eggs in fumigation boxes, fumigation of hatching eggs in the egg storage facility, sanitation of egg transport vehicles, the use of fumigant materials, and the implementation of occupational safety practices. The findings of this study are expected to provide information on the application of sanitation technology in poultry farming systems, particularly in maintaining hatching egg quality, reducing the risk of microbial contamination, and supporting hygienic and sustainable broiler production.

MATERIALS AND METHODS

Time and Location

This study was conducted from September to November 2024 at a broiler parent stock farm located in Mekarwaru Village, Gantar District, Indramayu Regency, West Java. The research site was a broiler breeding unit that applied a closed-house system and was supported by production houses, egg fumigation boxes, an egg storage facility, a fumigation room, and special vehicles for transporting hatching eggs. The unit was selected because it had an integrated sanitation and fumigation flow from the poultry house to the egg storage facility, making it suitable for investigation as an example of sanitation technology application in poultry farming systems.

Tools and Materials

The equipment used in fumigation activities included fumigant mixing containers, C-Formator measuring devices, formalin measuring devices, stopwatches or timers, exhaust fans, egg fumigation boxes, fumigation rooms, egg trays, egg trolleys, hatching egg transport vehicles, and poultry house sanitation equipment. The personal protective equipment observed included masks, gloves, eye protection, dedicated poultry house footwear, and other occupational safety equipment used by workers during fumigation activities.

The material observed in this study was the fumigant used in sanitation and fumigation processes at the broiler parent stock farm. The fumigant consisted of a combination of C-Formator and formalin at a ratio of 1:2. The use of fumigant materials was adjusted according to the fumigation room volume, the type of object being fumigated, and the standard operating procedures applied on the farm.

The research objects included closed-house poultry houses, poultry house equipment, hatching eggs, egg fumigation boxes, egg transport vehicles, egg storage facilities, egg fumigation rooms, fumigant materials, and workers involved in sanitation and fumigation activities.

Research Method

This study used a descriptive qualitative method with a field study approach. This method was employed to describe the application of fumigation as a sanitation and biosecurity technology in the hatching egg production system of broiler parent stock chickens. This approach was selected because the study did not aim to test treatments experimentally, but rather to describe the processes, stages, and appropriateness of fumigation practices implemented in the field.

The study focused on three main points in the hatching egg production chain: fumigation of closed-house poultry houses, fumigation of hatching eggs in farm fumigation boxes, and fumigation of hatching eggs in the egg storage fumigation room. In addition, sanitation of egg transport vehicles was also observed because these vehicles form part of the biosecurity pathway connecting the poultry houses, egg storage facility, and hatchery.

Data Collection Techniques

The data used in this study consisted of primary and secondary data. Primary data were obtained through direct observation, guided interviews, and field documentation. Observations were conducted by examining the stages of sanitation and fumigation, including poultry house cleaning, fumigant preparation, dose determination, material mixing, fumigation duration, gas residue disposal, hatching egg handling, and the use of personal protective equipment by workers.

Interviews were conducted with personnel directly involved in sanitation and fumigation activities, including poultry house workers, poultry house coordinators, and the person responsible for the egg storage facility. The interviews were directed toward obtaining information on the objectives of fumigation, implementation time, work procedures, types and doses of fumigant materials, residue control, use of personal protective equipment, and technical constraints in fumigation implementation.

Documentation was carried out by recording the condition of facilities, equipment, fumigant materials, fumigation processes, hatching egg conditions, use of personal protective equipment, and other supporting biosecurity facilities. Secondary data were obtained from company standard operating procedures, fumigation work instructions, supporting farm documents, and literature related to biosecurity, sanitation, fumigation, and poultry production management.

Observed Variables

The variables observed in this study included:

1. application of closed-house poultry house fumigation;
2. application of hatching egg fumigation in farm fumigation boxes;
3. application of hatching egg fumigation in the egg storage fumigation room;
4. sanitation of hatching egg transport vehicles;
5. use of fumigant materials based on room volume;
6. application of personal protective equipment by workers; and
7. integration of sanitation and fumigation in the hatching egg production chain.

