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Research Article



Influence of Brown Seaweed (*Turbinaria murayana*) in Optimizing Performance and Carcass Quality Characteristics in Broiler Chickens

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Abstract | This study aimed to determine the influence of ration supplementation with brown seaweed (*Turbinaria murayana*) on performance, carcass quality, physiological organs, liver fat and broiler liver cholesterol. This study used 100 DOC (day old chicken) broilers of Arbor Acres CP 707 strains. This study used a completely randomized design (CRD) with five treatments; each treatment was repeated four times. The treatments were presented as brown seaweed (*Turbinaria murayana*), by a rate of 0, 2.5%, 5%, 7.5%, and 10% in broiler ration. Data were analyzed using Analysis of Variance (ANOVA), and Duncan's Multiple Range Test to reveal the significant differences between different treatments applied. The results showed that the use of *Turbinaria murayana* up to the level of 10% in the ration can maintain performance, carcass quality, do not interfere with physiological organs, and can reduce the content of abdominal fat, liver fat and broiler liver cholesterol. The study concluded that the use of *Turbinaria murayana* as a rations supplemental material up to the 10% level can stimulate broilers' performance and carcass characteristics.

Keywords | Abdomen fat, Broiler, Carcass, Cholesterol, *Turbinaria murayana*

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INTRODUCTION

The broiler is a type of poultry farm commodity that plays an essential role in supporting economic growth speed in Indonesia and meets the needs of animal protein for the fast overgrowing populations. Besides broiler chicken meat has a relatively low and affordable price for the community. The growth of broiler chickens is quick, as broiler chicken can reach a live weight of 1.3-1.6 kg in 5-6 weeks (Zainuddin *et al.*, 2020). Excessive fat deposits usually follow the fast growth of the broilers, so that it will affect the carcass quality and become less liked by consumers, especially those who have problems with dietary fat. The broiler is a type of chicken meat containing more fat and cholesterol than local chicken (*Gallus domesticus*). The quality of carcasses and fat deposits in broilers or their chemical composition of meat are greatly influenced by nutritional factors provided (Thirumalaisamy *et al.*, 2016). Improving carcass quality, fat reduction, and broiler cholesterol can be made through the provision of feed

ingredients in the mixture of ration. One of the broiler ration ingredients that have the potential and is available continuously and can improve the quality of carcasses, reduce fat and cholesterol in broilers is seaweed.

Seaweed is a macroalgae plant that grows in the sea and has no real roots, stems, and leaves (Dewi *et al.*, 2019). Seaweed belongs to the benthic macroalgae group, which is inherent in the bottom of the water and belongs to the *Thallophyta* division. Classification of seaweed usually depends on the pigment contents that consists of 4 classes, namely green seaweed (*Chlorophyta*), red seaweed (*Rhodophyta*), brown seaweed (*Phaeophyta*) and blond seaweed (*Chrysophyta*) (Suparmi and Sahri, 2009). In the Indonesian sea waters, there are around 782 types of seaweed (Horhoruw *et al.*, 2009). The kinds of seaweed that are commonly found and quite abundant are *Gracilaria* sp., *Gelidium* sp., *Euचेuma* sp., (*Rhodophyta*), *Sargassum* sp., *Turbinaria* sp., *Padina* sp., (*Phaeophyta*), and *Ulva* sp. (*Chlorophyta*) (Anggadiredja *et al.*, 2010).

The utilization of seaweed has the potential to be used as animal and poultry feed ingredients in Indonesia because Indonesia has vast sea waters that are covered by seaweed that is characterized by availability, grows naturally, and has not been utilized. According to Mwalugha et al. (2015) red seaweed contains 1.50% crude fat, 14.28 crude fiber, 11.56 crude protein, 29.29% ash, green seaweed contains 1.65% crude fat, 13.30% crude fiber, 10.52% crude protein, 39.44% ash, while brown seaweed contains 2.26% crude fat, 14, 08% crude fiber, 8.20% crude protein and 43.05% ash. Reski et al. (2020) reported the nutrient contents of seaweed *Turbinaria murayana* as 5.65% crude protein, 1.01% crude fat, 16.13% crude fiber, 1920.80 kcal/kg ME, 1.0% Ca 1.01% P, and 8.03% alginate. Besides containing food substances, seaweed also contains alginate, fucoidan, and fucoxanthin, which can reduce fat and cholesterol levels. *Turbinaria murayana* grass content is processed by soaking the weeds in water for 3 hours to reduce its salt content before use in poultry rations the grass contents were presented as 0.79% NaCl, 16.09% dry matter, 6.35% crude protein, and 15.65 crude fiber (Reski et al., 2020).

