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Research Article

The Effect of Using Fermentation Products *Turbinaria murayana* Seaweed in Rations on the Quality of Quail Eggs (*Coturnix coturnix japonica*)

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Abstract | This study aimed to see the effect of fermented *Turbinaria murayana* seaweed using Local Microorganisms (LMo) made from fruit waste in rations on the quality of quail eggs. This study used a completely randomized design of 5 treatments with four replications. The treatment gave *Turbinaria murayana* seaweed fermented products with different levels, namely 0, 5, 10.15, and 20% in the ration. Research data were analyzed using analysis of variance (ANOVA), and differences between treatments were tested using the Duncans Multiple Range Test (DMRT). The study's results were that the administration of *Turbinaria murayana* seaweed fermentation products with different levels showed a very significant effect (P≤ 0.01) on the cholesterol content of egg yolks. However, no significant effect (P≥0.05) on egg weight, shell thickness, shell percentage, yolk percentage, white percentage and egg fat content. This study concludes that *Turbinaria murayana* seaweed fermentation products can be used in laying quail rations up to 20% by producing low-cholesterol eggs.

Keywords | Cholesterol, Eggs, Fat, Quail, *Turbinaria murayana*

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INTRODUCTION

Eggs are the main product produced by quail (*Coturnix-coturnix japonica*), which contains complete nutrition and is liked by the public. Quail eggs taste good and have complete nutritional content such as 13.30% crude protein, 0.63% crude fiber and 11.99% crude fat, and contain various vitamins and minerals (Thomas *et al*., 2016). In addition, quail eggs also have a low price compared to chicken eggs. However, quail eggs contain high cholesterol compared to chicken eggs, namely 844 mg/100g eggs (USDA, 2015) compared to 423 mg/100g in chicken eggs (Nurfianti and Tribudi, 2016). Excessive consumption of foods containing cholesterol can lead to the narrowing of the arteries, which is not suitable for the health of consumers. Thus, it can cause concern for consumers who consume quail eggs in excess. Therefore, it is necessary to make efforts to produce low-cholesterol quail eggs and maintain their quality to increase the public's attractiveness to consume them and not become a problem for the health of consumers.

The efforts can be made by providing feed ingredients in the ration mix, which contain sufficient nutrients and secondary metabolites that can reduce cholesterol in quail eggs. A feed ingredient that has the potential to be used as feed ingredient in a mixture of quail rations is *Turbinaria murayana* seaweed. *Turbinaria murayana* seaweed belongs to the brown seaweed that grows a lot

and attaches to coral reefs around the coast of the Nipah River, South Coastal District, West Sumatera Province (Reski *et al*., 2022). *Turbinaria murayana* seaweed contains secondary metabolites such as alginate fucoidan and fucoxanthin. Alginate is a high-fiber compound that can reduce cholesterol in the body (Kimura *et al*., 1996). Reski *et al*. (2021) reported that *Turbinaria murayana* seaweed contains alginate of 13.51%, and experiments giving *Turbinaria murayana* seaweed in broiler rations up to a level of 10% can maintain performance and reduce abdominal fat content. According to Akerina (2021), adding green seaweed flour to quail livestock rations can reduce the cholesterol content of egg yolks from 443.79 mg/100g to 430.59 mg/100g. Mohammadigheisar *et al*. (2020) reported that giving seaweed flour 5–10g/kg in rations improved broiler performance and reduced pathogenic bacteria in the gastrointestinal tract.

Turbinaria murayana seaweed which has been processed by the fermentation method using Local Microorganisms (LMo) 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 metabolic energy (Reski *et al*., 2022). Besides containing sufficient nutrients for livestock needs, *Turbinaria murayana* seaweed also has abundant availability because it only grows naturally and is not used by the surrounding community as food or feed ingredients. Previous research that has been carried out is the administration of *Turbinaria murayana* seaweed fermented products using LMo of fruit waste in rations up to a level of 20% can maintain performance, carcass quality and physiological organs, and reduce broiler abdominal fat content (Reski *et al*., 2022). There needs to research on the use of *Turbinaria murayana* seaweed as a product of fruit LMo fermentation in rations on the quality of quail eggs. Based on this, research has been carried out on the administration of *Turbinaria murayana* seaweed fermented fruit MOL products in rations on the quality of quail eggs.

