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Research Article

Leverage of Fermented *Turbinaria murayana* Seaweed on External Egg Quality

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Abstract | We aimed to determine the influence of using different levels of fermented *Turbinaria murayana* seaweed meal in the diet of laying hens on the external egg quality. We used a completely randomized design with five treatments and four replications. The treatments consisted of five levels of fermented *T. murayana* seaweed meal, i.e. 0, 5, 10, 15, and 20%. We evaluated some measures such as egg weight, length, width, shape index, eggshell strength, thickness, and eggshell weight. The results indicated that the different levels of fermented *T. murayana* seaweed meal in the laying hen diet did not significantly affect (p>0.05) egg weight, egg length, egg width, egg shape index, eggshell strength, eggshell weight, and eggshell thickness. The fermented *T. murayana* seaweed meal can be utilized up to 20% in the diet of laying hens without impacting the external quality of eggs.

Keywords | Egg quality, Egg weight, Laying hens, Seaweed meal, *Turbinaria murayana*

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INTRODUCTION

Turbinaria murayana seaweed meal has been identified to contain essential nutrients for livestock, such as carbohydrates, proteins, fats, vitamins, minerals, and other bioactive compounds. According to Reski *et al.* (2021), *T. murayana* seaweed meal with low salt content, 6.08% crude protein, 0.97% crude fat, 0.26% calcium, 0.42% phosphorus, and 1599.14 kcal/kg of metabolic energy. The fermentation of *T. murayana* can enhance its nutritional content, making it easier to digest and absorb within livestock's bodies. According to Reski *et al.* (2022), *T. murayana* seaweed meal fermented using local microorganisms derived from fruit waste contains 20.39% crude protein, 2.29% crude fat, 5.01% crude fiber, 1.91% calcium, 0.30% phosphorus, and 2340.74 kcal/kg of metabolic energy. Fermentation of *T. murayana* seaweed meal shows potential as a feed ingredient in laying hen rations because it contains enough nutrients and other bioactive compounds, which are expected to enhance egg quality.

Previous researchers have reported experiments on fermented *T. murayana* seaweed meal in poultry diets. For instance, using 15% fermented *T. murayana* seaweed meal in broiler diets can maintain performance and carcass quality without disturbing their physiological organs (Reski *et al.*, 2022). Reski *et al.* (2023) reported that using 20% fermented *T. murayana* seaweed meal in quail diets can sustain production performance and internal and external egg quality.

One of the factors influencing the quality of chicken eggs is providing feed ingredients with good quality and nutritional content (Undap *et al.*, 2022). Egg quality is a primary consideration for consumers. Harmayanda *et al.* (2016) suggest that external egg quality includes egg weight, length and width, and shell strength and thickness. Based on these considerations, we carried out a trial to evaluate the influence of the fermented *T. murayana* seaweed meal in laying hen diets concerning external egg quality.

MATERIALS AND METHODS

Research implementation

The research began by preparing a fermented *T. murayana* seaweed meal. The *T. murayana* seaweed was fermented using local microorganisms derived from fruit waste, with a dosage ratio of 500ml/250g *T. murayana* seaweed (Reski *et al.*, 2021). Subsequently, 200 ISA-Brown laying hens at 45 weeks of age were prepared as the research subjects, with an average weight of 1.7 kg per hen and an average daily egg production of 85%. Then, the formulation of the treatment diets was carried out according to a predetermined formula with a balance of protein and metabolic energy, according to Leeson and Summer (2005), which consisted of 17.50% crude protein and 2850 kcal/kg of metabolic energy. The was designed to last for six weeks, including a 1-week adaptation period. The treatment diets were provided twice daily, in the morning and afternoon, while water was provided *ad libitum*. Observations on the treatments were conducted throughout the research, focusing on the influence of using fermented *T. murayana* seaweed meal at different levels on the external quality of eggs. Measurement of each parameter was conducted at the Poultry Production Laboratory, Faculty of Animal Science, Universitas Andalas, during the last week of the experiment (the final three days of the sixth week), using a sample of 20 eggs on the first day, 20 eggs on the third day, and 20 eggs on the final day.

Material

This research utilized 200 ISA-Brown laying hens aged 45 weeks with an average daily egg production of 85%. The ingredients used in formulating the diets were corn, HK-338 concentrate, rice bran, clamshell meal, amino acids lysine, methionine, and fermented *T. murayana* seaweed meal as a treatment formulated to match the iso-protein and metabolic energy, precisely 17.50% protein and 2850 kcal/kg of metabolic energy (Leeson and Summer, 2005). Nutrient content (% As Fed) and metabolic energy (kcal/kg) of the feed ingredients composing the diet can be seen in Table 1, and the formulation of the treated diet can be found in Table 2.

Experimental design

The study employs a completely randomized design comprising five treatments, each repeated four times. The treatments involve different levels of fermented *T. murayana* seaweed meal (0, 5, 10, 15, and 20%) in the laying hen ration. A total of 200 laying hens were used and divided into 20 groups, with each group containing 10 laying hens.