Some dietary trials via using seaweed have been shown to reduce fat and cholesterol. Pantjawidjaja (2008) reported the provision of rations containing 4.5% seaweed *G. verucosa* and *E. cottoni* in reducing abdominal fat and cholesterol in broiler chicken meat. Previous research was carried on the administration of three different types of seaweed, namely: *Sargassum crassifolium*, *Turbinaria decurrens*, and *Padina australis* from Sungai Nipah Coast, South Pesisir Regency in broiler rations with a level up to 10%, and found their abilities to reduce the content of abdominal fat and broiler cholesterol, without negative impact on the physiological functions (Reski, 2015). But the use of *Turbinaria murayana* brown seaweed in broiler rations has never been studied before. This study aims to determine the effect of using, *Turbinaria murayana* seaweed a ration supplement on performance, carcass quality, physiological organs, liver fat, and broiler liver cholesterol.

ETHICAL STATEMENTS

This experiment was conducted according to the Guideline for ethics study of experimental animals based on the law of Republic of Indonesia number 18 of 2009 about Animal Livestock and animal husbandry.

RESEARCH IMPLEMENTATION

Turbinaria murayana seaweed were taken from the coast of the Nipah river, Pesisir Selatan Regency, West Sumatra, Indonesia. Feeding experiments were carried out in the experimental cage (Cage box 20 units measuring 80 x 60 x 50 cm), the nutrient content of seaweed *Turbinaria murayana* and liver fat were analyzed in the non-ruminant nutrition laboratory at the Andalas University, Padang, Indonesia. A liver cholesterol test was carried out in the anatomy, physiology, and pharmacology laboratories of the veterinary faculty of the Bogor Institute of Agriculture (IPB).

MATERIALS

This study used 100 DOC (day old chicken) broilers of Arbor Acres CP 707 strains. *Turbinaria murayana* seaweed that was immersed in the river water for 3 hours, as well as, other ingredients of the ration like milled corn, fine bran, soybean meal, bone meal, Bravo 311 and 511 concentrates, and coconut oil were mixed together to formulate the ration used in the experiment. Self-stirred treatment rations compiled iso protein 21% and iso energy 2900 kcal/kg were provided during 1-2 weeks of age, and iso protein 20% and iso energy 2900 Kcal/kg were provided during 3-4 weeks of age. Ration constituents and ingredients of were recorded in Tables 1 and 2, as well as, the composition of the treatment ration, the food substances, and the metabolic energy were recorded in Tables 3 and 4.

RESEARCH PROCEDURE

Turbinaria murayana seaweed originating from Sungai Nipah Coast, South Pesisir Regency were collected from

Table 1: Contents of Substance (% Dry matter) and Metabolic Energy Feedstuffs Composition of Ration (Kcal/kg) for 1-2 weeks treatment

Feed ingredients	Protein %	Fat %	Crude fiber %	Ca %	P %	ME (Kkal/kg)	Alginate %	NaCl %
Corn (a)	8.80	3.80	2.20	0.02	0.10	3340.00	0.00	0.03
<i>Turbinaria murayana</i> (b)	6.08	0.97	14.98	0.26	0.42	1599.14	13.51	0.73
Soybean Meal (a)	35.35	2.90	7.50	0.63	0.32	2240.00	0.00	0.00
Bravo 311 (b)	22.13	6.11	5.60	0.12	0.54	3206.83	0.00	0.00
Fine Bran (a)	12.90	13.00	16.15	0.69	0.26	1640.00	0.00	0.00
Bone Meal (a)	0.00	0.00	0.00	24.00	12.00	0.00	0.00	0.01
Coconut Oil (a)	0.00	100.0	0.00	0.00	0.00	8600.00	0.00	0.00

Source: (a) NRC (1994); (b) Reski et al. (2020).



