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The Evaluation Profile of Onion Peel Extract (*Allium Cepa* L.) on Scanning Electron Microscopy (SEM), Density, and Inhibitory Microbes as a Poultry Additive

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Abstract. This study aims to evaluate the scanning electron microscopy (SEM), density, and bacterial inhibition of onion peel as a potential poultry feed additive. The material used in this study was onion peel. Particle morphology was analyzed using a Scanning Electron Microscope (SEM) DEX tool with 10,000× magnification to observe particle structure and identify chemical elements. The density test was conducted to determine the volume occupied by particle mass. The bacterial inhibition test was carried out to identify the antimicrobial activity against *E. coli*, *Salmonella sp*. and lactic acid bacteria (LAB) around the wells. The results showed that the shape of the onion peel particles was irregular, resembling logs and lumps. The density of onion peel extract was (225 g/L). The inhibition test indicated that the solid extract of onion peel exhibited stronger antimicrobial activity compared to the solution or liquid extract. The inhibition zones of the solid extract were (10 mm) E. coli, (11.2 mm) Salmonella sp., and (7.1 mm) LAB. It can be concluded that onion peel flour has potential as a feed additive due to its digestible particle morphology (SEM), high particle density, and strong antimicrobial activity.
Keyword: additive, density, microbial inhibitory, onion peel, SEM

1 Introduction

The poultry industry in Indonesia continues to expand in response to increasing demand for animal protein. Feed remains the most critical and costly component in broiler production, directly influencing growth performance, health status, and production efficiency. The long-term use of antibiotic growth promoters has raised concerns related to antimicrobial resistance and food safety, leading to regulatory restrictions, including the prohibition of antibiotic feed additives under the Regulation of the Minister of Agriculture No. 14/PERMENTAN/PK.350/5/2017.

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As an alternative, phytobiotic feed additives derived from plant materials have gained attention due to their antimicrobial and antioxidant properties. Onion peel (*Allium cepa* L.), an agro-industrial by-product, contains bioactive compounds such as flavonoids, saponins, and phenolic acids, which have been reported to exhibit antibacterial activity and support gut health. The utilization of onion peel as a feed additive also aligns with sustainable livestock production through agricultural waste valorization.

Efforts made by farmers to reduce the use of antibiotics as feed additives include the addition of phytobiotics. Phytobiotics are plant compounds that can be used as feed additives derived from plants such as vegetables, fruits, medicinal plants, and grains [1]. Natural feed additives must still have good nutritional content, such as onion peels. Onion peel (*Allium cepa* L.) contains active compounds that can protect bulbs from physical and chemical damage. The active compounds contained in onion peel are flavonoids, saponins, and phenolic acids with antibacterial and antioxidant properties. The addition of onion peel to broiler chickens can increase weight gain [2]. Increased body weight gain is proportional to improved chicken health, amino acid digestibility, and intestinal health [3].

Based on the above description, the utilization of onion peel (*Allium cepa* L.) as a feed additive on production performance, blood profile, and immunity (IgA and IgG) in broiler chickens can be studied. Previous studies have primarily focused on the biological effects of onion-derived products on animal performance, whereas information on their physical characteristics and antimicrobial properties as feed ingredients remains limited. Therefore, this study aimed to provide preliminary data on the particle morphology, density, and antimicrobial activity of onion peel processed in different forms, as an initial step toward evaluating its suitability as a poultry feed additive.

2 Materials and methods

2.1 Materials

Onion peels were collected, cleaned, and processed into three forms: flour, solution, and solid extract. Distilled water was used as the solvent. Nutrient agar media and bacterial cultures of *E. coli*, *Salmonella* sp., and LAB were used for antimicrobial testing. The main equipment included SEM–EDX, analytical balance, glassware, laminar airflow cabinet, autoclave, incubator, and water bath.