MATERIALS AND METHODS

Ethich statements

This research was conducted according to the guideline for the ethical study of experimental animals based on the law of Indonesia number 18 of 2019 about Animal Livestock and Animal Science.

Research implementation

This study used *Turbinaria murayana* seaweed product of fruit LMo fermentation, using different levels, and the ingredients for the rations were formulated according to the levels needed. The treatment rations were given according to the specified protein iso and metabolic energy, namely 20% protein and 2800 Kcal/Kg of metabolic energy (Djulardi, 2022). The study was conducted in the experimental quail cage at the Faculty of Animal Husbandry, Anadalas University Change with Faculty of Animal Science, Universitas Andalas Padang, for six weeks. Each parameter was measured at the Laboratory of Non-Ruminant Animal Nutrition and the Laboratory of Poultry Production, Faculty of Animal Husbandry. Animal Husbandry, Andalas University, Padang.

Material

This study used 200 laying quails of the *Coturnix coturnix japonica* type aged 36 weeks with an average egg production of 65%. The feed ingredients for the ration formulation are corn, rice bran, corn gluten meal (CGM), soybean meal, fish meal, and stone flour, as well as *Turbinaria murayana* seaweed flour, a product of fruit LMo fermentation, as a treatment feed ingredient. Treatment rations were prepared and stirred by themselves, containing 20% iso protein and 2800 Kcal/kg energy iso. The content of food substances and energy metabolism of feed ingredients making up the ration can be seen in Table 1, and the composition of the treatment ration can be seen in Table 2.

Research procedure

The research began with the collection of *Turbinaria murayana* seaweed in the Nipah River Coastal Area,

Table 1: Content of nutrients (% dry weight) and metabolic energy (Kcal/kg) of feed ingredients for rations.

Nutrition composition	Crude Protein (%)	Crude Fat (%)	Crude Fibre (%)	Ca (%)	P (%)	ME (%)
Corn[a]	8.50	3.80	2.50	0.01	0.13	3300.00
Fermented *Turbinaria murayana*[b]	20.39	2.29	5.01	1.91	0.30	2340.74
Soybean meal[c]	48.00	0.50	3.00	0.20	0.33	2550.00
Fish meal[c]	51.75	3.32	1.00	6.50	4.00	2720.00
Rice bran[c]	13.00	5.00	12.00	0.06	0.80	1900.00
Top mix[d]	0.00	0.00	0.00	0.06	0.00	0.00
Corn gluten meal (CGM)[e]	51.67	2.85	0.39	0.77	0.66	3770.00
Stone meal[f]	0.00	0.00	0.00	38.00	0.17	0.00

[a]NRC (1994); [b]Reski *et al*. (2022); [c]Leesons and Summers (2005); [d]Medion (2019); [e]Montesqrit *et al*. (2020); [f]Khalil (2007).

Table 2: Composition of treatment rations and content of nutrients (%) and metabolized energy (Kcal/Kg) of treatment rations.

Nutrition composition	A	B	C	D	E
Corn	50.00	50.00	49.00	48.00	48.00
Fermented *Turbinaria murayana*	0.00	5.00	10.00	15.00	20.00
Soybean meal	9.00	8.00	8.00	7.00	7.00
Fish meal	9.00	9.00	8.00	8.00	7.00
Rice bran	16.00	12.00	9.00	6.00	2.00
Top mix	1.00	1.00	1.00	1.00	1.00
Corn gluten meal CGM	10.00	10.00	10.00	10.00	10.00
Stone flour	5.00	5.00	5.00	5.00	5.00
Total (%)	100.00	100.00	100.00	100.00	100.00
Crude Protein	20.47	20.49	20.52	20.59	20.57
Crude Fat	3.33	3.24	3.13	3.05	2.93
Crude Fibre	3.57	3.31	3.17	3.00	2.76
Calsium	2.60	2.69	2.71	2.81	2.83
Phosfor Available	0.66	0.64	0.59	0.57	0.52
ME	2805.30	2820.84	2820.67	2822.21	2836.05

A: treatment control ration (0% fermented *Turbinaria murayana* seaweed); B: treatment of the ration with 5% fermented *Turbinaria murayana* seaweed; C: treatment of rations with 10% fermented *Turbinaria murayana* seaweed; D: treatment of rations with 15% fermented *Turbinaria murayana* seaweed; E: treatment of rations with 20% fermented *Turbinaria murayana* seaweed.