These variables were selected because they are directly related to microbial contamination control, hatching egg quality, worker safety, and the sustainability of the poultry farming production system.

Research Procedure

The study began with the identification of the hatching egg production flow at the broiler parent stock farm. This identification was carried out to determine the relationship among closed-house poultry houses, egg fumigation boxes, egg transport vehicles, egg storage

facilities, and fumigation rooms. Subsequently, observations were conducted on the application of sanitation and fumigation at each production point.

In the closed-house poultry houses, observations were conducted on cleaning activities for the poultry houses and equipment after the rearing period ended or before the houses were reused. The equipment observed included feeders, drinkers, nest boxes, light traps, cooling pads, exhaust fans, control panels, hoppers, and other supporting facilities. After sanitation was completed, observations continued with the determination of fumigation points, measurement of C-Formator and formalin, mixing of fumigant materials, closure of the poultry house, fumigation duration, and gas residue disposal using exhaust fans.

In the egg fumigation boxes, observations were conducted after the eggs had been collected from the poultry houses. The observed eggs were hatching eggs obtained from nest boxes, intact, clean, uncracked, and suitable for hatching. Cracked, broken, excessively dirty eggs, or eggs collected from the poultry house floor were not included as hatching eggs. Eggs that met the criteria were arranged in egg trays, placed into the fumigation box, and fumigated according to the dose and duration applied on the farm.

In the egg storage facility, observations were conducted on the receiving process of hatching eggs from the poultry houses, coding based on house origin and production date, re-sorting, grouping of eggs according to size and physical condition, arrangement of eggs on trolleys, and further fumigation in the fumigation room. Observations were also conducted on the gas residue disposal process after fumigation and the transfer of eggs to transport vehicles.

Sanitation of hatching egg transport vehicles was observed to determine the continuity of biosecurity between the poultry houses and the egg storage facility. The observed aspects included vehicle cleanliness, washing or disinfection processes, and sanitation treatment after the vehicles were used to transport hatching eggs.

RESULTS AND DISCUSSION

Hatching Egg Production System and Critical Biosecurity Points

The observations showed that the broiler parent stock farm in Mekarwaru Village applied an intensive production system based on closed-house poultry housing. This system was used to support the stability of the rearing environment, particularly temperature, humidity, ventilation, stocking density, and hatching egg production efficiency. In the context of poultry farming, hatching eggs are important biological inputs because they serve as the initial source for day-old chick production, which is subsequently used in broiler farming systems.

The hatching egg production chain at the research site did not end with egg production by the hens, but included egg collection, selection, initial fumigation, transportation, storage sorting, further fumigation, and distribution to the hatchery. Each stage had a potential risk of microbial contamination and therefore required layered biosecurity management. The critical biosecurity points identified in this study included closed-house poultry houses, egg fumigation boxes, egg transport vehicles, the egg storage facility, and the egg storage fumigation room.

These results indicate that fumigation at the broiler parent stock farm in Mekarwaru Village was not implemented as a single isolated measure, but rather as part of an integrated production sanitation system. From the perspective of applied agroecotechnology, this system can be understood as the application of sanitation technology to maintain the quality of biological inputs, namely hatching eggs, so

that they remain suitable for use in the broiler production chain.

Gambar 1. Lokasi Penelitian.

Observation Point	Function in Poultry Farming Production	Main Risk	Role of Fumigation/Sanitation
Closed-house poultry house	Rearing area for broiler parent stock and hatching egg production	Accumulation of microorganisms in the house, equipment, air, and litter	Reduces sources of contamination before the next rearing period
Egg fumigation box	Initial fumigation of eggs after collection from the poultry house	Microbial contamination on eggshells	Reduces initial contamination before eggs are transferred to the egg storage facility
Egg transport vehicle	Means of distributing eggs from the poultry house to the egg storage facility	Cross-contamination during transportation	Maintains sanitation continuity between production units
Egg storage facility	Area for sorting, coding, and temporary storage of eggs	Decline in egg quality due to recontamination	Maintains egg quality before delivery to the hatchery
Egg storage fumigation room	Further fumigation before hatching eggs are distributed	Microorganisms carried during transportation and sorting	Strengthens protection of hatching eggs before incubation