2.2 Methods

1. Flour is made by separating clean onion peels to be air-dried and then dried in an oven for 3 days at a temperature of 50°C. The simplisia is ground using a grinder and then filtered using a 230 mesh sieve.
2. The solution obtained after the filtering process is then mixed with distilled water in stages. A 1:10 ratio is produced, followed by stirring and soaking for 1 day, then filtering.
3. The extract produced is a continuation of the onion solution, which is evaporated for 2 hours and concentrated in a water bath.
4. SEM can determine the morphology of the sample at high resolution and identify the chemical elements contained using an EDX device.
5. Density testing was conducted to determine the density of the sample by dividing the weight of the material by the volume of space it occupied (g/L).
6. Bacterial inhibition testing can identify the inhibition zone of an antimicrobial substance against microorganisms using the well method. Analyses were conducted

in duplicate (n = 2), and the results were expressed as mean values. The study was designed as an wxploratory assessment; therefore, data were analyzed descriptively without inferential statical testing.

2.3 Observation variables

Particle morphology and elemental composition were analyzed using SEM–EDX. Density was determined by dividing sample weight by occupied volume (g/L). Antimicrobial activity was evaluated using the well diffusion method by measuring inhibition zone diameters. All data were analyzed descriptively and presented as mean values without statistical comparison, and therefore the results should be interpreted cautiously.

3 Results and discussion

3.1 The Evaluation Effect of Onion Peel Extract (*Allium cepa* L.) on Scanning Electron Microscopy (SEM)

The results of microscopic testing of onion peel extract show that the components and structure of onion peel powder can be determined using a Scanning Electron Microscope (SEM). The shape and structure of onion peel tested using the LSUMP 1583 25 SEM instrument at 5,000x magnification can be seen in Figure 1, and at 10,000x magnification in Figure 2.

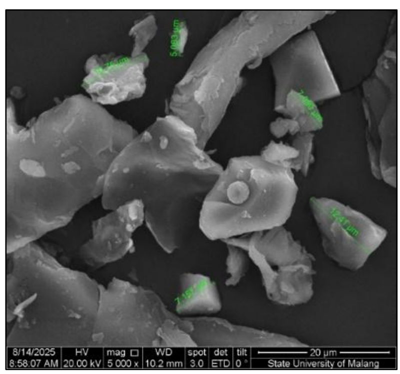

Fig. 1. Structure and size of particles on onion peel at 5,000x magnification with a working distance of 10.2 mm

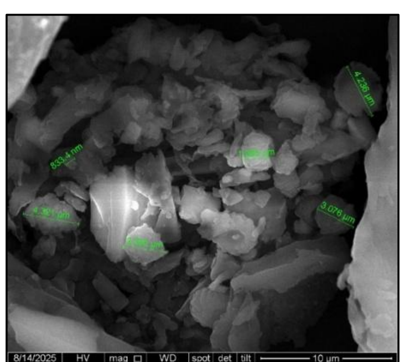

Fig. 2. Structure and size of particles on onion peel at 10,000x magnification with a working distance of 10.1 mm

Based on Figure 1 and Figure 2, it can be seen that onion peel is shaped like irregular lumps and chunks. This may be because during the grinding process and sieving using a 230 mesh sieve, the onion peel does not produce particles of the same size, resulting in variations in the shape and size of the particles. Based on a magnification of 10,000x, the size ranges from 833.4 nm to 1,985 µm. This particle size range is considered acceptable for powdered feed ingredients and may support uniform mixing and digestion in poultry diets, which is powdered rather than pellet-shaped [4]. The shape of the feed can affect absorption and the metabolic process in livestock. Onion peel contains chemical elements as shown in Table 1.

Table 1. Chemical content of onion peel

Element	Weight (%)	Atom (%)
C	60.93	67.97
O	37.60	31.49
Mg	0.10	0.06
Si	0.19	0.09
K	0.38	0.13
Ca	0.80	0.27

Mineral elements such as magnesium (Mg), potassium (K), and calcium (Ca) in onion peel function in stimulating muscles or nerves in livestock. Calcium is one of the dominant elements [5] in Table 1, which is useful for maintaining life by performing the process of demineralization in the blood. Calcium plays a role in chickens by aiding blood clotting and muscle relaxation. These elements are important for biological processes, including enzyme function and oxygen transport during maintenance.

