The Effect of White Oyster Mushroom (*Pleurotus ostreatus*) Flour Addition in Feed to the Performances of Laying Hens

M H Natsir and M I T Wicaksono

Faculty of Animal Science, University of Brawijaya, Jl. Veteran, Malang 65145, Indonesia

emhanatsir@ub.ac.id

Abstract. The purpose of this study is to determine the effect of *Pleurotus ostreatus* flour addition at different concentrations in feed to the production performances of laying hens. The research materials were 240 *Hy-line* laying hens at the age of 32 weeks. The method used in this study was conducted as laboratory experiment in a completely randomized design with 6 treatments and 5 replications. The control treatments consisted of basal feed (P0) as the negative control treatment; and basal feed added with 0.2% Zinc Bacitracin (P1) as the positive control treatment. The experimental treatments include basal feed with the addition of *Pleurotus ostreatus* flour at 0.3% (P2); 0.6% (P3); 0.9% (P4); and 1.2% (P5). The observed variables were feed intake, hen day production (HDP), egg mass and weight, feed conversion ratio (FCR), and income over feed cost (IOFC). The obtained data was analysed with Analysis of Covariance (ANCOVA) with the help of Microsoft Excel and followed with Duncan’s Multiple Range Test (DMRT) to determine significances. The results showed that the addition of *Pleurotus ostreatus* flour in feed significantly affect (P<0.05) the egg weight and had highly significant effect (P<0.01) on the IOFC of laying hens. However, there is no significant effect (P>0.05) on feed intake, HDP, egg mass, and FCR. This research concludes that the addition of *Pleurotus ostreatus* flour on feed as Antibiotic Growth Promoter (AGP) substitution at 0.6% concentration had the best egg weight and IOFC.

1. Introduction

The white oyster mushroom (*Pleurotus ostreatus*) is a popular food crop in Asia, especially in Indonesia. The crop is commonly used for consumption and medical purpose. It is known to reduce cholesterol levels, while also has antibiotics and antibacterial activities. The consumption of white oyster mushrooms has been reported to reduce cholesterol levels due to the lovastatin content [1]. Moreover, the mushroom is known to has the ability to synthesis silver nanoparticles (AgNPs) which inhibits pathogenic bacteria, thus showed its potential to be used as natural antibiotic [2], and provide an alternative for commercial which have now been banned by the Indonesian government. The increasing bacterial resistance to antibiotic drugs has led to the awareness of using natural ingredients to be used in animal feeds [3]. It is noting that the residue of commercial antibiotics from the animal products had negative effects to the human, while also added with the existence of resistant to certain pathogenic bacteria resistance.

The use of herbal plants, such as white oyster mushroom as an alternative to the commercial antibiotics can be considered noting that the mushroom also contained various nutrients that are...
beneficial for the health of the livestock and human as well. Mushrooms have been known as health-promoting agent due to its antioxidants, phenolic compounds, tocopherols, carotenoids, and antibacterial contents [4]. The active compounds in Pleurotus ostreatus such as phenolic compounds and flavonoids would inhibit the lipid oxidation and peroxidation [5]. The in vitro analysis has showed that ethanol extraction of Pleurotus ostreatus would produce 54.90 mg/g phenolic compounds [6]. This study aims to determine the optimal addition of white oyster mushroom (Pleurotus ostreatus) flour in feed to the production of laying hens, which include feed consumption, hen day production (HDP), egg mass, egg weight, feed conversion ratio (FCR), and income over feed cost (IOFC).

2. Materials and methods

2.1. Laying hen
This study used 240 laying hens of Hy-line strain at 32-week-old with the average egg mass was at 38.19±5.01 g/bird and coefficient of variation at 13.14%. The laying hens were treated and observed for 6 weeks.

2.2. White oyster mushroom flour
This research used white oyster mushroom (Pleurotus ostreatus) that harvested at 5 days from oyster mushroom cultivation in Bendosari Village, Tulungagung Regency, Indonesia. As much as 97 kg fresh weight of white oyster mushrooms were processed into flour and resulted in white oyster mushroom flour with 9.7 kg dry matter.

2.3. Housing and rearing equipment
The battery type with a multilevel cage system was used in this research. The cage was sized at 20 x 30 x 40 cm, made from stainless steel and equipped with feed container and nipple drinker.

2.4. Feed
The laying hen basal feed was made by self-mixing feedstuffs with the composition is presented in Table 1, while the nutritional value of the basal feed can be seen in Table 2. The feed was given twice a day as much as 110 g/bird/day at 7.30 AM and at 1.00 PM, while the drinking water was given ad libitum.

![Table 1. Basal feed composition](image)
2.5 Method
The method used in this research was a laboratory experiment in a completely randomized design consisted of 6 treatments and 5 replications, thus resulted in 30 experiment units with each consisted of 8 laying hens for each replication. The treatments were as follow:
P0: Basal feed (negative control)
P1: Basal feed + Zinc Bacitracin (0.2%) (positive control)
P2: Basal feed + white oyster mushroom powder (0.3%)
P3: Basal feed + white oyster mushroom powder (0.6%)
P4: Basal feed + white oyster mushroom powder (0.9%)
P5: Basal feed + white oyster mushroom powder (1.2%)

The observed variables to determine the effect of white oyster mushroom flour addition in laying hens feed were feed consumption, hen day production (HDP), egg mass, egg weight, feed conversion ratio (FCR), and income over feed cost (IOFC).

