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Antibacterial Activity of Onion Skin Meal Against Lactic Acid Bacteria, *Escherichia coli,* and *Salmonella* sp. as a Broiler Feed Additive

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Abstract:

The research aimed to determine the antibacterial activity of garlic, shallot, and onion's skin meal against lactic acid bacteria, *Escherichia coli,* and *Salmonella* sp. as an alternative feed additive for broilers. The materials used were garlic, shallot, and onion's skin meal, as well as isolates of lactic acid bacteria, *Escherichia coli*, and *Salmonella* sp. The research utilized three treatments, labeled as T1 (bacteria isolate+ garlic skin meal), T2 (bacteria isolate + shallot skin meal) and T3 (bacteria isolate+ onion skin meal). The parameters that were measured included the inhibition zone for lactic acid bacteria, *Escherichia coli,* and *Salmonella* sp. The methods employed in this research were laboratory analyses using quantitative descriptive. The results indicated that the inhibition zone for lactic acid bacteria was 4.4 mm with garlic skin meal, 2.5 mm with shallot skin meal, and 3.5 mm with onion skin meal. For *Escherichia coli* the inhibiotion zone was 5.5 mm with garlic skin meal, 3.6 mm with shallot skin meal, and 4.2 mm with onion skin meal. Regarding *Salmonella* sp.*,* the inhibition zone was 6.2 mm with garlic skin meal, 4.8 mm with shallot skin meal, and 5.2 mm with onion skin meal. The research concluded that the best results in inhibiting lactic acid bacteria, *Escherichia coli*,and *Salmonella* sp. were achieved garlic skin meal.

Keywords **—Broiler,*Escherichia coli,* lactic acid bacteria*,* onion skin meal*, Salmonella* sp.**

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I. INTRODUCTION

Broilers are one type of poultry that have high productivity in producing meat. Broiler productivity is influenced by breed, feed, and rearing management. Feed in broiler farming requires more attention because 60-70% of production costs are spent on feed. Production costs can be reduced if the feed efficiency used by chickens is increased. One of the steps that can be taken to improve feed efficiency is by adding feed additives to the feed. Antibiotics are one of the feed additives often used by farmers. However, the long-term use of antibiotics can cause negative effects, namely the presence of antibiotic residues in carcasses and visceral organs and bacterial resistance in human [1]. Therefore, there is a need for an alternative to antibiotics, namely the use of phytobiotics. One type of herbal plant that can be used as a phytobiotic is garlic, shallot, and onion.

Onions are one type of herbal plant that contains chemical compounds such as flavonoids, fructans, organosulfur, and saponins that are beneficial for the health of the poultry body. Not only the bulb part of the onion, but it also turns out that the onion skin, which is often discarded, is known to have chemical compounds that are no less useful than the bulb part. Chemical compounds in garlic skin that can act as antibacterials are flavonoids, alkaloids, saponins, quinones, and polyphenols [2]. Chemical compounds in shallot skin that can act as antibacterials are alkaloids, flavonoids, terpenoids, saponins, polyphenols, and quercetin [3]. Chemical compounds in onion skin that can act as antibacterials are flavonoids, tannins, saponins, and phenols. The antibacterial compounds in onion skin can inhibit the growth of gram positive (lactic acid bacteria) and gram negative bacteria (*Escherichia coli* and *Salmonella* sp.).

Lactic Acid Bacteria (LAB) are non pathogenic bacteria present in the digestive tract. Livestock productivity and health are greatly influenced by the lactic acid bacteria that dwell in digestive tract.This includes enhancing the nutritional value of feed, controlling intestinal infections, and improving digestion by inhibiting the growth of pathogenic bacteria in the digestive tract. *Escherichia coli* and *Salmonella* sp. are pathogenic bacteria found in the digestive tract of chickens. *Escherichia coli* bacteria in the small intestine cause damage to the villi, interfering with the process of feed absorption [4]. Meanwhile, *Salmonella* bacteria in the digestive tract can disrupt chicken growth and result in high mortality rates [5]. This study aims to determine the antibacterial activity of garlic, shallot, and onion's skin meal againstLactic Acid Bacteria (LAB),*Escherichia coli*, and *Salmonella* sp. as an alternative feed additive for broilers.