Table 2: Contents of Substance (% Dry Matter) and Metabolic Energy of Feedstuff Composition (Kcal/kg) for 3-4 weeks treatment.

Feed ingredients	Protein %	Fat %	Crude fiber %	Ca %	P %	ME (Kcal/kg)	Alginate %	NaCl %
Corn (a)	8.80	3.80	2.20	0.02	0.10	3340.00	0.00	0.003
<i>Turbinaria murayana</i> (b)	6.08	0.97	14.98	0.26	0.42	1599.14	13.51	0.73
Soybean Meal (a)	35.35	2.90	7.50	0.63	0.32	2240.00	0.00	0.00
Bravo 311 (b)	22.02	6.98	6.04	0.12	0.68	3222.82	0.00	0.00
Fine Bran (a)	12.90	13.00	16.15	0.69	0.26	1640.00	0.00	0.00
Bone Meal (a)	0.00	0.00	0.00	24.00	12.00	0.00	0.00	0.01
Coconut Oil (a)	0.00	100.00	0.00	0.00	0.00	8600.00	0.00	0.00

Source: (a) NRC (1994); (b) Reski et al. (2020).

Table 3: Composition of treatment ration for 1-2 weeks treatment and content of food substances and metabolic energy of treatment ration.

Feed ingredients	Treatment				
	A	B	C	D	E
Corn	19.50	19.00	19.00	19.00	18.00
<i>Turbinaria murayana</i>	0.00	2.50	5.00	7.50	10.00
Soybean Meal	31.50	32.00	32.00	32.00	33.50
Bravo 311	34.00	34.00	34.00	34.00	33.00
Fine Bran	10.00	7.50	5.00	2.50	0.00
Bone Meal	1.50	1.50	1.50	1.50	1.50
Coconut Oil	3.50	3.50	3.50	3.50	4.00
Total (%)	100	100	100	100	100
Nutrient					
Crude Protein	21.67	21.63	21.46	21.29	21.34
Crude Fat	8.40	8.10	7.79	7.49	7.63
Crude Fiber	6.31	6.31	6.28	6.25	6.25
Calcium	0.67	0.66	0.65	0.64	0.64
Phosphor	0.38	0.39	0.39	0.39	0.39
Metabolizable energy	2912.22	2905.70	2904.68	2903.66	2913.77
Alginate	0.00	0.34	0.68	1.01	1.35
NaCl	0.00	0.02	0.04	0.05	0.07

five different locations, then mixed together to be used as research samples. Seaweed was washed and cleaned from the remnants of sea sand and small corals attached to the seaweeds, and immersed in running water for 3 hours. After immersion, *Turbinaria murayana* seaweed was dried to 12-14% moisture content and finely ground to flour.

The cages were entirely cleaned and disinfected using lime and formaldehyde 5 cc/liter of water. Cages were numbered 1 to 20, and the treatments were randomly placed in a cage with a lottery system. The treatment consisted of treatment A = 0% seaweed (control), treatment B = 2.5%, treatment C

= 5%, treatment D = 7.5% and treatment E = 10% seaweed *turbinaria murayana*. Placement of chicks in a cage was carried as follows: 10 chicks were taken randomly, weighed, and the average weight sought to be used as a benchmark weight. Broiler chicks were housed in the cages using the average weight with 2 levels taken below and two levels above the average. Chicks were put in the cages from the lowest to the highest weight starting from cage number 1 to cage number 20 and starting again from cage number 20 to cage number 1 and so on until the chicks are all filled into the cage. Each cage unit contains five chicks.

Table 4: Composition of treatment ration for 3-4 weeks treatment and content of food substances and metabolic energy of treatment ration.

