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Andalasian Livestock

ISSN 3063-1912 (Online)

Research Article

Effect of Different Extraction Methods on the Quality of Alginates Derived from Turbinaria murayana Seaweed as a Poultry Feed Additive

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Article history:
Received: 18-04-2025 | Revised: 20-05-2025 | Accepted: 18-06-2025 | Published: 30-07-2025

ABSTRACT

This study aimed to evaluate the effect of different extraction methods on the quality of alginate derived from *Turbinaria murayana* seaweed as a poultry feed additive. An experimental approach was employed using a completely randomised design (CRD) consisting of three treatments and six replications. The treatments involved three different extraction methods: acid, alkaline, and calcium pathways. The data were analysed using analysis of variance (ANOVA), and significant differences among treatments were further examined using Duncan's Multiple Range Test. The results indicated that the extraction method had a highly significant effect ($P<0.01$) on alginate dry matter content and purity, while it had no significant effect ($P>0.05$) on alginate pH. Among the tested methods, the acid extraction pathway produced the highest quality alginate, meeting the quality standards set by the Food Chemicals Codex (FCC, 2004), with a dry matter content of 86.57%, a pH value of 9.17, and alginate purity of 36.28%.

Keywords: alginate, extraction, feed additive, poultry, seaweed

INTRODUCTION

Using local natural resources as alternative raw materials in the livestock industry has gained increasing attention, particularly supporting sustainable and self-reliant production systems. One promising yet underutilised marine commodity is brown seaweed, especially *Turbinaria murayana*, which is abundantly found along the coastal areas of West Sumatra, notably in Sungai Nipah Beach, Pesisir Selatan Regency. This species is known to contain important bioactive compounds such as alginate, fucoidan, fucoxanthin, and polyphenols, which have been reported to exert beneficial physiological effects when incorporated into animal feed rations (Mushollaeni & Rusdiana, 2011; Maharani et al., 2017; Reski et al., 2021).

Alginate, a significant brown seaweed cell wall component, is an anionic polysaccharide composed of guluronic and mannuronic acid units. Its colloidal properties make it valuable across various industries, including food, pharmaceuticals, and textiles (Draget et al., 2005). In livestock applications, particularly in poultry, alginate has gained interest as a functional feed additive due to its ability to support gut health and enhance nutrient absorption (Zargar et al., 2015; Bahar et al., 2012). Previous studies have shown that dietary supplementation with marine polysaccharides can improve growth performance and feed efficiency (Bojorges et al., 2023).

DOI: 10.25077/alive.v2.n2.p163-169.2025

However, the extraction method employed highly influences the quality of alginate extracted from seaweed. The three main approaches commonly applied are acid, alkaline, and calcium-based methods (Peteiro, 2007; Reski et al., 2025). Each method operates on different principles and exhibits varying efficiencies in yield, viscosity, moisture content, and final product purity (Maharani et al., 2017; Mushollaeni & Rusdiana, 2011). For instance, the acid extraction method produces alginate with higher viscosity and purity but is associated with higher operational costs than the calcium method (Maharani et al., 2017). On the other hand, calcium-based extraction tends to yield alginate with higher dry matter content but lower purity due to residual calcium ions that are difficult to eliminate (Husni et al., 2012).

Considering the importance of alginate quality as a poultry feed additive, a comprehensive evaluation of various extraction methods is essential. This study was conducted to compare the effectiveness of the three extraction techniques in producing alginate from *Turbinaria murayana* based on parameters such as dry matter content, pH, and purity. The findings are expected to provide a scientific basis for determining the most efficient and practical extraction method, while also supporting the downstream utilisation of local seaweed resources as a high-value and competitive poultry feed additive.

MATERIAL AND METHODS

Materials

The primary material used in this study was *Turbinaria murayana* seaweed, collected from Sungai Nipah Beach, Pesisir Selatan Regency. The seaweed was soaked for two days to remove excess salt, then thoroughly cleaned and sun-dried until it reached a moisture content of approximately 12%, followed by grinding into fine powder (Reski et al., 2024). This powdered seaweed was subsequently used for the extraction process employing three different methods: acid, alkaline, and calcium-based extractions. Additional materials used in the extraction procedures included 1% HCl, 5% HCl, 7.5% Na_2CO_3, 0.1 M $CaCl_2$, 96% ethanol, filter paper, and distilled water (Reski et al., 2025).

Methods

This study employed an experimental approach with a completely randomised design (CRD), comprising three extraction treatments and six replications. The treatments consisted of three different alginate extraction methods: acid-based, alkaline-based, and calcium-based pathways. Data were subjected to analysis of variance (ANOVA), and in cases of significant differences among treatments, Duncan's Multiple Range Test (DMRT) was used to determine specific group differences. The parameters evaluated included dry matter content, pH value, and alginate purity.

