Research Article

Immersion Treatment of Brown *Padina australis* Seaweeds for Poultry Production

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Abstract | *Padina australis* is a brown algae categorized as seaweed with a widespread in Indonesian coastal waters. We aimed to reduce the salt concentration of the brown seaweed *P. australis* by immersing it in flowing water. We used a completely randomized design (CRD) with different immersion durations (0, 4, 8, 12, 16, 20, and 24 h) of *P. australis* in flowing water. Each treatment received four replications. We evaluated dry matter (DM), organic matter (OM), crude protein (CP), ash, salt, and alginate contents. The results revealed a significant ($p<0.05$) impact on OM, CP, ash, salt, and alginate contents but did not significantly affect DM. Immersing *P. australis* in flowing water for 4 h is the optimal duration for decreasing salt content up to 97.62% while increasing CP and alginate levels proportionally. Immersion treatment in flowing water maintained the DM, OM, and ash contents.

Keywords | Brown seaweeds, Flowing water immersion, Nutritional substance, Poultry feed, Salt

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INTRODUCTION

Animal feed has experienced significant advancements propelled by the growing demand for animal protein. This industry's prominent challenge is its dependence on imported feed ingredients. Fluctuations in prices and the global availability of these feedstuffs can significantly impact the stability of poultry production. Within this context, exploring alternative local feed ingredients is essential to mitigate reliance on imports. One promising alternative is brown seaweed. Brown seaweed thrives in Indonesian marine waters and can potentially reduce the use of imported feedstuffs such as corn in poultry rations (Reski et al., 2021, 2023; Dewi et al., 2023). Nevertheless, no reports have addressed the utilization of brown *Padina australis* seaweed as a component in poultry ration formulation.

Brown *P. australis* seaweed thrives and is widely distributed across Indonesian waters. *P. australis* constitutes 10.79% crude fiber, 8.61% crude protein, 0.92% crude fat, 5.12% calcium, 1.43% phosphorus, 10.07% NaCl, and gross energy of 1643.69 kcal/kg, as well as bioactive compounds including 8.65% alginates, 0.87% fucoidan, and 0.75 mg/g fucoxanthin (Limantara and Heriyanto, 2011; Mahata et al., 2015; Salosso et al., 2020). *P. australis* contains fucoxanthin in quantities of up to 0.638 mg/g wet weight (Limantara and Heriyanto, 2011). The bioactive compounds act as hypocholesterolemic, antiviral, antibacterial, anti-inflammatory, anti-thrombin, anticoagulant, antilipemic, and stimulant (Pal et al., 2014). The fucoidan and alginate contents have effectively reduced cholesterol levels (Carrillo et al., 2012). *P. australis* holds significant potential as a functional feed ingredient for poultry as it contributes to nutrient fulfillment with its bioactive substances have capabilities for enhancing the health and productivity of poultry.

The brown *P. australis* seaweed has a high salt content restricting its potential as a feed ingredient in poultry feed as it contributes to trigger diarrhea and even fatalities (Mahata et al., 2015). Therefore, the salt concentration must be reduced before its application to poultry rations. According to Dewi et al. (2015), immersion of brown *Sargassum binderi* seaweed in flowing water for 15 hours led to a significant decrease in salt content up to 94%. Up to this point, no reports have addressed salt content reduction in *P. australis* through the immersion in running water. Thus, we investigated the effects of immersing process of brown *P. australis* seaweed in running water for poultry feed.

MATERIALS AND METHODS

Institutional approval number

This experiment was approved by the Indonesian Minister of Education, Culture, Research, and Technology, Indonesia, with approval number 115/E5/PG.02.00. PL/2023.

Collection of *Padina australis*

The brown *P. australis* seaweed was obtained using the simple random sampling technique from the shores of Painan Selatan Painan, District IV Jurai, Pesisir Selalatn Regency, West Sumatra Province, Indonesia. Geographical map, sampling site for brown *P. australis* seaweed https://painanselatanpainan.pesisirselatankab.go.id/index.php/artikel/2022/7/12/peta-nagari-painan-selatan-painan (Communication and Informatics Service for Pesisir Selatan Regency, 2020). Every section of this marine plant was sampled.

