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Research Article

Impact of Utilization of Brown Seaweed *Sargassum crassifolium* in Broilers Diet as a Substitution of Traditional Feed Ingredients

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Abstract | Due to increasing trend in prices of traditional feed ingredients, researchers are exploring marine resources as a novel cheap substitutions for poultry industry. This study aims to determine the effect of partial replacement of traditional feed ingredients like corn and rice bran with brown seaweed *Sargassum crassifolium* on broiler performance. The study employed a fully randomized design, incorporating four replacement treatments (0%, 6%, 12%, and 18%) of brown seaweed *Sargassum crassifolium* within the broiler diet. Each treatment was replicated five times. A total of 100-day-old chicks were used in the experiment and reared under standard conditions. The results showed that inclusion of brown seaweed *Sargassum crassifolium* up to 18% in broiler diet did not affect ($p>0.05$) daily feed intake, daily weight gain, feed conversion ratio, live weight, carcass percentage with skin and without skin; however, it significantly ($p<0.05$) reduced the abdominal fat pad percentage of broiler. In conclusion, the inclusion of brown seaweed *Sargassum crassifolium* in the broiler diet up to 18% reduces corn utilization by 24.49% and rice bran by 54.45% at the starter period and reduces corn up to 21% and rice bran by 50% at the grower period without interfering with their performance.

Keywords | Broiler, Corn, Performance, Rice bran, *Sargassum crassifolium*

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INTRODUCTION

Corn is the primary energy source in the poultry diet. However, the Indonesian government is still importing corn to stabilize the price of corn and the sustainability of poultry farming businesses in Indonesia. Currently, the government is paying serious attention to exploring Indonesia's marine natural resources to accelerate Indonesia's economic growth, known as the blue economy. Exploration and research on brown seaweed for poultry feed ingredients are rarely carried out, even though nutrients and bioactive compounds have the potential as functional feed to reduce corn in poultry diets (Reski et al., 2022; Dewi et al., 2019). Exploration of Indonesian seaweed for poultry feed has been carried out by several workers (Reski et al., 2021; Dewi et al., 2023; Reski et al., 2023). However, there has been no report on exploring brown seaweed *Sargassum crassifolium* on broiler performances. *Sargassum crassifolium* thrives naturally in almost all Indonesian seas and contains 6.42% protein, 0.9% fat, 32.36% nitrogen free extract, 14.99% crude fiber, 1.38% Calcium, 0.93% Phosphorus, 19.87% neutral detergent fiber, 14.70% acid detergent fiber, 3.57% cellulose, 5.16% hemicellulose, 10.86% lignin, 11.21% NaCl, 8.65% alginate bioactive compounds, 0.87% fucoidan, and 0.75mg/g fucoxanthin in dry weight (Mahata et al., 2015). Fucoxanthin and Fucoidan are anti-ox-

idants that can maintain body cells' health. Fucoidan and alginate in brown seaweed can reduce cholesterol (Carrillo et al., 2012). According to Reski et al. (2022), the administration of brown seaweed *Turbinaria murayana*, which contains secondary metabolites such as alginate, fucoidan, and fucoxanthin, can reduce the fat and cholesterol content in broiler meat.

The main problem in the utilitation of *Sargassum crassifolium* in a poultry diet is high salt and crude fiber content. The excessive salt concentration present in poultry feed results in instances of diarrhea and mortality (Mahata et al., 2015). Hence, there is a requirement for a method to diminish the salt content of *Sargassum crassifolium* prior to its incorporation into the poultry diet. According to Dewi et al. (2018) the *Sargassum binderi*'s salt decreased by 94% (i.e., from 11.21% to 2.9%) after being soaked in water for 15 hours. Current study, therefore was planned to examine the effect of partial replacement of traditional feed ingredients with *Sargassum crassifolium* seaweed into the broiler diet on broiler performance.

MATERIAL AND METHOD

Material

This experiment used 100 day-old chicks of broiler Lohmann strain MB-202 Platinum with an average weight of 45.2 ± 2.82 g/bird, which were placed in cages without separating males and females. The cages used were box cages with walls and wire floors, totaling 20 units measuring 60 × 50 × 50 cm each. Each cage accommodates five broiler chickens. The utilized experimental diet consisted of a formulation comprising the subsequent feed components: corn, rice bran, fish meal, soybean meal, meat bone meal (MBM), corn gluten meal (CGM), methionine, vitamin-mineral premix as well as coconut oil, along with *Sargassum crassifolium* seaweed flour. Each ingredient was weighed and mixed homogeneously according to the diet composition.