Feed Ingredients	Treatment				
	A	B	C	D	E
Corn	25.00	24.50	24.00	23.50	23.00
<i>Turbinaria murayana</i>	0.00	2.50	5.00	7.50	10.00
Soybean Meal	27.50	28.00	28.00	28.50	29.00
Bravo 311	33.00	33.00	33.00	33.00	33.00
Fine Bran	10.00	7.50	5.00	2.50	0.00
Bone Meal	1.50	1.50	1.50	1.50	1.50
Coconut Oil	3.00	3.00	3.50	3.50	3.50
Total	100	100	100	100	100
Nutrient					
Crude Protein	20.48	20.44	20.23	20.19	20.15
Crude Fat	8.24	7.93	8.11	7.80	7.50
Crude Fiber	6.22	6.22	6.18	6.17	6.17
Calcium	0.65	0.64	0.63	0.62	0.61
Phosphor	0.41	0.41	0.41	0.42	0.42
Metabolizable energy	2936.53	2930.01	2955.29	2948.77	2942.24
Alginate	0.00	0.34	0.68	1.01	1.35
NaCl	0.00	0.02	0.04	0.05	0.07

MEASURED PARAMETERS

BROILER PERFORMANCE

Feed consumption (g/head/day) was calculated based on the consumption rates. Measured every week, the initial ration minus the remaining ration divided by duration (seven days). Weight gain (g/head/day) was calculated as follows: the initial weights minus the final weight is then divided by seven days to gain weight per head per day.

Feed conversions were calculated by comparing feed intake per chick per day divided by weight gain per head per day.

CARCASS QUALITY

Live weights or final weights (g/head) were estimated at the age of four weeks, chickens from each trial unit were weighed for their life weight (g/head). The percentage of the carcass was presented as the ratio between carcass weight and live weight times 100%. The percentage of abdominal fat was presented as the ratio between the weight of abdominal fat with live weight multiplied by 100%.

Organs and tissues were represented as follows: the liver, pancreas, and ventricular percentage were calculated as the ratios between the liver, pancreas, and ventricular weights compare to the lifetimes weights multiplied by 100%.

Liver fat was calculated according to the following formula:

$$\text{Liver fat} = (b-c) / a \times 100\%$$

Where;

a is the initial sample weight; b is the weight of the package before extraction, and c is the weight of the package after extraction.

CHOLESTEROL ANALYSIS

with the Cholesterol High Performance (CHOD-PAP KIT) method (Boehringer, 1993). Liver cholesterol (mg/100g) = (Sample Absorbance)/(Standard Absorbance) x Standard Level.

RESEARCH METHODS AND STATISTICAL ANALYSIS

This study used a Completely Randomized Design with five different levels of treatment using *Turbinaria murayana* seaweed (0, 2.5%, 5%, 7.5%, and 10%) in the broiler ration. Each treatment was repeated four times. The data obtained were analyzed by Analysis of variance. If there are differences between treatments, then the differences between treatments are tested with the Duncan Multiple Range Test / DMRT (Steel and Torrie, 1991).

RESULTS

BROILER PERFORMANCE

The result of the study of Broiler Performance (ration

consumption, weight gain, and feed conversion) is shown in Table 5. The results of analysis of variance showed that the use of *Turbinaria murayana* seaweed in the ration had no significant effect (P≤0.05) on consumption, weight gain and broiler ration conversion.

Table 5: Average ration consumption (g/head/day), weight gain (g/head/day) and feed conversion for four weeks of treatment

Treatment	Ration consumption	Weight gain	Feed conversion
A (0% <i>Turbinaria murayana</i>)	73,77	42,74	1,73
B (2,5% <i>Turbinaria murayana</i>)	72,86	42,06	1,73
C (5% <i>Turbinaria murayana</i>)	72,03	41,98	1,72
D (7,5% <i>Turbinaria murayana</i>)	72,63	41,95	1,73
E (10% <i>Turbinaria murayana</i>)	72,00	41,96	1,72
SE	0,49	0,34	0,02

SE: Standard Error.

BROILER CARCASS QUALITY

The result of the study of Average live weight, percentage of the carcass, and the percentage of abdominal fat of broiler chickens for four weeks of treatment are shown in Table 6. The results of analysis of variance showed that the use of *Turbinaria murayana* seaweed in the ration had no significant effect (P≤0.05) on live weight, carcass percentage and had a significant effect (P≥0.05) on the percentage of broiler abdominal fat.