Application of Sanitation and Fumigation in Closed-House Poultry Houses

Fumigation of closed-house poultry houses was carried out after the rearing period had ended or before the houses were reused for the next production period. Before fumigation, the houses and equipment were cleaned. Cleaning was performed on the poultry house floor, feeding and drinking equipment, nest boxes, light traps, hoppers, cooling pads, exhaust fans, control panels, and service areas. Electronic equipment was protected before fumigation to prevent damage caused by fumigant gas exposure.

The observed closed-house poultry house measured 120 m × 15 m × 2 m, with an approximate volume of 3,600 m^3. The fumigant used consisted of C-Formator and formalin at a ratio of 1:2, namely 6.5 kg of C-Formator and 13 liters of formalin. The fumigant materials were placed at 13 points, consisting of 12 points in the rearing area and 1 point in the service area. After the materials were mixed, the house was closed for 24 hours, after which gas residues were removed using exhaust fans.

The application of poultry house fumigation indicates that the farm had integrated sanitation and disinfection as part of production environment management. From an agricultural perspective, the poultry house is the main production space that determines breeder health, hatching egg production stability, and facility-use efficiency. A poultry house that is not properly cleaned and fumigated may become a source of disease transmission for the next flock, thereby potentially reducing productivity.

Poultry house fumigation also reflects the implementation of good farming practices in intensive poultry farming. Sanitation was first conducted to remove organic matter, dust, feed residues, and feces that could reduce fumigant effectiveness. Thus, fumigation did not replace sanitation but served as a subsequent measure after the house had been cleaned. This practice is important because organic matter can protect microorganisms and reduce the effectiveness of the disinfection process.

Tabel 1. Statistik Deskriptif Parameter Fisika-Kimia Air Laut pada Kondisi Pasang dan Surut.

Observed Component	Observation Result	Significance in the Poultry Farming System
Implementation time	After the rearing period or before birds entered the house	Interrupts the contamination cycle between production periods
Fumigation objects	House, equipment, floor, service area, and supporting facilities	Reduces microbial contamination in the production environment
House volume	±3,600 m³	Serves as the basis for determining fumigant dosage
Fumigant material	C-Formator and formalin	Used as a disinfection technology in enclosed spaces
Dosage	6.5 kg C-Formator and 13 liters formalin	Adjusted according to house volume
Fumigation points	13 points	Supports even distribution of fumigant gas
Fumigation duration	24 hours	Provides sufficient contact time between the fumigant and target surfaces
Residue disposal	Exhaust fans	Reduces residual gas exposure to workers and livestock

Fumigation of Hatching Eggs in Farm Fumigation Boxes

Hatching eggs produced in the closed-house poultry houses were collected periodically and then selected before being placed in fumigation boxes. Eggs used as hatching eggs were obtained from nest boxes, had normal shapes, were not cracked or broken, were relatively clean, and were suitable for hatching. Eggs collected from the poultry house floor were not used as hatching eggs because they had a higher risk of contamination.

The egg fumigation box in the poultry house area had a capacity of 120 egg trays, or approximately 3,600 eggs. Each egg tray contained 30 eggs. The fumigation box had an approximate volume of 0.98 m³. The fumigant used was C-Formator and formalin at a ratio of 1:2, namely 7 g of C-Formator and 14 cc of formalin. The fumigation process lasted for 20 minutes.