Experimental Diet

The diet utilized in this experiment was designed following broiler diet requirements. The diet contained 23% protein with an energy level of 2800 kcal/kg for broiler in the starter period (1-2 weeks, Table 1). Furthermore, the treatment diet contained 20% protein and an energy level of 2900 kcal/kg for the grower period (3-6 weeks, Table 1).

Preparing Brown Seaweed *Sargassum crassifolium* Flour

The brown seaweed *Sargassum crassifolium* was gathered from the shores of Sungai Nipah Beach in West Sumatra Province, Indonesia. The collected seaweed underwent a thorough cleaning process to remove any traces of sand and small coral fragments adhering to it. The seaweed was then immersed in a consistently moving stream of water for 15 hours. Following this immersion, the brown seaweed, *Sargassum crassifolium*, was naturally dried under the morning sun until its moisture content reached approximately 12 to 14%. It was then finely ground into a flour-like consistency (Dewi et al., 2023).

Experimental Design

The present experiment employed a fully randomized arrangement, incorporating four distinct levels of *Sargassum crassifolium* (0%, 6%, 12%, and 18%) within a broiler diet. Each of these treatments was replicated five times.

Measurements

Daily feed intake (g/bird/d): was measured by calculating the difference between the given diet and the remaining diet with the following formula:

Daily feed intake = Given diet (g) – Final remaining diet (g)

Daily weight gain (g/bird/d): was measured by calculating the difference between the body weight at the end of the previous week and the body weight at the beginning of the preceding week and divided seven (7) days using the following formula:

$$\text{Daily Weight Gain} = \frac{\text{Final Live Weight (g)} - \text{Starting Live Weight (g)}}{\text{Seven (7) days}}$$

Feed conversion ratio: was measured by dividing daily feed intake with daily weight gain with the following formula:

$$\text{Feed conversion} = \frac{\text{Daily Feed Intake (g/bird/d)}}{\text{Daily Weight Gain (g/bird/d)}}$$

Live weight (g/bird): was derived from the weight measurement of broilers in each treatment prior to slaughter, where the chickens were weighed after a 12-hour fasting period. Subsequently, the measurements were recorded in g/bird after the experiment (six weeks). The selected chickens in each experimental unit were those with body weights closest to the average weight within that particular experimental unit.

Carcass percentage with skin (%): was calculated by dividing carcass weight by skin and live weight and multiplying by 100%.

$$\text{Carcass percentage with skin} = \frac{\text{Carcass weight with skin (g/bird)}}{\text{Live weight (g/bird)}} \times 100\%$$

Carcass percentage without skin (%) was calculated by multiplying the carcass weight without skin by 100%.

$$\text{Carcass percentage without skin} = \frac{\text{Carcass weight without skin (g/bird)}}{\text{Live weight (g/bird)}} \times 100\%$$

Percentage of abdominal fat (%) was obtained by multiplying the abdominal fat pad weight by 100%.

$$\text{Abdominal fat pad percentage} = \frac{\text{Abdominal Fat Pad weight (g/bird)}}{\text{Live weight (g/bird)}} \times 100\%$$

Statistical analysis

The data were subjected to analysis of variance (ANOVA) for evaluation. Differences among treatments were examined using Duncan's multiple-range tests outlined by Stell & Torrie (1995).

RESULTS

As shown in the Table 2, the statistical analysis revealed that incorporating *Sargassum crassifolium* brown seaweed at levels of up to 18% in the broiler diet had no significant impact ($p>0.05$) on parameters like daily feed intake, daily weight gain, and feed conversion ratio. Likewise, live weight, carcass percentage with and without skin was also remained unaffected ($p>0.05$) by the supplementation of *Sargassum crassifolium* brown seaweed. Nonetheless, it significantly influenced ($p<0.05$) the abdominal fat percentage in broilers (Table 3).

DISCUSSION

Including brown seaweed *Sargassum crassifolium* with low salt content in the diet did not affect broiler feed intake. It seems that, the presence of *Sargassum crassifolium* in the diet did not interfere with the palatability of the diet; therefore, there is no difference in feed consumption. According to Alnasrawi (2016), the diet's palatability was controlled by taste, smell, and colour, all of which contribute to the livestock's appetite. Furthermore, Horhoruw et al. (2009) reported that a diet containing up to 15% red seaweed *Gracilaria edulis* in the laying hen's diet throughout the pullet phase did not impact feed intake. The average feed intake of broiler diet in this experiment ranged from 67.29 – 68.39 g/bird/d. The results of this experiment are not much different from the results reported by Reski et al. (2021), which stated that the inclusion of brown seaweed *Turbinaria murayana* up to 10% in broiler diet had no significant effect on feed consumption with average feed consumption ranging from 72.00 – 73.77 g/bird/d.