Table 6: Average live weight (g/head), percentage of the carcass (%) and percentage of abdominal fat (%) of broiler chickens for four weeks of treatment.

Treatment	Live weight	Percent- age of carcass	Percentage of abdominal fat
A (0% <i>Turbinaria murayana</i>)	1387,00	72,92	1,55 ^a
B (2,5% <i>Turbinaria murayana</i>)	1370,25	72,16	1,41 ^a
C (5% <i>Turbinaria murayana</i>)	1330,50	72,93	0,95 ^b
D (7,5% <i>Turbinaria murayana</i>)	1291,25	72,02	0,97 ^b
E (10% <i>Turbinaria murayana</i>)	1335,75	72,68	0,94 ^b
SE	25,71	0,70	0,07

SE: Standard Error; ^{a/b}The different superscripts in the same column indicate differences at P<0.05.

PHYSIOLOGICAL ORGANS

The mean percentage of the liver, pancreatic percentage and ventricular percentage of broiler chickens for four weeks of treatment are shown in Table 7. The results of the analysis of variance showed that the use of 10 *Turbinaria murayana* seaweed in the ration had no significant effect (P≤0.05) on the percentage of liver, pancreas and broiler ventricles.

FAT AND CHOLESTEROL LEVELS IN THE LIVER

Average liver fat and liver cholesterol of broiler chickens for four weeks of treatment are shown in Table 8. The results of the analysis of variance showed that the use of *Turbinaria murayana* seaweed in the ration had no significant effect ($P < 0.05$) on broiler liver fat and cholesterol.

Table 7: Mean percentage of the liver (%), pancreatic percentage (%) and ventricular percentage (%) of broiler chickens for four weeks of treatment.

Treatment	Percent- age of liver	Pan- creatic percent- age	Ventricu- lar per- centage
A (0% <i>Turbinaria murayana</i>)	1,78	0,26	2,04
B (2,5% <i>Turbinaria murayana</i>)	1,91	0,23	2,02
C (5% <i>Turbinaria murayana</i>)	1,82	0,25	2,02
D (7,5% <i>Turbinaria murayana</i>)	1,91	0,27	2,12
E (10% <i>Turbinaria murayana</i>)	1,96	0,25	2,26
SE	0,09	0,01	0,06

SE: Standard Error

Table 8: Average liver fat (%), and liver cholesterol (mg/100g) of broiler chickens for four weeks of treatment.

Treatment	Liver fat	Liver chole- sterol
A (0% <i>Turbinaria murayana</i>)	14,93 ^a	62,35 ^a
B (2,5% <i>Turbinaria murayana</i>)	14,91 ^a	37,24 ^b
C (5% <i>Turbinaria murayana</i>)	14,65 ^a	37,12 ^b
D (7,5% <i>Turbinaria murayana</i>)	13,71 ^b	34,48 ^b
E (10% <i>Turbinaria murayana</i>)	13,46 ^b	35,58 ^b
SE	0,20	0,06

SE: Standard Error; ^a^bThe different superscripts in the same column indicate differences at $P < 0.05$

DISCUSSION

BROILER PERFORMANCE

RATION CONSUMPTION

Supplementing broiler chickens with *Turbinaria murayana* seaweed in different levels of the ration showed no differences because it has the same level of palatability. The use of *Turbinaria murayana* seaweed in rations up to the level of 10% affected the aroma of the ration with the specific smell of seaweed (fishy odor), and thus increased the palatability of the treatment rations to match the palatability of the control ration. According to Alnasrawi (2016), the palatability of rations was determined by the taste, odor, and color that contribute to appetite in livestock. In comparison, the palatability of rations containing *Gracilaria edulis* seaweed (red seaweed) up to 15% in the pullet phase chicken ration was undisturbed and was nearly the same as the control ration (Horhoruw

et al., 2009). Thus *Turbinaria murayana* seaweed can be used as a mixture of poultry rations for its constituents of all the required nutritive substances needed for poultry. The reduced use of fine bran and corn in the ration with the inclusion of different levels of *Turbinaria murayana* seaweed does not change the nutritional contents of each ration, so the consumption rates remain the same. According to Suprijatna et al. (2005) and Pazla et al. (2018), consumption rates of rations were influenced by livestock type, feed energy content, food balance, and livestock age. Besides, Kartasudjana and Suprijatna (2010) stated that the physical form of livestock also influenced the consumption rates of rations.