II. MATERIALS AND METHODS

A. *Research Materials*

The materials used in this research included garlic, shallot, and onion's skin meal, isolates of lactic acid bacteria, *Escherichia coli,* and *Salmonella* sp.,MRS-A media, Mac Conkey Agar media, NA media, and distilled water. The tools used in this research were petri dishes, incubators, L glass, paper discs, and calipers.

B. *Research Methods*

The research method used was laboratory analysis using quantitative descriptive with three treatments. Bacterial inhibition testing was conducted using the disc diffusion method. The treatments used were T1 (bacterial isolates + garlic skin meal), T2 (bacterial isolates + shallot skin meal), and T3 (bacterial isolates + onion skin meal).

C. *Research Procedures*

1. Onion Skin Meal Preparation
   The procedure for making garlic, shallot, and onion's skin meal was as follows: fresh onion skin was selected, cleaned by washing with running water, and aerated. Subsequently, the onion skin was dried using an oven at 50°C for 24 h. The dried onion skins were then ground and sieved using a 100-mesh sieve to form meal.
2. Bacterial Inhibition Test
   The procedure for testing bacterial inhibition using the Kirby Bauer disc method involved culturing lactic acid bacteria on MRS-A media, *Escherichia coli* and *Salmonella* sp. bacteria on MacConkey Agar media for 24 h. Afterward, bacterial suspensions were prepared by homogenizing 1 ml of distilled water with each cultured bacterium. Petri dishes containing NA media were prepared and incubated for 24 h. Bacteria were inoculated onto the agar plates using an L-shaped glass rod, and the petri dishes were sealed to prevent contamination. Paper discs were soaked in each sample for 20 min and then left to air dry. Subsequently, the paper discs were aseptically placed onto the NA media, which had previously been inoculated with bacteria. The media was incubated at 37°C for 24 h in an incubator. The diameter of the inhibition zone was measured using a caliper with an accuracy of 0.02 mm. According to the criteria established by [6], the interpretation of bacterial inhibition was as follows: a clear zone diameter of ≥20 mm indicated very strong inhibition, 10-20 mm indicated strong inhibition, 5-10 mm indicated moderate inhibition, and ≤5 mm indicated weak inhibition.

D. *Research Variables*

The variables observed were the inhibition diameter of garlic, shallot, and onion skin meal against Lactic Acid Bacteria (LAB), *Escherichia coli*, and *Salmonella* sp.

E. Data Analysis

The data obtained were recorded and discussed descriptively.

III. RESULTS AND DISCUSSION

TABLE I
ANTIBACTERIAL ACTIVITY OF GARLIC, SHALLOT, AND ONION'S SKIN MEAL AGAINST LACTIC ACID BACTERIA (LAB), *ESCHERICHIA COLI,* AND *SALMONELLA* SP

Treatments	Inhibition Zone Diameter (mm)		
	LAB	***Escherichia coli***	***Salmonella* sp.**
T1	4.4	5.5	6.2
T2	2.5	3.6	4.8
T3	3.5	4.2	5.2

A. Lactid Acid Bacteria (LAB)

The results in Table 1 showed that garlic, shallot, and onion's skin meal could inhibit the growth of lactic acid bacteria. The highest inhibition zone diameter was found in garlic skin meal, which was 4.4 mm, and the lowest inhibition zone diameter was found in shallot skin meal, which was 2.5 mm. Based on the provisions of bacterial inhibition according to [6], garlic, shallot, and onion's skin have weak inhibition ability because they have an inhibition zone diameter of less than 5 mm. Lactic acid bacteria were non-pathogenic bacteria that could have beneficial effects on poultry health, so the smaller the diameter of the inhibition zone, the better the feed additive. The results of this study indicated that antibacterial compounds in onion skins had not been able to inhibit the growth of lactic acid bacteria strongly, so the population of lactic acid bacteria in the digestive tract increased and affected the production of lactic acid, which was useful for poultry health. According to [7], lactic acid bacteria can control pathogenic bacteria, spur immune response, compete with toxins produced by bacteria to attach to receptors found in the epithelium of the small intestine, and change metabolism by increasing the activity of digestive enzymes, ferment glucose into lactic acid, are not pathogenic and safe for consumption, prevent the growth of harmful bacteria, and increase digestibility and absorption.