The daily weight gain of broiler does not affected by including of *Sargassum crassifolium* in the diet. The average broiler body weight gain found in this experiment was 42.44 to 45.73 g/bird/d. The findings of this experiment are consistent with those of Reski et al. (2021), whose research indicated that the inclusion of up to 10% brown seaweed *Turbinaria murayana* in the broiler diet had no significant impact on broiler body weight. The average daily weight gain ranged from 41.95 to 42.74 g/bird/day. Uzer et al. (2013) correlated broiler weight gain closely with feed intake, whereby higher feed consumption correlated with increased daily weight gain and vice versa. The current experiment illustrated that broilers efficiently utilized total feed and energy intake for their bodily tissue formation. Fathurrahman et al. (2017) further emphasized the connection between body weight gain and feed consumption for optimal growth, thereby necessitating a blend of high-quality feed ingredients in terms of quality and quantity.

The addition of up to 18% *Sargassum crassifoilum* has no effect on broiler feed conversion because daily feed intake and daily weight gain were not significantly different. The value of feed intake obtained in this experiment was directly proportional to body weight gain for each treatment, so the feed conversion rate was also not different. According to Wijayanti (2011), the high and low feed conversion rate is caused by the feed consumed and the body weight gain achieved. Thus, the high or low feed conversion rate is influenced by the feed consumption and the body weight gain obtained. The average broiler feed conversion in this experiment ranged from 1.50 to 1.60. The results of this experiment are better than the results reported by Reski et al. (2021), which stated that the inclusion of *Turbinaria murayana* up to 10% in broiler diet had no significant effect on feed conversion by producing an average feed conversion ranging from 1.72 to 1.73. This was due to the feed consumption and broiler body weight gain in this experiment having relatively the same values for each treatment, so the feed conversions were also relatively the same.

Brown seaweed *Sargassum crassifolium* in a broiler diet does not affect broiler live weight. Feed consumption and body weight gain both have an impact on broiler live weight. In this experiment, the broiler's feed consumption and daily weight gain were nearly identical for each treatment; thus, the broiler's live weight was not significantly different. According to Manullang et al. (2016), the live weight of broilers is impacted by the amount of feed intake and daily weight gain. This is also supported by the opinion of

Table 1: Experimental diet composition (%) and its metabolizable energy (kcal/kg) level.

Feed ingredients*	Diet (%)							
	Starter phase (1-2 weeks)				Grower phase (2-6 Week)			
	A	B	C	D	A	B	C	D
Corn	49	45	41	37	56.5	52.5	48.5	44.5
Rice Bran	13.75	11.25	8.75	6.25	15	12.5	10	7.5
Fish Meal	15	15	15	15	8.25	8.25	8.25	8.25
Soybean Meal	14.25	14.75	15.25	15.75	9	9.5	10	10.5
MBM	3	3	3	3	4	4	4	4
CGM	4.5	4.5	4.5	4.5	6.75	6.75	6.75	6.75
Vitamin-mineral premix	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Coconut Oil	0.25	0.25	0.25	0.25	0.5	0.5	0.5	0.5
Sargassum crassifolium	0	6	12	18	0	6	12	18
Total	100	100	100	100	100	100	100	100
Crude Protein	23.30	23.28	23.26	23.24	20.24	20.22	20.20	20.18
Crude Fat	3.60	3.32	3.04	2.76	3.62	3.34	3.06	2.78
Crude Fibre	3.05	4.32	5.58	6.84	3.24	4.50	5.77	7.03
Calcium	1.03	1.29	1.55	1.82	0.91	1.18	1.44	1.70
Phosphorus Available	0.79	0.74	0.69	0.65	0.72	0.68	0.63	0.58
Lysine	1.51	1.52	1.53	1.54	1.14	1.15	1.16	1.17
Methionine	0.53	0.53	0.53	0.53	0.47	0.47	0.47	0.47
Alginate	0	2.61	5.22	7.82	0	2.61	5.22	7.82
NaCl	-	0.17	0.35	0.52	-	0.17	0.35	0.52
Metabolizable Energy	2828	2824	2819	2814	2918	2914	2909	2905

MBM: meat bone meal, CGM: corn gluten meal

Table 2: Daily feed intake, weight gain, and feed conversion ratio in broiler chickens fed *Sargassum crassifolium* seaweed for six weeks.

Level of *Sargassum crassifolium* (%)	Daily feed intake (g/bird/d)	Daily weight gain (g/bird/d)	Feed conversion ratio
0	67.29	44.35	1.56
6	68.39	45.73	1.60
12	68.01	42.44	1.77
18	68.38	44.40	1.66

Table 3: Live weight, carcass percentage with skin, carcass percentage without skin, and abdominal fat pad percentage of broiler chickens fed *Sargassum crassifolium* seaweed for six weeks.