WEIGHT GAIN

The use of *Turbinaria murayana* seaweed in the ration had no significant effect on broilers weight gain. The absence of the influence could be attributed to the insignificant differences in the consumption rate of broiler rations in each treatment ration containing *Turbinaria murayana* seaweed up to 10%. Feed consumption rates did not differ between treatments giving seaweed *Turbinaria murayana* in the ration caused the amount of food and energy consumed between treatments to be nearly the same, so that the nutritive requirements by broilers in different treatment groups didn't also reveal significant differences, and the increased broiler body weight didn't differ significantly. The amount of ration consumed can determine the amount of body weight gain (Rizal et al., 2010). Furthermore, Horhoruw et al. (2009) reported the provision of rations containing seaweed *Gracilaria edulis* (red seaweed) in the pullet phase chicken did not have a significant effect on broiler weight gains, this was contributed to food substances and energy between the same treatments, so that weight gains were also not significantly different among groups. Situmorang et al. (2013) also reported that *Gracilaria verrucosa* seaweed flour up to 7.5% in the ration did not have a significant effect on broiler body weight gains.

Also, there were no significant differences in body weight gains in each treatment of *Turbinaria murayana* seaweed in a broiler ration mixture, which might be attributed to the nutritional quality of each research ration with the use of *Turbinaria murayana* seaweed up to a level of 10% to match the quality of control ration (without seaweed), despite the reduction in the use of fine bran and corn in the ration with the inclusion of *Turbinaria murayana* seaweed in the ration mixture. Reduced usage of fine bran and corn in the ration by the use of *Turbinaria murayana* seaweed, can maintain body weight gains equivalent to the control ration. According to Wahju (2004), the weight gains of livestock were influenced by the amount and quality of ration consumed, where ration constituents were the main factor that determines the speed of growth.



The use of *Turbinaria murayana* seaweed in the ration had no significant effect on broiler ration conversions. Influential treatment of *Turbinaria murayana* seaweed treatment that is different in broiler ration to feed conversions, was caused by ration consumption and broiler body weight gains between treatments of *Turbinaria murayana* seaweed was also not significantly different, so the conversions become nearly the same. According to Rasyaf (2009) and Rizal et al. (2010) feed conversions were a comparison value between the amount of feed consumed, with bodyweight gains of chickens, and the feed conversion rates showed achievement of ration used by chickens. The lower the conversion values of the ration, the more efficient use of the ration was to produce meat or eggs. According to Horhoruw et al. (2009) *Gracilaria edulis* (red seaweed) seaweed feeding in the pullet phase chicken ration was not significantly different from feed conversions, this was because ration consumptions and weight gains had no significant effect. Consumption of the same ration followed by body weight gains that did not show and differences would result in the conversions of the same ration. According to Leeson and Summer (2001) factors that affect feed conversions include growth speed, consumption rates, the energy content in the ration, livestock size, the fulfillment of nutrients in the ration, environmental temperature, and animal health.

BROILER CARCASS QUALITY

LIVE WEIGHT

The use of *Turbinaria murayana* seaweed in the ration showed no significant effect on the live weights of broilers. There were no real differences between the treatment of *Turbinaria murayana* seaweed with different levels and up to 10% in the ration on the live weights of broiler chickens, this might be due to the lack of differences in the consumption of rations treated with of *Turbinaria murayana* seaweed. The nutritional quality, and quantity of the rations consumed between different treatment levels were the same contributing no difference in the weight. According to Rasyaf (2009), the live weights of poultry is influenced by the quality and quantity of food and maintenance management regarding the management system, namely intensive maintenance patterns related to the pattern of ration provision, chicken health care and cleanliness of the cage. Meliandasari et al. (2013), revealed the provision of rations containing seaweed *Gracilaria verrucosa* in broiler rations had no significant effect on the live weights of broilers. They attributed this to the balance of protein and energy, synchronized type and age, and uniform environmental conditions. Furthermore, Bangun et al. (2013) reported that the use of *Gracilaria verrucosa* seaweed flour up to 7% in broiler rations did not have a significant effect on the live weight of broilers. Rasyaf

(2009), found that food factors related to quality and quantity could affect the growth of broilers.