The macroclimatic conditions for the collection sites: Nagari Painan Selatan Painan has an area of ±645.90 ha with a height of 5 m above sea level. In general, Nagari Painan Selatan Painan has a tropical climate, so the temperature is hot, with temperatures of 21–30 °C. Rainfall in Nagari Painan Seltan Painan is 2,000 – 3,000 mm/year. The location of the Painan Selatan District of Painan from north to south is ±12 km. Geographically, Painan Selatan Painan Village is located at 100° 32`-100° 47` East Longitude and 1° 09.70` - 1° 22.70` South Latitude.

The immersing of brown *P. australis* seaweed in flowing water

Fresh *P. australis* (200 g) was submerged using nylon nets within a flowing water current. The river had a depth of approximately 1.3 m and a 0.6745 m^3/sec flow. *P. australis* was immersed in a completely randomized design (CRD) for 0, 4, 8, 12, 16, 20, and 24 hours with four replications for each time factor. Following submersion, *P. australis* was removed from the river and oven-dried at 60°C until a moisture content of 14% was achieved.

Analysis preparation of *P. australis*

The dried samples were grinded using a Laboratory Blender Waring, 8010G, 2 speed, 1, 2 L with glass container. Subsequently, the samples were analyzed to quantify dry matter (DM), organic matter (OM), crude protein (CP), ash, salt, and alginate content.

Analysis and measurement

The proximate analysis method measures the DM, OM, CP, and ash content (AOAC, 1990). The salt content was evaluated using the Kohman method after Sudarmadji et al. (1996), whereas alginate content was calculated using the Zaelanie method (Zaelanie et al., 2001). The number of samples used to analyze DM, OM, ash, and alginate was 1 g each, while for CP analysis, a sample of 0.5 g and 2 g of salt was used. The total number of samples used for the research was 6.5 g.

Statistical analysis

The data were analyzed using analysis of variance (ANOVA). Subsequently, the investigation of differences among treatments was executed Duncan's multiple range test (DMRT) was used with a significance level ($p<0.05$). The statistical model used in the analysis was: $Yij= \mu + Pi +Kj +\varepsilon ij$, following the instructions outlined by Steel and Torrie (1991).

RESULTS AND DISCUSSION

The immersion of *P. australis* in flowing water did not yield any significant effects on the DM content (Table 1). The dissolution and release of the majority of inorganic and organic compounds such as salts, sands, shellfish, vitamins, and other impurities attached to the *P. australis* during the immersing process, did not impact the DM content. The OM in *P. australis* decreased when soaked for 4 to 24 hours. The immersion procedure led to the depletion of water-soluble macrominerals (Martinson et al., 2012; Mack et al., 2014). Certain minerals and vitamins were depleted by the immersion of hay (Longland et al., 2014).

Subjecting *P. australis* to immersion in flowing water had a significant ($P<0.05$) increase in OM (Table 1). This immersion process leads to the dissolving of certain substances such as salt and water-soluble vitamins contributing to an increase in the OM. According to Dewi et al. (2018), immersing *S. binderi* seaweed in flowing water for varying durations led to an augmentation in OM and CP levels. Materials treated through water immersion result in the loss of certain dissolved substances, thus enhancing the OM composition (Kwari et al., 2011). The boiling, immersion, and autoclaving treatments result in a reduction in the anti-nutritional elements and an elevation in the nutritional composition of the materials (Udensi et al., 2010)

Table 1: Mean values for dry matter, organic matter, and crude protein content in brown *Padina australis* seaweeds following immersion in flowing water.

Immersion time (h)	Dry matter (%)	Organic matter (%)	Crude protein (%)
0	94.59	41.76[b]	7.37[b]
4	93.35	42.80[b]	12.62[a]
8	91.85	51.98[a]	12.74[a]
12	92.46	52.13[a]	12.67[a]
16	93.79	54.03[a]	13.17[a]
20	92.91	54.36[a]	13.63[a]
24	93.02	53.41[a]	13.36[a]
SEM	0.52	1.14	0.35

SEM: Standard error of the mean. Different superscripts in the same column indicate significantly different effects (P<0.05) between treatments.