South Coastal District, West Sumatra Province. Before being fermented, soak the seaweed for 3 hours to reduce its salt content. Then the seaweed soaked in running water is drained for 2 hours and fermented for seven days using the fruit LMo inoculum. Furthermore, the soaked low-salt seaweed fermented using LMo made from fruit waste. The ratio of inoculum and substrate doses was 2:1, which required 2 litres of fruit LMo inoculum for 1 kg of *Turbinaria murayana* seaweed. *Turbinaria murayana* fermented products were mixed into a ratio based on the iso protein content of 20% and iso 2800 Kcal/Kg metabolic energy with five levels of treatment using different fermented *Turbinaria murayana* seaweed flour. Namely 0, 5, 10, 15, and 20%. The rations made from fermented *Turbinaria murayana* seaweed, prepared for each treatment, were tested on quail for six weeks of the experiment.

Measured parameters

The parameters measured in this study are.

1. Egg weight (g/egg) obtained by weighing the whole egg divided by the total number of eggs.
2. Shell thickness (mm) is measured using a vernier calliper.
3. Yellow colour is measured using a yolk colour fun tool with a scale of 1-15 (Sudaryani, 1996).
4. The percentage of egg yolk (%) is obtained from the ratio between the weight of the yolk divided by the weight of the egg multiplied by 100%.
5. Percentage egg white (%) obtained from the ratio between the weight of the egg white divided by the weight of the egg multiplied by 100%.
6. Eggshell percentage (%) is obtained from the ratio between the weight of the eggshell divided by the weight of the egg multiplied by 100%.
7. The fat content of the yolk (%) was analyzed using the soxhlet method according to the Association of official analytical chemists (AOAC, 2005).
8. The egg yolk cholesterol content (mg/100g) was measured using the Libermann-Burchard method (Elwakkad *et al.*, 2012). The measurements were carried out at the Fitria Laboratory Clinic in Padang City.

Research methods and statistical analysis

The method used was a completely randomized design experiment (CRD) with five treatments using different fermented *Turbinaria murayana* seaweed products (0, 5, 10, 15, and 20%) in rations with five replications. Data were analyzed using analysis of variance. If there are differences between treatments, then tested with the Duncan Multiple Range Test (DMRT) (Steel and Torrie, 1991).

RESULTS AND DISCUSSION

External quality of quail eggs

The results showed that the use of *Turbinaria murayana* seaweed flour as a fermented product up to 20% in the ration had no significant effect ($P \geq 0.05$) on egg weight, shell thickness and percentage of quail egg shells (Table 3).

Table 3: Average egg weight (g/egg), eggshell thickness (mm), and eggshell percentage (%).

Treatment	Egg weight	Eggshell thickness	Eggshell percentage
A (0% Fermented *T. murayana*)	9,92	0,17	14,89
B (5% Fermented *T. murayana*)	10,00	0,14	13,35
C (10% Fermented *T. murayana*)	10,17	0,16	13,52
D (15% Fermented *T. murayana*)	10,33	0,14	13,89
E (20% Fermented *T. murayana*)	9,42	0,14	14,58
SE	0,40	0,01	0,80

SE: Standar Error.

Internal quality of quail eggs

The results showed that the use of *Turbinaria murayana* seaweed as a fermented product up to 20% in the ration had no significant effect ($P \geq 0.05$) on egg yolk colour,

Table 4: Mean egg yolk colour, egg yolk percentage (%), egg white percentage (%), egg yolk fat (%), and egg yolk cholesterol (mg/100g).