Garlic skin meal had the highest inhibition zone diameter compared to shallot and onion's skin meal. This was thought to be because garlic skin contained antibacterial compounds such as alkaloids, terpenoids, flavonoids, and saponins that could inhibit the growth of gram positive and gram negative bacteria. This is in accordance with research conducted by [2], which shows that garlic skin can inhibit the growth of gram positive bacteria, namely *Staphylococcus aureus*, because it contains secondary metabolites that have antibacterial activity. Onion skin meal could inhibit the growth of lactic acid bacteria, although not as strongly as garlic skin meal. This was thought to be due to the presence of antibacterial compounds in onion skin that could inhibit the growth of lactic acid bacteria. This is in accordance with [8], which states that onion skin contains compounds that act as antibacterials, such as flavonoids, saponins, phenols, and tannins. These antibacterial compounds can be bactericidal (kill bacteria) and bacteriostatic (inhibit bacterial growth), so they inhibit the growth of lactic acid bacteria [9]. Shallot skin meal had the lowest inhibition zone diameter compared to other treatments. This was thought to be because the antibacterial compounds in shallot skin were not able to penetrate the cell wall, making it difficult to inhibit or kill the growth of lactic acid bacteria. This is in accordance with [10], which states that lactic acid bacteria have thicker cell walls, making it more difficult for antibacterials to penetrate these cell walls and, as a result, inhibiting the growth of lactic acid bacteria becomes challenging.

B. Escherichia coli

The results in Table 1 showed that garlic, shallot, and onion's skin meal could inhibit the growth of *Escherichia coli* bacteria. The highest inhibition zone diameter was found in garlic skin meal, which was 5.5 mm, and the lowest inhibition zone diameter was found in shallot skin meal, which was 3.6 mm. Based on the criteria for bacterial inhibition as defined by [6], garlic, shallot, and onion's skin meal currently exhibit weak inhibition abilities as they have inhibition zone diameters of less than 5 mm.

Garlic skin meal had the highest inhibition diameter in inhibiting the growth of *Escherichia coli* bacteria compared to shallot skin meal and onion skin meal. This was attributed to the presence of antibacterial compounds in garlic skin, such as saponins,flavonoids, alkaloids, and terpenoids, which allowed it to inhibit the growth of *Escherichia coli* bacteria. According to [11], flavonoids exhibit antibacterial activity against *Escherichia coli*. The mechanism of action of flavonoids as antibacterials involves inhibiting DNA synthesis, disrupting the function of the cytoplasmic membrane, and inhibiting the transfer of energy required for bacterial metabolism. Onion skin meal was able to inhibit the growth of *Escherichia coli* bacteria, although its inhibitory effect was not as potent as that of garlic skin meal. This was attributed to the presence of antibacterial compounds in onion skin meal, which allowed it to inhibit the growth of *Escherichia coli* bacteria. This aligns with the findings of [8], who state that onion skin contains bioactive compounds that function as antibacterials. These compounds operate by inhibiting pathogenic bacteria through the disruption of cell wall formation caused by the aggregation of lipophate components within cell walls, leading to alterations in the composition of cell walls. Shallot skin meal had the lowest inhibition zone diameter compared to other treatments. This was attributed to the belief that the antibacterial compounds in shallot skin were unable to penetrate the cell wall of *Escherichia coli*, making it challenging to inhibit bacterial growth. This aligns with the findings of [12], who stated that the cell wall structure of *Escherichia coli* negative bacteria can influence the outcomes of the inhibition zone. *Escherichia coli* bacteria have a more complex cell wall that is composed of three layers: lipoprotein on the outside, lipopolysaccharide in the middle, and peptidoglycan inside. This makes it more difficult for antibacterial substances to enter the bacteria. This is further supported by [13], who noted that the fat content within the cell wall of gram-negative bacteria can impact the activity of thymohydroquinone, leading to a reduction in the produced inhibition.