PERCENTAGE OF CARCASS

The use of *Turbinaria murayana* seaweed in the ration had no significant effect on the percentage of broiler carcasses. The difference in the effect of each treatment given ration containing seaweed *Turbinaria murayana* up to 10% had the same quality of ingredient as the control ration, especially protein. Suprijatna et al. (2005), reported that protein is an essential material in the formation of tissues and eggs. Therefore the availability of adequate protein in the ration is critical. Soeparno (2009), reported that the quality of the carcass is influenced by genetics, species, nationality, livestock type, sex, age, and feed provided. Siagian et al. (2015) reported that the use of *Gracilaria verrucosa* seaweed flour up to 10% level in quail ration was not significantly different from the percentage of quail carcass. Also, the different treatment of ration containing *Turbinaria murayana* seaweed with different levels was not significantly different as the living weights and carcass weights were not significantly different in each treatment so that the ratios between carcass weights and guardian life weights was the same. This is following the opinion of Murtidjo (2003) who stated that the percentage of carcasses is an important factor to assess broilers production because it is very closely related to the body weight, where the higher the weights, the higher carcass production increases. Live weights and growth rates can also affect the composition of the carcass of broiler (Soeparno, 2009).

PERCENTAGE OF ABDOMEN FAT

Turbinaria murayana seaweed supplementation in the ration had a significant effect on the percentage of abdominal fat of broiler chickens. The abdominal fat percentage in broiler chickens supplemented with *Turbinaria murayana* seaweed rations (treatments B, C, D, and E) was lower than abdominal fat in broiler chickens consumed control rations (treatment A). This is might be attributed to alginate compounds in the treated rations that can reduce fat and cholesterol levels in the body. Alginate compounds can bind with bile salts, these alginates cannot be digested by poultry because birds do not have alginate digestive enzymes, so alginates that bind to bile salts will be excreted through feces. With the reduced gall saline being extracted, the liver will actively synthesize bile salts, consuming extra amounts of cholesterol as the building stone (Dwiyitno, 2011). Panjawidjaja (2008), reported the provision of rations containing seaweed *Gracilaria verrucosa* and *Euchemia cottoni* up to 4.5% could reduce the abdominal fat. Reski (2015) also reported that providing broilers with rations containing three different types of seaweed (*Sargassum crassifolium*, *Padina australis*, and *Turbinaria decurrens*) can reduce the abdominal fat of broiler chickens.

Turbinaria murayana seaweed supplementation in the ration had no significant effect on the percentage of broiler hearts. The influence of each treatment on liver percentages showed that the provision of rations containing seaweed *Turbinaria murayana* up to 10% did not affect the weights and physiological functions of the liver as metabolic and detoxifying tissue, and when abnormalities occur in the liver, it is indicated by an enlargement or reduction of the liver (Whittow, 2000). It was further explained that the size and weight of the liver are influenced by several factors such as breed and species, body configurations, genetics, and feed provided. This is consistent with the results reported by El-deek and Brika (2009), who reported that giving seaweed up to 12% in duck rations did not have a significant effect on liver weight. Hendro (2015) reported that the effect of three different types of seaweed (*Sargassum crassifolium*, *Padina australis*, and *Turbinaria decurrens*) in the ration did not affect the liver weights of broiler chickens.

PERCENTAGE OF PANCREAS

Turbinaria murayana seaweed addition in the ration had no significant effect on the percentage of broiler pancreas. This showed that the provision of rations containing *Turbinaria murayana* seaweed up to 10% did not affect the weights and functions of the pancreas. The apparent difference between treatments for the pancreas percentage showed that the use of *Turbinaria murayana* seaweed in the ration up to 10% did not affect the development and work of the pancreas and was the same as pancreatic control so that the normal function of the pancreas in expressing digestive enzymes were not interrupted. Furthermore, it is explained that the pancreas has two functions which are all related to the use of ration energy, namely exocrine and endocrine. This is consistent with the results reported by Hendro (2015) which states that the administration of three different types of seaweed (*Sargassum crassifolium*, *Padina australis* and *Turbinaria decurrens*) in the ration did not affect the percentage of broiler pancreas.