A significant (p<0.05) increase in CP was revealed after the immersion of *P. australis* (Table 1) concerning 4 hours duration. This enhancement was attributed to the dissolving of the various substances in *P. australis* in water contributing to an increase in OM and subsequently, an increase in CP. Post-immersion of brown *S. binderi* seaweed in flowing water, an increase in OM and CP levels was observed (Dewi et al., 2018). Immersing the brown *Turbinaria murayana* and *Turbinaria decurrens* seaweed in flowing water could augment CP and OM content (Reski et al., 2020; Rizal et al., 2022).

The immersion of *P. australis* in flowing water significantly (P< 0.05) decreased the ash content (Table 2) concerning the 4-hour duration. The ash content decreased by the dissolution and release of the inorganic compounds and substances like salt, sand, shells, and other contaminants adhered to *P. australis* throughout the immersion. Nelson and Cox (2013) reported that salt is a compound that dissolves easily in water. Moreover, the water discharge employed in this experiment at a rate of 0.6745 m^3/sec expedited the dissolution of inorganic and organic compounds from *P. australis* due to the collision between the water flow and the seaweed. The stirring intensity usually affects the solubility of a solid (Libretexts, 2019). The immersion duration reduces the concentration of inorganics such as phosphorus, potassium, and magnesium (Martinson et al., 2012).

Water functioning as an organic solvent can dissolve ions like salts. In addition, river water flow can bind and clean seaweed and remove salt and dirt attached to seaweed, which can attract and dissolve salt and sand stuck to seaweed. According to Dewi et al. (2018), the immersion of *S. binderi* in flowing water for 15 hours decreased salt content and heightened levels of OM and CP. Rizal et al. (2022) also reported that immersing *T. decurrens* in flowing water reduces salt content.

Table 2: Mean values for ash and salt in brown *Padina australis* seaweeds following immersion in flowing water.

Immersion time (h)	Ash (%)	Salt (%)
0	58.24[a]	11.33[a]
4	57.20[a]	0.27[b]
8	48.02[b]	0.24[b]
12	47.87[b]	0.59[b]
16	45.97[b]	0.43[b]
20	45.64[b]	0.77[b]
24	46.59[b]	0.75[b]
SEM	0.84	0.39

SEM: Standard error of the mean. Different superscripts in the same column indicate significantly different effects (P<0.05) between treatments.

Table 3: Mean values for alginate in brown *Padina australis* seaweeds following immersion in flowing water.

Immersion time (h)	Alginate (%)
0	17.52[d]
4	33.12[c]
8	34.06[bc]
12	36.30[abc]
16	36.47[abc]
20	37.77[ab]
24	38.02[a]
SEM	0.21

SEM: Standard error of the mean. Different superscripts in the same column indicate significantly different effects (P<0.05) between treatments.

The immersion process significantly (p<0.05) increased the alginate content (Table 3) with increasing immersing time. The increase of the alginate content in *P. australis* with increased immersion duration was caused by an increase in OM. Alginate is a polysaccharide that is abundant in brown seaweeds (Phaeophyceae). Alginate accounts for as much as 40% of the dry weight of brown seaweed (Draget, 2009; Rinaudo, 2014). While examining nutrient composition using proximate analysis (AOAC, 1990), carbohydrates were included within the OM category. Consequently, a linear increase in OM content could correspond to an elevated alginate content in *P. australis* post-immersion. The increase in alginate content in *P. australis* can be attributed to the insolubility of alginate in water, thereby preserving the integrity of the alginate structure.

CONCLUSIONS AND RECOMMENDATIONS

Immersing *P. australis* in flowing water for 4 hours is the optimal time for reducing salt content up to 97.62% while increasing crude protein and alginate levels proportionally. This treatment sustained the contents of dry matter, organic matter, and ash.

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NOVELTY STATEMENT

There have been no previous reports on reducing salt content in brown seaweed *P. australis* through immersion in flowing water. The modified *Padina australis* with reduced salt content holds the potential as a viable ingredient in poultry feed formulations.

AUTHOR'S CONTRIBUTION

Maria Endo Mahata played a role in every phase of the study, encompassing research design, experiment implementation, sample examination, data analysis, drafting, and refining of the manuscript. Yose Rizal and Zurmiati participated in the research and contributed to manuscript editing. Sepri Rezki assumed responsibility for the investigation and data analysis. The article composition was a collaborative effort involving all authors who assessed the statistical analysis and endorsed the definitive version for publishing.

Conflict of interest

The authors have declared no conflict of interest.

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