Treatment	Egg yolk colour	Egg yolk percentage	Egg white percentage	Egg yolk fat	Egg yolk cholesterol
A (0% Fermented *T. murayana*)	9.00	35.25	49.86	24.73	425.25[a]
B (5% Fermented *T. murayana*)	9.00	33.39	53.36	24.47	416.25[a]
C (10% Fermented *T. murayana*)	8.50	33.06	53.43	24.66	319.35[b]
D (15% Fermented *T. murayana*)	8.25	34.45	51.66	24.50	255.46[c]
E (20% Fermented *T. murayana*)	8.25	33.60	51.82	24.94	213.31[c]
SE	0.42	0.69	1.31	0.41	18.98

SE: Standar Error; Different superscripts showed significant differences (P ≤ 0.01) between treatments.

percentage of yolk and egg white, egg yolk fat, and had a very significant effect (P ≤ 0.01). On egg yolk cholesterol content (Table 4).

Egg weight

The weight of quail eggs treated with *Turbinaria murayana* seaweed fermented products in the rations did not show a significantly different effect between the treatments. Quail egg weight in this study ranged from 9.92-10.33 g/egg. The differences in egg weight between treatments were not significant because the nutritional content of each treatment ration was not different, so the nutrients obtained by quail in producing eggs were equally fulfilled. According to Nastiti *et al.* (2014), quail consuming rations with the same nutritional content will produce egg weight that is not different from the average weight of normal quail eggs, which is 10.49 g/egg. According to Rizal *et al.* (2022) that the use of fermented *Turbinaria decurrens* seaweed in laying hen rations up to a level of 18% does not affect egg weight. Kusumorini *et al.* (2021) reported that using kale flour in quail rations resulted in quail egg weights ranging from 9.06-10.82 g/egg. Using *Turbinaria murayana* seaweed as a fermented product up to a level of 20% in laying quail rations can produce an average egg weight equal to the control ration, and its use in rations can replace fine bran and part of corn and fish meal.

Eggshell thickness

The thickness of quail egg shells in the study using fermented *Turbinaria murayana* seaweed products up to 20% in the ration showed no significant difference between treatments. The thickness of the egg shells in this study ranged from 0.14-0.17 mm, similar to the study conducted by Kusumorini *et al.* (2021), which is 0.17-0.18 mm. The difference was not significant in the thickness of the shell due to the mineral balance of calcium and phosphorus in the treatment rations, which were also not different. According to King'ori (2011), the factors that affect the thickness of the eggshell are the balance of calcium, phosphorus and magnesium in the livestock ration given. Rizal *et al.* (2022) reported that the use of fermented Turbinaria decurrens seaweed in the ration of laying hens up to a level of 18% did not affect the thickness of the eggshells of laying hens. Thus, fermented *Turbinaria murayana* seaweed flour can be used up to 20% in quail livestock rations.

Eggshell percentage

The effect of using *Turbinaria murayana* seaweed as a fermented product up to 20% in the ration showed no significant effect on the weight percentage of shellfish. This is because the shells weight and the resulting eggshells' thickness are also not different. The percentage of shells produced in this study was between 13.85-14.89% of the egg weight. According to Rizal *et al.* (2022), the use of *Turbinaria decurrens* seaweed fermented products in laying hen rations up to 18% does not affect the percentage of eggshells because the weight of the shells also has no effect.

According to Yuwanta (2010), the percentage of quail eggshell weight ranges from 9-11% with a shell weight between 0.56-9 g/item. Meanwhile, according to Listyowati (2009), the percentage of quail egg shells was 20.7%.

Egg yolk color

The use of fermented *Turbinaria murayana* seaweed up to 20% in the ration showed no significant effect on egg yolk colour. This is because the fat content in egg yolks is also not different, between 24.47-24.94%. According to Agustantikaningsih *et al.* (2015), the colour of quail egg yolks is influenced by the amount of fat and protein in the egg, which will affect the thickness and colour of the egg. According to Rizal *et al.* (2022), using Turbinaria decurrens seaweed fermented products in the ration of laying hens up to a level of 18% in the ration does not affect the colour of the egg yolk with a colour score between 8.40-8.80. The colour of the yolk obtained in the results of this study ranged from 8.25-9, with the score scale used is 1-15. This result is higher than the results of research conducted by Agustantikaningsih *et al.* (2015), namely 6.74-6.94 with experiments using fermented seaweed waste flour in quail rations. According to Djulardi *et al.* (2021), the yolk colour

score on a scale of 1-15 ranges from 8.25-8.75.