Measured parameters

The variables observed in this experiment were the weight of the eggs (g/egg), obtained by weighing each egg using a digital scale (Osuka HWH, Japan). The length and width of the eggs (mm) were measured using a vernier caliper (150 Digital Calliper, Nankai Japan). The egg shape index is obtained by dividing the egg's width by length multiplied by 100%. The eggshell strength was measured using the DET6500 brand Egg Shell Strength Meter. The weight of the eggshell (g) was determined by weighing the eggshells of each replicate and dividing by the number of replicates using a digital scale (Osuka HWH, Japan). The thickness of the eggshell (mm) was measured using a vernier caliper (150 Digital Calliper, Nankai Japan).

Statistical analysis

All data were analyzed using analysis of variance (ANOVA) in SPSS version 25. If differences among treatments were found, further analysis was conducted using the Duncan Multiple Range Test method (Steel and Torrie, 2002).

Table 1: Nutrient content (%) and metabolic energy (Kcal/kg) of the feed ingredients composing the diet.

Feed ingredients	Crude protein	Crude fat	Crude fiber	Calcium	Phosphorus available	Metabolic energy	Methionine	Lysine
Corn	7.95	2.91	2.55	1.82	0.08	3300.00	0.20	0.20
HK-338 concentrate	44.33	4.34	1.64	10.44	0.48	2623.00	0.80	1.70
Fermented *Turbinaria murayana*	20.39	2.29	5.01	1.91	0.30	2340.74	0.01	0.38
Rice bran	8.38	3.72	15.40	2.60	0.14	1900.00	0.29	0.11
Clamshell meal	0.00	0.00	0.00	24.97	0.24	0.00	0.00	0.00
Lysine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00
Methionine	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00

Table 2: Formulation of the experimental treatment diets.

Feed ingredients	A	B	C	D	E
Corn (%)	57.50	57.00	56.50	56.00	55.500
HK-338 concentrate (%)	27.00	25.50	23.80	22.10	20.34
Fermented *Turbinaria murayana* (%)	0.00	5.00	10.00	15.00	20.00
Rice bran (%)	13.00	9.85	6.80	3.77	0.90
Clamshell meal (%)	2.28	2.40	2.60	2.80	2.90
Lysine (%)	0.20	0.21	0.23	0.24	0.25
Methionine (%)	0.02	0.04	0.07	0.09	0.11
TOTAL (%)	100.00	100.00	100.00	100.00	100.00
Crude protein (%)	17.63	17.68	17.65	17.62	17.58
Crude fat (%)	3.33	3.25	3.16	3.07	2.99
Crude fiber (%)	3.91	3.64	3.38	3.12	2.89
Calcium (%)	4.77	4.65	4.53	4.41	4.26
Phosphorus available (%)	0.20	0.20	0.21	0.21	0.21
Metabolic energy (kcal/kg)	2852.71	2854.05	2852.05	2850.42	2850.27
Methionine (%)	0.39	0.39	0.39	0.39	0.39
Lysine (%)	0.79	0.79	0.79	0.79	0.78

Table 3: Average egg weight, length, width, shape index, and eggshell strength, weight, and thickness.

Treatments of diet	Egg weight (g)	Egg length (mm)	Egg width (mm)	Egg shape index (%)	Eggshell strength (Kg/cm^2)	Eggshell weight (g)	Eggshell thickness (mm)
A (0% Fermented *T. murayana*)	57.17	53.55	42.05	78.55	4.43	6.83	0.32
B (5% Fermented *T. murayana*)	57.21	54.33	42.44	78.11	4.31	7.00	0.31
C (10% Fermented *T. murayana*)	56.57	54.72	42.48	77.64	4.42	7.00	0.31
D 15% Fermented *T. murayana*)	57.40	53.74	42.74	79.56	4.48	7.17	0.32
E (20% Fermented *T. murayana*)	56.02	53.91	42.50	78.84	4.71	7.08	0.30
Standard Error	0.57	0.48	0.22	0.62	2.60	0.18	0.01

RESULTS AND DISCUSSION

The experimental findings are summarized in Table 3.

The research results indicated that the use of fermented *T. murayana* seaweed meal at different levels in the laying hen diet did not significantly affect egg weight, egg length, egg width, egg shape index, eggshell strength, eggshell weight, and eggshell thickness.