3.2 The Evaluation Effect of Onion Peel Extract (*Allium cepa* L.) on Density

The results of the density test of onion peel extract showed that the density of the sample was 255 g/L. The density of onion peel powder was higher than that of fresh peel without processing, which was 169 g/L. Density was measured by comparing the weight of the sample with the volume of the sample [6]. A comparison between the two forms of onion peel flour shows a significant difference in density values. Density can be measured by the higher the mesh value, the higher the density value of the material. The form of flour as feed material affects the density value because it has undergone a grinding process. A high density value is proportional to an increase in feed consumption and can reduce the amount of feed spillage [7].

3.3 The Evaluation Effect of Onion Peel Extract (*Allium cepa* L.) on Inhibiting Microbes

The results of antimicrobial testing on onion peel extract to assess antimicrobial activity in the three sample forms against pathogenic test bacteria such as *E. coli*, *Salmonella* sp. and Lactic Acid Bacteria can be seen in Table 2.

Table 2. Bacterial inhibition zone on onion peel

Test Parameters	Sample	Result		
		E. coli (mm)	*Salmonella* sp. (mm)	LAB (mm)
Antimicrobial Activity	Flour	10	11.2	7.1
	Solution	2.8	1.65	3
	Extract	6.4	5.05	8.55

Based on Table 2, onion peels with three different shapes were used in the well diffusion method to produce a large inhibition zone diameter. This antimicrobial test aimed to determine the ability of onion peels to inhibit the growth of bacteria, namely *E. coli, Salmonella sp.,* and BAL. This clear zone indicates the ability of onion peels to inhibit bacterial growth. The classification of the response to bacterial growth inhibition based on the inhibited zone is as follows: a diameter >20 mm indicates a strong inhibitory response, a diameter of 16-20 mm indicates a moderate inhibitory response, a diameter of 10-15 mm indicates a weak inhibitory response, and <10 mm indicates a less effective inhibitory response [8].

Table 2 shows that the flour sample has the ability to inhibit bacteria weak to moderate inhibitory renponses based on inhibition zone classification on *E. coli, Salmonella sp.,* and BAL bacteria compared to other sample forms. The presence of a clear zone in the bacterial inhibition test can be used as an indicator of a compound's ability to inhibit bacteria, while sterile distilled water can be used as a negative control because it has no inhibitory effect, as evidenced by the absence of a clear zone [9]. Onion extract can inhibit the growth of E. coli bacteria based on several influencing factors, such as the processing method, storage method, and storage duration. These factors influence the antimicrobial properties in onion extract [10].

4 Conclusion

It can be concluded that onion peel flour exhibits suitable physical characteristics, including irregular but digestible particle morphology and relatively high bulk density, as well as measurable antimicrobial activity under in vitro conditions. Although these findings support its potential use as a natural poultry feed additive, the conclusions remain preliminary due to the descriptive nature of the study and the absence of statistical analysis. Further studies involving replicated experimental designs, statistical evaluation, and in vivo poultry trials are required to validate its practical application. This study was conducted as an exploratory assessment to generate preliminary data on the physical and antimicrobial properties of onion peel processed in different forms. The absence of inferential statistical analysis and in vivo validation limits the generalization of the findings. Therefore, the results should be interpreted cautiously and primarily as baseline information for further experimental studies. From a practical perspective, onion peel flour demonstrated favorable physical characteristics, including higher bulk density and powdered morphology, which may facilitate handling, storage, and incorporation into poultry feed formulations. Its measurable antimicrobial activity suggests potential application as a natural phytobiotic additive, particularly within sustainable feed production systems utilizing agro-industrial by-products.

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