Yolk and white percentages

The use of *Turbinaria murayana* seaweed as a fermented product up to 20% in the ration showed no significant effect on the percentage of yolk and white quail eggs. This is because the balance between the weight of the yolk and the weight of the egg white in each treatment is also not different. The egg yolk weight in this treatment was 33.06-35.25% of the total egg weight, while the percentage of egg white weight in this study was 49.86-53.43%. This result is greater than the research conducted by Listyowati (2009), namely the egg white content of 47.4% and egg yolk of 31.9%. Thus, *Turbinaria murayana* seaweed fermented products can be used in quail livestock rations up to 20%.

Egg yolk fat

The fat content in this study showed no significant differences between treatments. This was because the fat content of the rations in each treatment was almost the same. According to Yamamoto *et al.* (2007), the fat content in the ration will affect the fat from the egg yolks. The fat content of the rations in this study ranged from 2.67-3.57%. Using *Turbinaria murayana* seaweed as a fermented product up to a level of 20% in the ratio produces egg yolk fat between 24.47-24.94%. The fat content obtained in this study was higher than the results reported by Thomas *et al.* (2016), namely 11.99%.

Egg yolk cholesterol

In this study, fermented *Turbinaria murayana* seaweed flour up to 20% in the ration can reduce egg yolk cholesterol levels. The higher the use of *Turbinaria murayana* seaweed flour as a fermented product in the ration, the higher the decrease in egg yolk cholesterol. This is because the secondary metabolites contained in *Turbinaria murayana* seaweed are fermented products, namely alginate of 13.51%. Alginate is a high-fiber secondary metabolite compound that can reduce fat and cholesterol levels by binding to bile salts in the intestine and excreted through the faeces. The liver will actively re-synthesize bile salts due to a lack of bile salts bound by alginate. The essential ingredients for forming bile salts are fat and cholesterol, so this condition will reduce the fat content in the body and eggs (Reski *et al.*, 2021). Furthermore, it was conveyed that the use of *Turbinaria murayana* seaweed up to a level of 10% in the ration can reduce the fat content of the broiler abdomen. According to Akerina (2021), adding green seaweed flour to quail livestock rations can reduce the cholesterol content of egg yolks from 443.79 mg/100g to 430.59 mg/100g. The lowest cholesterol content in this study was found in fermented *Turbinaria murayana* seaweed at a level of 20%, namely 213.31 mg/100g. This result is much lower than the experiment conducted by Akerina (2021) using green seaweed flour, namely 430.59 mg/100g. Thus, the use of *Turbinaria murayana* seaweed flour as a fermented product can be used up to a level of 20% in rations to produce low-cholesterol quail eggs that are safe and healthy for consumption by the public.

CONCLUSIONS AND RECOMMENDATIONS

Giving *Turbinaria murayana* seaweed flour as a fermented product 20% in the ration can produce low-cholesterol quail eggs and does not interfere with both external and internal quality. Its use of up to 20% in rations can replace rice bran and reduce the use of corn, fish meal and soybean meal.

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NOVELTY STATEMENT

Using *Turbinaria murayana* seaweed as a 20% fermented product in the ration can produce low-cholesterol quail eggs, with the resulting quail cholesterol level of 213.31 mg/100g.

AUTHOR'S CONTRIBUTION

All authors in this article have contributed to the research up to the writing. Sepri Reski, Ridho Kurniawan Rusli, Montesqrit and Maria Endo Mahata have worked together from the preparation of ideas, research concepts, data collection and processing. All authors have also agreed to submit this article to the journal.

Conflict of interest

The authors have declared no conflict of interest.

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