Research Implementation

The initial stage of this study involved the collection of *Turbinaria murayana* seaweed from the coastal area of Sungai Nipah, Pesisir Selatan. Following the soaking and washing processes to remove adhering dirt and salts, the seaweed was sun-dried until it reached a moisture content of approximately 12% (Reski et al., 2020). The dried seaweed was then ground into powder using a hammer mill grinder. The extraction process was subsequently carried out using three different methods: acid, alkaline, and calcium pathways, as described by Peteiro (2007) and Reski et al. (2025). Each method was applied using the same amount of raw material and followed standardised technical procedures, including temperature control, reaction duration, and solution concentration. The extracted alginate was dried and subjected to quality analysis based on

selected parameters. Each extraction method collected a 500 g sample for quality analysis. All laboratory analyses were conducted at the Non-Ruminant Nutrition Laboratory, Faculty of Animal Science, Universitas Andalas. The parameters observed in this study included dry matter content, pH value, and alginate purity. Dry matter content was analysed using the proximate method by AOAC (2005) standards. The pH was measured using a digital pH meter, while alginate purity was determined through a gravimetric approach following the purification process.

Data Analysis

The experimental data were analysed using analysis of variance (ANOVA). When significant differences among treatments were detected, further analysis was conducted using Duncan's Multiple Range Test (DMRT), following the procedure outlined by Steel and Torrie (1991).

RESULTS AND DISCUSSION

The average values of dry matter content, pH level, and alginate purity obtained from samples extracted using different methods (Table 1). These results provide a comparative overview of how each extraction technique affects the physical and chemical characteristic of alginate.

Table 1. Mean Values of Dry Matter Content, pH Level, and Alginate Purity Extracted Using Different Methods

Extraction Method	Dry Matter (%)	pH	Alginate Purity (%)
Acid Method	86.57^{b}	9.17	36.28^{a}
Alkaline Method	85.98^{b}	9.22	19.69^{c}
Calcium Method	94.28^{a}	9.20	31.79^{b}
SE	0.32	0.02	0.35

Note: Different superscripts indicate significant different effects (P<0.01); SE: standard error

Effect of Extraction Method on Alginate Dry Matter Content

The extraction of alginate from *Turbinaria murayana* using different methods showed a highly significant effect (P<0.01) on the dry matter (DM) content of the resulting alginate. The calcium-based method produced the highest dry matter content (94.28%) compared to the acid (86.57%) and alkaline (85.98%) methods, can be seen in Figure 1. These findings are consistent with the report by Maharani et al. (2017), which stated that calcium extraction often yields higher recovery due to the formation of calcium alginate fibers precipitated by $CaCl_2$. However, the viscosity and overall quality tend to be lower. This indicates that a higher dry matter content does not necessarily reflect superior alginate quality.

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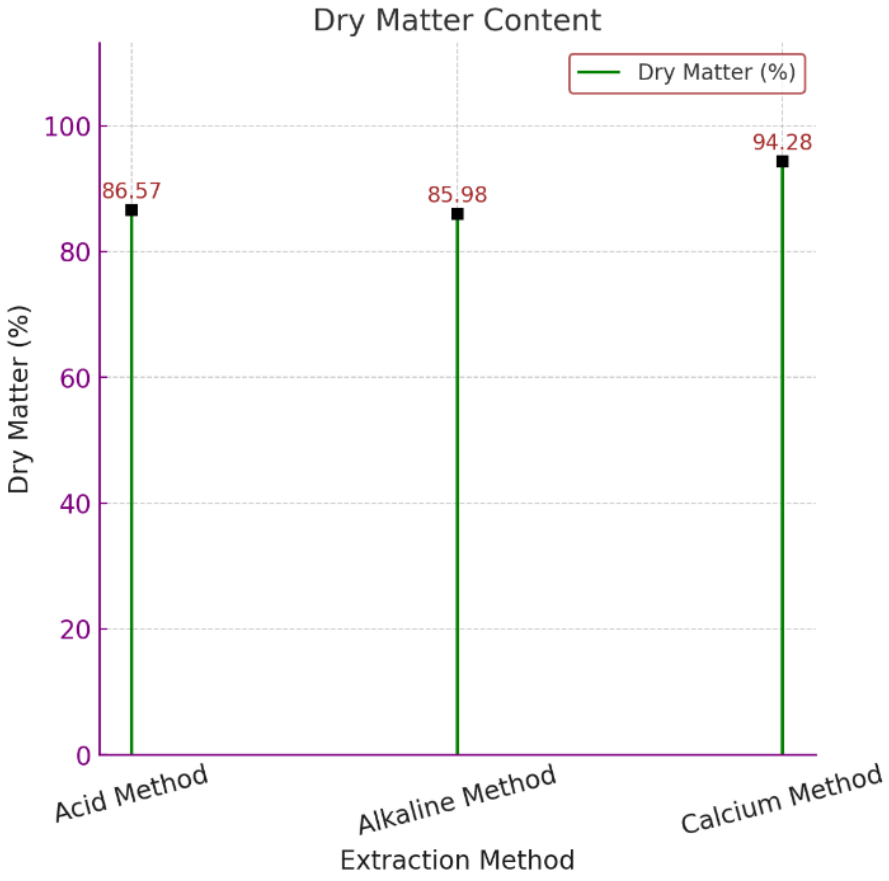