3. Result and discussion
The production of laying hens which consisted of feed consumption, HDP, egg mass, egg weight, FCR, and IOFC in this research can be seen in Table 3.

Table 2. Nutritional value of the basal feed

| Nutritional content                        | Value   |
|--------------------------------------------|---------|
| Metabolizable energy (kkal/kg)             | 2,670.75|
| Dry matter (%)                             | 89.06   |
| Ash (%)                                    | 10.78   |
| Crude protein (%)                          | 19.66   |
| Crude fiber (%)                            | 3.48    |
| Crude ether (%)                            | 4.77    |
| Ca (%)                                     | 3.96    |
| P (%)                                      | 0.71    |

Notes: The proximate analysis is conducted in the Laboratory of Feed and Nutrition, Faculty of Animal Science, Universitas Brawijaya

Table 3. The effect of white oyster flour addition to the laying hens production

| Treatments | Feed intake (g/bird/day) | HDP (%)  | Egg mass (g/bird) | Egg weight (g) | FCR (Rp/bird/day) | IOFC (Rp/bird/day) |
|------------|--------------------------|----------|-------------------|----------------|-------------------|-------------------|
| P0         | 107.40 ± 0.63            | 72.78 ± 4.01| 43.09 ± 2.96      | 59.07 ± 1.05   | 2.53 ± 0.19     | 555.81 ± 18.88    |
| P1         | 107.93 ± 1.11            | 75.18 ± 4.58| 45.41 ± 3.25      | 60.34 ± 1.10   | 2.44 ± 0.27     | 559.83 ± 22.91    |
| P2         | 107.28 ± 0.85            | 77.61 ± 4.13| 46.40 ± 1.83      | 59.80 ± 1.03   | 2.31 ± 0.11     | 545.76 ± 17.03    |
| P3         | 107.05 ± 1.43            | 77.58 ± 4.87| 47.38 ± 3.69      | 61.03 ± 1.27   | 2.31 ± 0.22     | 545.56 ± 30.71    |
| P4         | 107.04 ± 0.68            | 79.07 ± 6.70| 47.10 ± 4.05      | 59.53 ± 1.02   | 2.32 ± 0.22     | 493.86 ± 18.76    |
The results showed that the treatment did not give significant effect (P > 0.05) to the consumption of laying hens. The condition showed that the given white oyster mushroom flour in all treatments did not give negative effect to the laying hen, while the maximum feed consumption is restricted to 110 g/bird/day. However, this study showed that the highest feed consumption is seen at P5, which reached 107.82 g of consumed feed for each hen daily. The increased feed consumption was caused by the bioactive content such as flavonoids, antioxidant and antibacterial compounds that balance the intestinal microflora, thus optimize the digestive process. This is similar with [7] which showed that flavonoids, as the secondary metabolites of plants, have antibacterial, anti-fungal and anti-inflammatory properties.

The results of this research showed that there was no significant difference on HDP. The result is due to the similar total feed consumption of the laying hens and resulted in similar HDP as well. The lower feed consumption generally caused low protein consumption, which is essential in protein synthesis for egg production [8]. Moreover, the low protein consumption can be also caused by the saponin content in the white oyster mushroom flour, and turning into a limiting factor for its consumption. On the other hand, white oyster mushroom flour also contained bioactive compounds that binds the anti-nutrient agent and improve the laying hen production. The extracted saponin from white oyster mushroom flour was 2.95% [9]. In addition, the dried oyster mushroom also contained phenolic compound as much as 70.2 mg/g will inhibit the lipid oxidation and support the laying hen production [5]. Zahro and Agustini [9] added that the bioactive compounds in the form of flavonoids, antioxidants and anthocyanins would reduce the occurrence of pathogenic bacteria and increase the HDP of laying hens.

The egg mass did not show significant difference (P > 0.05) due to the similar HDP of all treatments, although other variables showed significant differences (P < 0.05). The addition of white oyster mushroom flour did not affect the HDP due to the presence of eggs [11], while also affected by other factors such as the period of clutch-laying egg that can affect the value of egg mass during the research. The results of this study also showed a significant difference (P < 0.05) on egg weight. The results of the Duncan’s multiple distance test (DMRT) showed that the addition of white oyster mushroom powder 0.3% (P2) has begun to increase the egg weight value. The statistical analysis showed that the addition of white oyster mushroom flour at 0.3 to 0.6% has the egg weight compared to the laying hens fed with AGP 0.2% zinc bacitracin addition. The result is caused by the antinutrient substances, such as saponin, contained in the mushroom. Saponins would bind proteins and amino acids and reduce the level of protein digestibility, even though can act as antibacterial as well [9]. In this research, we have also extract the saponin from the white oyster mushroom and showed the saponin content was 2.95%. This value was lower when compared to [12] which obtained 4.02% saponin in the white oyster mushroom.

The results of statistical analysis showed that the effect of treatment on feed conversion have no significant effect (P > 0.05). The use of mushrooms as a substitute for AGP from the Basidiomycota class needs to be considered because it is able to suppress the growth of pathogenic bacteria, increase the growth of non-pathogenic bacteria thus affecting good intestinal morphology in the digestion process of laying hens [13]. The results of statistical analysis in this study indicate that the addition of white oyster mushroom powder has a very significantly different effect (P < 0.01) on the IOFC.

4. Conclusion
Based on the results of the study, it can be concluded that addition of white oyster mushroom flour at 0.6% affect the egg weight and IOFC of the laying hens.

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