According to [14], *Escherichia coli* is one type of pathogenic bacteria found in the small intestine of broilers. An increase in the population of *Escherichia coli* bacteria within the digestive tract or in the surrounding environment can lead to various diseases in livestock, including diarrhea, colibacillosis, pericarditis, respiratory tract infections, peritonitis, and salpingitis [15]. Factors such as cage sanitation, cleanliness of feed and drinking water, and poor environmental conditions can contribute to an increase in the number of *Escherichia coli* bacteria [16]. [17] have stated that maintaining a low number of *Escherichia coli* bacteria in the small intestine of broilers promotes healthy villi, allowing for efficient nutrient absorption and ultimately contributing to improved broiler performance.

C. *Salmonella* sp.

The results of the study in Table 1 showed that garlic, shallot, and onion's skin meal could inhibit the growth of *Salmonella* sp. The highest inhibition zone diameter was found in garlic skin meal, which was 6.2 mm, and the lowest inhibition zone diameter was found in shallot skin meal, which was 4.8 mm. Based on the provisions of bacterial inhibition according to [6], garlic skin meal is categorized as moderate in inhibiting the growth of *Salmonella* sp. bacteria because it has an inhibition zone diameter between 5-10 mm, while shallot and onion's skin meal are categorized as weak because they have an inhibition zone diameter of less than 5 mm.

Garlic skin meal had the highest inhibition diameter in inhibiting the growth of *Salmonella* sp. bacteria compared to shallot and onion's skin meal. This was thought to be because garlic skin contained flavonoids, saponins, alkaloids, and terpenoids, which were antibacterial compounds that could inhibit the growth of *Salmonella* sp. bacteria. This is in accordance with [18], who state that garlic skin contains antibacterial compounds such as alkaloids,flavonoids, tannins, saponins,and terpenoids. According to [19], flavonoid, tannin, saponin, and alkaloid compounds can inhibit the growth of *Salmonella* sp. The flavonoid compound group functions as an antibacterial by denaturing cell proteins and damaging cell membranes without being able to repair again. Tannins have antibacterial activity with the mechanism of action of wrinkling the cell wall or cell membrane, disrupting the permeability of the cell itself, resulting in inhibited growth and cell death. Saponin compounds can permeate through the outer membrane and weak cell walls before binding to the cytoplasmic membrane. This process reduces and disrupts cell stability and allows cytoplasm to leak out of the cell, which leads to cell death. Alkaloid compounds can act as antibacterials by disturbing the constituent components of peptidoglycan in bacterial cells, resulting in cell death and inhibiting the development of an intact layer of the cell wall.

Onion skin meal could inhibit the growth of *Salmonella* sp. bacteria, although not as strongly as garlic skin meal. This was due to the content in onion skin, which was antibacterial in nature and could inhibit the growth of *Salmonella* sp. bacteria. This is in accordance with [8], which states that onion skin contains various active compounds that act as antibacterials, such as flavonoids, phenols,saponins, and tannins. Based on the mechanism of antibacterial action on the content of secondary metabolite compounds contained in inhibiting the growth of *Salmonella* sp., the antibacterial compounds in onion skin have mechanisms of action such as inhibiting the synthesis of cell walls, integrity of bacterial cell wall permeability, enzyme activity, and the synthesis of nucleic acids and proteins [20]. Shallot skin meal had the lowest inhibition zone diameter compared to other treatments. This was thought to be due to the inability of the compounds in shallot skin to inhibit the growth of *Salmonella* sp. bacteria because of the very high resistance of the bacteria. This is in accordance with [21], which states that *Salmonella* sp. has a cell wall that is not easily denatured by active substances.

The presence of *Salmonella* sp. bacteria can cause digestive and metabolic disorders in poultry, thus reducing the growth performance of poultry as producers of hatching eggs and meat [22]. *Salmonella* sp. bacteria that often attack chickens are *Salmonella pullorum* or bacteria that cause lime disease. Chickens can be infected with *Salmonella* sp. from feed. According to [23], feed contaminated with *Salmonella* sp. is a source of disease that can enter poultry farms, and *Salmonella* sp. contamination is a serious problem because its contamination can contaminate eggs and can produce chicks that are carriers of *Salmonella* sp.

IV. CONCLUSIONS

The best results in inhibiting lactic acid bacteria, *Escherichia coli*, and *Salmonella* sp. and were obtained with garlic skin meal. Garlic, shallot, and onion's skin meal were effective in inhibiting the growth of lactic acid bacteria, *Escherichia coli*, and *Salmonella* sp., indicating their potential use as feed additives for broilers.

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