Figure 1. Extraction Method on Alginate Dry Matter Content

The Effect of Extraction Method on Alginate pH

The results indicated that the extraction method had no significant effect (P>0.05) on the pH of the extracted alginate, with values ranging between 9.17 and 9.22, can be seen in Figure 2. This alkaline pH suggests that all treatments yielded alginate within a stable and safe range for use as a feed additive. According to Bojorges et al. (2023), pH stability is critical for maintaining the functional properties of alginate, particularly its gel-forming and binding capabilities. A neutral to mildly alkaline pH is favourable in poultry digestive systems, as it minimises irritation and enhances the solubility of other bioactive compounds contained within the alginate matrix. These findings agree with Peteiro (2007), who reported that alginate pH characteristics are strongly influenced by seaweed species and the chemical treatment applied during extraction. The observed pH values in this study fall within the safe industrial and feed application range of 3.5–10 as specified by the Food Chemicals Codex (FCC, 2004), and align with the normal pH range of alginate (5–10) reported by Bahar et al. (2021). Maharani et al. (2017) further noted that excessively acidic conditions may lead to depolymerisation and reduced gel quality, while highly alkaline conditions (pH >10) can cause β-elimination degradation. Therefore, this study's moderately alkaline pH values can be considered ideal for maintaining alginate stability and functionality.