Level of *Sargassum crassifolium* (%)	Live weight (g/bird)	Carcass percentage with skin (%)	Carcass percentage without skin (%)	Abdominal fat pad percentage (%)
0	1775.8	68.82	60.78	1.28^{a}
6	1823.2	67.92	60.03	1.21^{ab}
12	1688.2	68.49	61.65	0.66^{bc}
18	1776.8	67.40	60.90	0.58^{c}

The presence of dissimilar superscripts within the column denotes statistically significant differences at a significance level of ($p<0.05$).

Murtidjo (2003), which stated that live weight is closely related to feed consumption. In contrast, feed consumption increases, and live weight increases and vice versa. The mean live weight of broilers fed *Sargassum crassifolium* seaweed in this experiment was 1688.20 g/bird to 1823.20 g/bird. The results of this experiment are higher than those of Nurulmukhlis et al. (2014) using red seaweed *Gracilaria verrucosa* in broiler diet, which reached broiler live weight

ranging from 1174.67–1359.00 g/bird.

The inclusion of *Sargassum crassifolium* seaweed in broiler diets up to 18% did not affected broiler carcass percentages, both with and without skin. The carcass percentage (both with and without skin) was affected by broiler live weight; in this experiment, the live weight of the broiler was not affected by *Sargassum crassifolium* in the diet. According to Dewi et al. (2014), one factor influencing the carcass percentage of broiler is live weight because the carcass percentage is obtained from the comparison between carcass weight and live weight. In addition, the opinion of Ikasari (2017), body weight, genetics, sex, age, and nutrition in diet are factors that affect broiler carcass weight. The diet's nutritional content and feed consumption in this experiment were also not different, so both carcass percentages with skin and without skin were not different. The percentage of broiler carcasses with skin and without skin in this experiment is 67.40% to 68.82% and from 60.03 to 61.65%. The results of this experiment are similar to the results of Dewayani et al. (2015), who stated that the carcass percentage of broiler Lohmann Platinum Strain aged 42 days was 59.30% to 63.37%.

Including brown seaweed *Sargassum crassifolium* in the diet up to 18% affects the percentage of abdominal fat pad on the broiler. Alginate compound (43.47%) in *Sargassum crassifolium* seaweed is a factor in reducing the broiler's abdominal fat pad percentage. Increasing *Sargassum crassifolium* level in the diet will increase the alginate content in the diet. According to Surbayono (2016) alginate does not digest by poultry because alginate lyase does not produce in poultry gastrointestinal tract for hydrolysis alginate. Alginate can decrease the content of the abdominal fat pad of a broiler by binding the bile salts, which solve both fat and cholesterol in the gastrointestinal tract of the broiler so that lower absorption of both fat and cholesterol occurs. Furthermore, binding alginate and bile salt will be excreted from the body through feces. Wikanta et al. (2003), reported that alginate cannot be digested in the body, and the body will actively re-produce bile salts, whose essential ingredient is fat, to reduce fat levels in the body. In this experiment's average abdominal fat pad percentage ranged from 0.58% to 1.28%. This experiment's results are consistent with those of Reski et al. (2021), experiment who stated that the inclusion of *Turbinaria murayana* brown seaweed up to 10% in a broiler diet resulted in an abdominal fat percentage of 0.94 to 1.55. This follows the opinion of Salam et al. (2013); the abdominal fat pad percentage of broiler ranged from 0.73 to 3.78%.

CONCLUSION

The inclusion of brown seaweed *Sargassum crassifolium* in the broiler diet by up to 18% reduces corn utilization by up to 24.49%, and rice bran by 54.45% at the starter period; and reduces corn up to 21% and rice bran by 50% at grower period, without interfering their performance (daily feed intake, daily weight gain, feed conversion ratio, live weight, carcass percentage with and without skin). Therefore, *Sargassum crassifolium* could be used in poultry diets as a cheaper substitute for costly traditional feed ingredients.

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CONFLICT OF INTEREST

The authors have not declared any conflicts of interest.

NOVELTY STATEMENT

Brown seaweed *Sargassum crassifolium* after lowering its salt content is a new feed ingredient for poultry that have never been tested in the broiler diet for its potential to replace traditional feed ingredients. Our research showed that brown seaweed *Sargassum crassifolium* could be included up to 18% in the broiler diet without compromising the performance and quality of the carcass.

AUTHOR'S CONTRIBUTION

The article's authors all contributed to the experiment and writing. Together with Maria Endo Mahata, Zurmiati, Yose Rizal, Sepri Reski, and others, they have made preparations beginning with research hypotheses, study ideas, and data gathering and processing. Additionally, all authors have agreed to submit this article to the Journal of Animal Health and Production.

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