Table 3. Application of hatching egg fumigation in farm fumigation boxes

Observed Component	Observation Result	Significance for Hatching Egg Quality
Egg source	Eggs from nest boxes	Reduces the initial risk of contamination from the poultry house floor
Egg selection	Intact, clean, uncracked, and hatchable eggs	Maintains the physical quality of eggs before fumigation
Fumigation box capacity	120 egg trays or ±3,600 eggs	Supports egg handling at production scale
Fumigation box volume	±0.98 m³	Serves as the basis for determining fumigant dosage
Fumigant material	C-Formator and formalin	Reduces microbial contamination on eggshells
Dosage	7 g C-Formator and 14 cc formalin	Adjusted according to the fumigation box volume
Fumigation duration	20 minutes	Provides contact time with the eggshell surface
Main purpose	Initial fumigation after egg collection	Maintains egg quality before transfer to the egg storage facility

Egg fumigation in the fumigation box was an important stage because it was carried out immediately after eggs were collected from the poultry house. This stage can be understood as a postharvest treatment for poultry farming products. Hatching eggs, as biological products, must be handled immediately so that microbial contamination on the eggshell does not develop or carry over into subsequent distribution stages.

In the broiler production system, hatching egg quality is directly related to hatchability and DOC quality. If microbial contamination is not controlled from the beginning, the risk of contamination may continue to the egg storage facility and hatchery. Therefore, initial fumigation in the fumigation box functions as the first protective measure for maintaining hatching egg quality.

Sanitation of Egg Transport Vehicles

The observations showed that the farm used special vehicles to transport hatching eggs from the poultry houses to the egg storage facility. These vehicles functioned as connectors between production units. Although the eggs had been fumigated in the poultry house area, recontamination could still occur during transportation if the vehicles, egg trays, trolleys, or workers were not maintained in clean condition.

Vehicle sanitation was carried out to maintain biosecurity continuity from the poultry houses to the egg storage facility. This measure is important because vehicles can serve as media for microorganism transfer from one production area to another. In modern poultry farming, hatching egg transportation should be viewed as part of the quality control system rather than merely as a product transfer activity.

Vehicle sanitation has important value for production sustainability because hatching eggs must remain protected during transportation. If vehicle cleanliness is not maintained, fumigation conducted in the poultry house may become less effective due to recontamination. Thus, vehicle sanitation is part of biosecurity technology that maintains product quality throughout the production chain.

Fumigation of Hatching Eggs in the Egg Storage Facility

After the eggs arrived at the egg storage facility, they were coded according to house origin and production date. Further sorting was then conducted to separate cracked, hairline-cracked, abnormal, excessively dirty, or otherwise unsuitable eggs. Suitable eggs were grouped according to size and physical condition, arranged in egg trays, placed on trolleys, and then transferred into the fumigation room.

The egg storage fumigation room measured 3.64 m × 2.23 m × 2.20 m, with an approximate volume of 17.85 m^3. The fumigant used was C-Formator and formalin at a ratio of 1:2, namely 220 g of C-Formator and 440 cc of formalin. The fumigation process lasted for 20 minutes. After fumigation, gas residues were released for 15 minutes through an exhaust duct assisted by an exhaust fan.

Fumigation in the egg storage facility functioned as a further treatment after initial fumigation in the farm fumigation boxes. This stage is important because the eggs had undergone transportation, receiving, coding, and re-sorting processes. Each of these processes had the potential to cause recontamination. Therefore, further fumigation strengthened the contamination control system before the eggs were delivered to the hatchery.

From an agricultural perspective, fumigation in the egg storage facility demonstrates that product quality management is carried out not only during production but also during postharvest handling and distribution. Hatching eggs, as inputs for broiler production, must be maintained in a clean, intact, and hatchable condition. This is important because hatching egg quality affects hatchability, DOC quality, and broiler farming productivity in subsequent stages.

Table 4. Application of hatching egg fumigation in the egg storage facility

Observed Component	Observation Result	Significance in the Production System
Stage before fumigation	Coding, sorting, and egg grouping	Supports traceability and quality control

Fumigation object	Hatching eggs in egg trays and trolleys	Reduces microbial contamination before delivery to the hatchery
Fumigation room volume	±17.85 m³	Serves as the basis for determining fumigant dosage
Fumigant material	C-Formator and formalin	Disinfection technology for enclosed spaces
Dosage	220 g C-Formator and 440 cc formalin	Adjusted according to the fumigation room volume
Fumigation duration	20 minutes	Provides fumigant gas contact time
Residue disposal	15 minutes using an exhaust fan and exhaust duct	Reduces the risk of chemical exposure
Main purpose	Further fumigation	Maintains hatching egg quality before delivery to the hatchery

Integration of Sanitation and Fumigation in the Hatching Egg Production Chain

The results showed that sanitation and fumigation at the broiler parent stock farm in Mekarwaru Village were implemented in multiple layers. Sanitation was conducted before fumigation to remove dirt and organic matter, whereas fumigation was carried out to suppress residual microorganisms on the surfaces of poultry houses, equipment, rooms, and eggshells.