PERCENTAGE OF VENTRICULUS

Turbinaria murayana seaweed usage in the ration had no significant effect on the ventricular percentage in broilers. This showed that the usage of rations containing *Turbinaria murayana* seaweed up to 10% did not affect the weights and function of the ventriculus. Suparjo et al. (2003) showed that ventriculus (Gizzard) is a place to mechanically digest food and respond to high crude fiber in the ration. *Turbinaria murayana* seaweed given in rations up to 10% contains 14.98% crude fiber, the percentage of crude fiber in the treatment ration in this study was following the tolerance limits of crude fiber requirements for broiler chickens. Rizal (2006) revealed that the amount of crude fiber in broiler rations was limited to 3-6%, so that the crude fiber

found in seaweed does not affect ventricular size (Gizzard). Also, the fact that the percentage of ventriculus in each treatment provided with rations containing *Turbinaria murayana* was affected by the shape and texture of each ration. Simanjuntak and Patabo (2016) mentioned the factors that influence the size of the ventriculus are the size of the livestock, type of feed and the amount (volume) of food consumed. The measure of ventricular strength (Gizzard) is influenced by the eating habits of the chicken (Yuwanta, 2004; Mahata et al., 2008).

FAT AND CHOLESTEROL LEVELS IN THE LIVER

FATTY LIVER

Supplementing rations with *Turbinaria murayana* seaweed had a very significant effect on liver fat. The apparent difference between treatment A (without seaweed), treatment B (2.5% seaweed), and C (5% seaweed) was caused by alginate in the ration given in treatment B, and C was still small, i.e. 0.34, and 0.64% in the ration, so it did not contribute the decrease in broiler liver fat, but there were decreases in liver fat in treatments B and C compared to treatment A. Furthermore, treatment A was significantly different from treatment D and E. This showed that by increasing the alginate content in treatments D and E, namely 1.01 and 1.35%, it can reduce the liver fat content, due to the role of alginate compounds in binding to bile salts in the intestine, while alginate cannot be digested by the poultry body for the lack of alginase enzymes. Pratiwi et al. (2016) states that food fiber, besides being able to bind cholesterol directly, also binds intraluminal bile acids and inhibits the enterohepatic circulation of bile acids.

LIVER CHOLESTEROL

Turbinaria murayana seaweed usage in the ration had a very significant effect on broiler liver cholesterol. Treatment A was significantly different from treatment B, C, D, and E, with no differences between the latter four treatments. The differences between treatments A with treatments B, C, D, and E are caused by the supplementation with *Turbinaria murayana* in the ration contributing to higher alginate which can bind salts of bile and discharged out of the body reducing cholesterol. Dwiyoitno (2011) reported that food fiber plays a role in binding bile salts produced by cholesterol in the liver, then discarded with feces. Furthermore, Winarno (2004) also stated that food fiber can reduce cholesterol in the body. In general, the fiber content in seaweed includes alginate, agar, and carrageenan (Pratiwi et al., 2016). He explained the decrease in cholesterol levels was attributed to the fiber content in alginate, which causes bile acids to increase and come out through feces. Astawan et al. (2005) reported that the addition of seaweed flour to hypercholesterolemic rations could reduce total cholesterol, LDL, triglycerides and atherogenic index.

Turbinaria murayana brown seaweed up to 10% in the ration can maintain performance, carcass quality, and organ weights and functions, and can reduce the content of abdominal fat, liver fat, and liver cholesterol.

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AUTHOR'S CONTRIBUTION

The authors were hereby given a declaration that this work was done by all of them named in this paper and all liabilities pertaining to claims relating to the content of this article will be borne by them. Sepri Reski, Maria Endo Mahata, Yose Rizal, and Roni Pazla conceived the idea, participates in data collection and run the test. All authors participated in conceptualization of the idea, study design, review, and editing of paper. All authors have read and agreed with submission of final paper to the journal.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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