Egg weight

The average egg weight aligns with the reported average egg weight by Tugiyanti and Iriyanti (2022), which ranged from 54.03 to 58.55 g per egg. Using fermented *T. murayana* seaweed meal up to a 20% level in the diet of laying hens can equal egg weights to those fed a control diet. This equivalence arises due to the balanced protein and energy metabolism in each diet, ensuring that the absorbed nutrients utilized by the body for egg production remain consistent. Energy and protein are two essential components required by the chicken's body. Therefore, with energy and protein balances, similar products in terms of eggs and meat will be produced, not differently (Agustini *et al*., 2014). Adding fermented *T. murayana* seaweed meal to the laying hens' diet does not alter the protein and energy balance of the diet. However, it does change the percentage of corn, HK-338 concentrate, and rice bran used, decreasing their utilization as fermented *T. murayana* seaweed meal is incorporated more. This change occurs because fermented *T. murayana* seaweed flour contains higher metabolic energy than rice bran and is closer in metabolic energy to corn. Additionally, it contains relatively high crude protein content. Reski *et al*. (2022) reported that fermented *T. murayana* seaweed meal contains 2340 kcal/kg of metabolic energy and 20.39% crude protein. Furthermore, experiments involving fermented *T. murayana* seaweed meal in laying quails up to a 20% level resulted in egg weights similar to those of quails consuming the control diet (Reski *et al*., 2023).

Egg shape index

The average egg lengths and widths were similar to the average length of chicken eggs, as Soewarno (2013) reported, which falls between 54.00 and 59.10 mm in length and 41.00 to 44.95 mm in width. Meanwhile, the egg shape index produced in this research was higher than the findings reported by Kasmiati and Sumpe (2018), 76.74%, and Fadillah (2022), 74.41%. This study's slight differences in length, width, and egg shape index are attributed to the consistent protein content in each treatment's diet. This indicated that the protein used in egg formation within the body remains consistent across treatments. The increased use of fermented *T. murayana* seaweed in the diet does not affect the protein content of the diet because the protein contained in the fermented *T. murayana* seaweed powder can substitute for the protein present in the replaced feed ingredients. Reski *et al.* (2022) reported that fermented *T. murayana* seaweed powder contains crude protein at 20.39%, which can reduce the use of corn and rice bran in the diet.

Eggshell strength

The average strength of eggshells was consistent with those reported by Ramadhani (2023), which were 3.96-4.92 kg/cm^2, and higher than the findings reported by Tumova *et al.* (2014), which were 3.60 kg/cm^2. The slight difference in the eggshell strength obtained was attributed to the balanced calcium and phosphorus minerals in each treatment's diet, which were not significantly different. Suprijatna *et al.* (2005) reported that laying hens consuming feed with sufficiently high levels of calcium and phosphorus would produce strong and thick eggshells. A diet containing 20% fermented *T. murayana* seaweed meal resulted in the highest eggshell strength, reaching 4.71 kg/cm^2. According to Ramadhani (2023), feeding fermented *T. decurrens* seaweed meal up to 18% in the di*et al*so resulted in the highest eggshell strength of 4.92 kg/cm^2, attributed to seaweed flour as a contributor of calcium and phosphorus in the diet.

Shell weight

The average weight of eggshells indicated no significant difference among treatments. This was because neither the thickness of the eggshells nor the egg weight differed. According to Aziz *et al.* (2020), the weight of eggshells is associated with their thickness; the thicker the eggshell, the heavier it tends to be. The increased use of fermented *T. murayana* seaweed meal in the diet of laying hens resulted in an increase in eggshell weight due to the calcium content contributed by the fermented *T. murayana* seaweed meal. This calcium content can be well digested and absorbed in the body, influencing the eggshells' quality.

Shell thickness

The eggshell thickness revealed no significant differences among the respective treatments and aligns with the usual eggshell thickness standards for laying hens, which typically range between 0.33-0.35 mm (Muntasih *et al.*, 2019). This lack of difference was attributed to the balanced calcium and phosphorus in the diet, which function in the formation of eggshells within the body. According to Ramadhani (2023), an experiment involving the addition of fermented *T. decurrens* seaweed meal in the diet up to 18% resulted in similar eggshell thickness among treatments, measuring between 0.40-0.42 mm.

CONCLUSIONS AND RECOMMENDATIONS

Fermented *T. murayana* seaweed meal can used in the diet of laying hens up to a level of 20% without affecting the external quality of eggs. The utilization of 20 % fermented *T. murayana* seaweed meal can reduce the usage of corn, rice bran, and HK-338 concentrate.

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NOVELTY STATEMENT

Research on using fermented *T. murayana* seaweed meal in the diet of laying hens has yet to be conducted. Its utilization has demonstrated positive effects, namely, reducing the usage of corn, rice bran, and HK-338 concentrate while maintaining the external quality of eggs.

AUTHOR'S CONTRIBUTION

All the authors mentioned in the paper have actively taken part in the research activities and have made substantial contributions to the creation of this article. Collectively, Sepri Reski, Ridho Kurniawan Rusli, and Maria Endo Mahata have been involved in shaping the research ideas and collecting and analyzing data. Furthermore, all authors have agreed to submit this manuscript to the Advances in Animal and Veterinary Sciences journal.

Ethical statements

This study adhered to the ethical standards for experimental animal research outlined in Indonesian Law No. 18 of 2019 about Animal Husbandry and Veterinary Science.

Conflict of interest

The authors have declared no conflict of interest.

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