Table 5. Integration of sanitation and fumigation in the hatching egg production chain.

Production Stage	Sanitation Conducted	Fumigation Conducted	Objective
Poultry house preparation	Cleaning of the house, equipment, floor, and service area	Fumigation of the closed-house poultry house	Preparing a hygienic production environment
Egg collection	Egg selection and light cleaning of eggs	Fumigation in the fumigation box	Reducing initial contamination on eggshells
Egg transportation	Cleaning of vehicles and transport facilities	Vehicle disinfection	Preventing cross-contamination
Egg storage facility	Coding, sorting, and egg grouping	Fumigation in the egg storage room	Maintaining egg quality before delivery to the hatchery
Post-fumigation	Gas residue disposal	Exhaust fan and exhaust duct	Maintaining worker safety and workplace environmental safety

This integration shows that fumigation at the research site had become part of the production biosecurity system, rather than merely a technical activity involving chemical use. In applied agroecotechnology, this is important because technologies used in farms must be able to support productivity, maintain product quality, and minimize environmental risks.

Layered fumigation also reflects efforts to maintain hatching egg quality throughout the production chain. Hatching egg quality is not determined only by breeder condition, but also by poultry house cleanliness, egg collection methods, equipment sanitation, transportation, sorting, and temporary storage. Therefore, fumigation serves as one of the risk-control technologies in poultry farming production systems.

Use of Fumigants, Occupational Safety, and the Production Environment

The use of fumigants at the research site was carried out by considering the volume of the space and the object being fumigated. In closed-house poultry houses, a higher dose was used because the room volume was larger and the fumigation objects included the entire house and its equipment. In fumigation boxes and the egg storage fumigation room, the dose was adjusted according to the room size and the number of eggs being fumigated.

Workers used personal protective equipment, including masks, gloves, eye protection, and dedicated footwear according to the needs of the fumigation activity. The use of personal protective equipment is important because the fumigants used are chemically active and may pose risks if inhaled or if they come into contact with the skin and eyes. In addition, the use of exhaust fans and exhaust ducts indicated an effort to reduce exposure to residual gas after fumigation was completed.

Table 6. Use of fumigants and occupational safety aspects

Fumigation Location	Fumigation Duration	Residue Control	Personal Protective Equipment Used	Main Risk
Closed-house poultry house	24 hours	Exhaust fan	Mask, gloves, eye protection, dedicated footwear	Gas exposure in a large enclosed space
Egg fumigation box	20 minutes	Fumigation box exhaust channel	Mask and gloves	Exposure during material preparation
Egg storage fumigation room	20 minutes	Exhaust fan and exhaust duct for 15 minutes	Mask, gloves, eye protection	Gas exposure in an enclosed room

Occupational safety is an important component in the application of modern agricultural technology. Effective fumigation must also consider worker and environmental safety. The use of chemicals without proper control of dosage, exposure duration, ventilation, and personal protective equipment may pose occupational health risks and cause air pollution in the production environment. Therefore, the success of fumigation is not only measured by its ability to reduce microorganisms, but also by the capacity of the system to protect workers and sustain the farm environment.

Implications for Hatching Egg Quality and Poultry Farming Productivity

The application of sanitation and fumigation at the broiler parent stock farm in Mekarwaru Village had direct implications for hatching egg quality. Poultry house fumigation contributed to preparing a clean production environment for broiler parent stock. Egg fumigation in fumigation boxes functioned to reduce initial contamination on eggshells. Fumigation in the egg storage facility served as a further treatment before the eggs were delivered to the hatchery. These three stages formed a complementary contamination control system.

In poultry farming systems, hatching eggs are the initial component that determines the success of broiler production. High-quality hatching eggs have the potential to produce healthy, uniform DOC with good growth performance. Conversely, hatching eggs contaminated with microorganisms may increase the risk of hatching failure, embryonic mortality, and low DOC quality. Therefore, fumigation can be understood as a technology that supports poultry farming productivity.

In addition, structured fumigation also supports production efficiency. A clean poultry house environment, protected hatching eggs, and hygienic distribution pathways can reduce the risk of losses caused by contamination. Thus, fumigation provides benefits not only for animal health but also for the economic aspects of poultry farming enterprises.

General Discussion

Overall, the results showed that the broiler parent stock farm in Mekarwaru Village had implemented fumigation as part of biosecurity sanitation technology. Fumigation was carried out at critical points in the hatching egg production chain, namely closed-house poultry houses, egg fumigation boxes, egg transport vehicles,

and the egg storage fumigation room. This pattern indicates that sanitation management was implemented in multiple layers to maintain hatching egg quality from the time the eggs were produced in the poultry house until before they were delivered to the hatchery.

In the context of applied agrotechnology, these findings show that sanitation technology in poultry farms is directly related to agricultural productivity. Fumigation functions to maintain the quality of the production environment, reduce the risk of microbial contamination, support hatching egg quality, and strengthen the sustainability of the broiler production chain. Therefore, fumigation should not be understood merely as a procedure involving chemical use, but as part of technological management in poultry farming production.

Nevertheless, the use of chemical fumigants must still be managed carefully. Periodic evaluation of dosage, effectiveness, ventilation, residue disposal, and compliance with personal protective equipment requirements should be conducted to ensure that fumigation remains safe for workers and the environment. In the future, poultry farms should also consider the possible use of more environmentally friendly alternative sanitation agents, provided that their effectiveness remains sufficient to maintain hatching egg quality.

Based on these results, the application of fumigation at the broiler parent stock farm in Mekarwaru Village can be considered relevant as a sanitation technology practice in poultry farming systems. This practice supports contamination control, maintains the quality of biological inputs, improves production chain efficiency, and strengthens the implementation of biosecurity in modern poultry farming enterprises.

CONCLUSION

The application of fumigation at the broiler parent stock farm in Mekarwaru Village was part of sanitation and biosecurity technology in the poultry farming system. Fumigation was implemented in an integrated manner at several critical points in the hatching egg production chain, including closed-house poultry houses, egg fumigation boxes in the poultry house area, egg transport vehicles, and the egg storage fumigation room. This implementation indicates that microbial contamination control was carried out in multiple layers, beginning from the poultry house environment until the eggs were ready to be delivered to the hatchery.

Fumigation of closed-house poultry houses played a role in preparing a clean production environment and interrupting the contamination cycle between rearing periods. Fumigation of hatching eggs in fumigation boxes functioned as an initial treatment to reduce microbial contamination on eggshells after the eggs were collected from the poultry houses. Further fumigation in the egg storage fumigation room helped maintain hatching egg quality after the eggs had undergone transportation, sorting, and grouping. Sanitation of egg transport vehicles also supported the continuity of biosecurity by reducing the risk of cross-contamination between production units.

The fumigant used, consisting of a combination of C-Formator and formalin, was applied by considering room volume, dosage, fumigation duration, and gas residue disposal. In addition, the use of personal protective equipment by workers indicates that occupational safety had become part of fumigation implementation. This aspect is important because fumigation must not only be effective in reducing microorganisms but also safe for workers and the production environment.

Overall, fumigation applied at the broiler parent stock farm in Mekarwaru Village supported the management of

hatching egg quality as a biological input in the broiler production chain. This practice contributed to improved biosecurity, protection of hatching egg quality, production efficiency, and the sustainability of the poultry farming system. Therefore, fumigation can be considered a relevant applied agricultural sanitation technology to support modern poultry production, while still requiring periodic evaluation of fumigant effectiveness, compliance with standard operating procedures, occupational safety, and opportunities for the use of more environmentally friendly alternative sanitation materials.

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