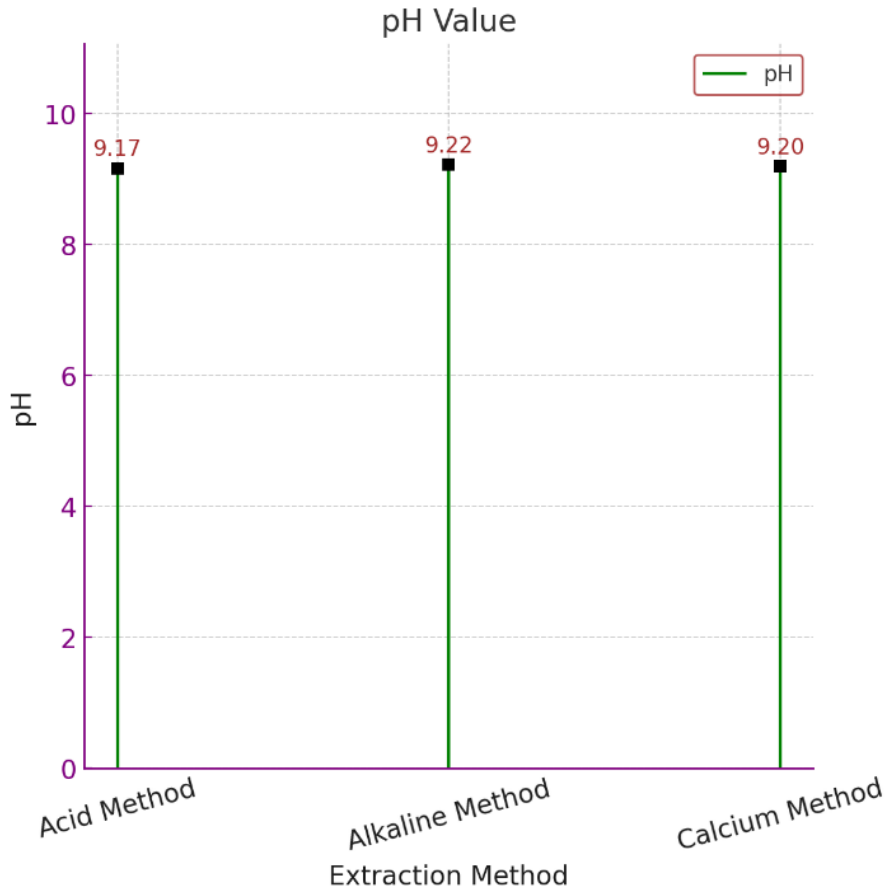


Figure 2. Extraction Method on Alginate pH

Effect of Extraction Method on Alginate Purity

The extraction method significantly affected alginate purity ($P<0.01$). The acid extraction method yielded the highest purity (36.28%), followed by the calcium method (31.79%) and the alkaline method (19.69%), can be seen in Figure 3. This result indicates that the acid pathway was more effective in releasing and isolating pure alginate from other impurities, such as marine pigments and minerals. The high purity obtained from acid extraction may be attributed to the ability of acids to disrupt molecular bonds and selectively dissolve non-alginate compounds. These findings are consistent with Reski et al. (2025), who reported that the acid method produced optimal yield and quality of alginate extracted from *Turbinaria murayana*. Alginate purity is a critical factor that directly influences its functionality as a feed additive, particularly regarding water-binding capacity, gel formation, and its role as a natural antimicrobial agent. According to the Food Chemicals Codex (FCC, 2004), the minimum standard for alginate purity in feed and industrial applications ranges between 30% and 40%, and only the acid method in this study consistently met that standard. Mushollaeni and Rusdiana (2011) noted that acid extraction is highly effective in removing proteins, pigments, and marine minerals through a leaching stage with HCl and subsequent precipitation using Na_2CO_3 and isopropanol. This combination maximises the elimination of non-alginate compounds. Furthermore, Maharani et al. (2017) reported that acid extraction produces sodium alginate with high viscosity, which reflects an intact polymer structure and greater purity. This explains why alginate obtained through acid extraction exhibits superior functional quality. Similarly, Winarno (1996) stated that the recommended purity level for food and feed-grade alginate ranges between 30% and 40%, a criterion only met by the acid method in the present study.

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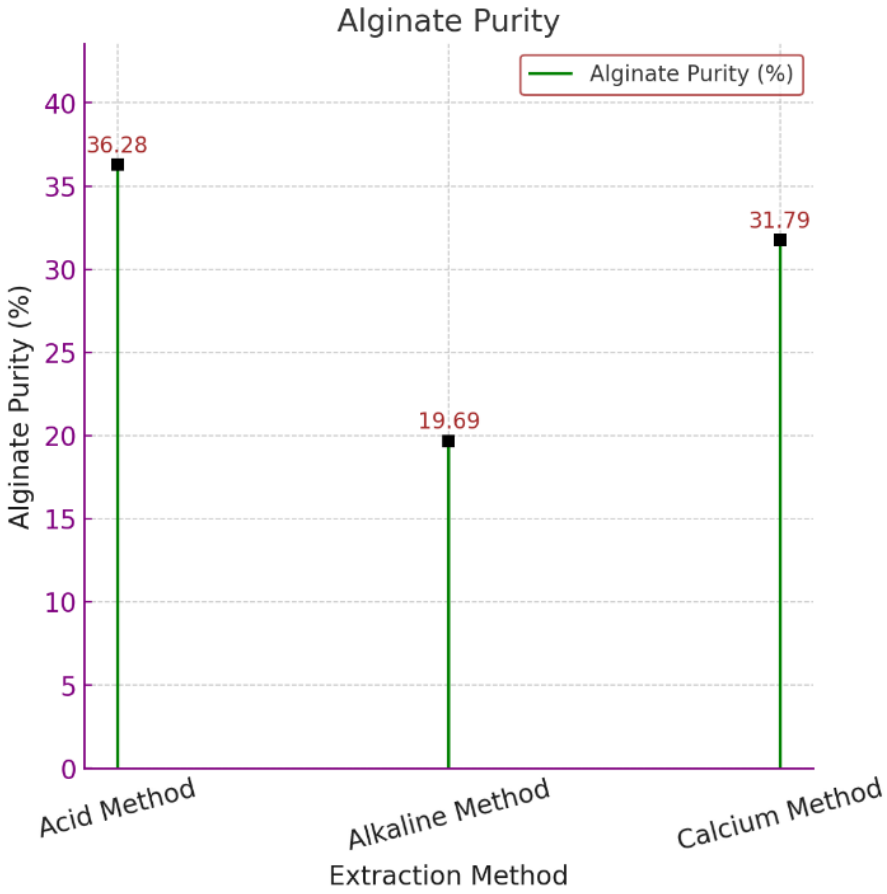


Figure 3. Extraction Method on Alginate Purity

CONCLUSIONS

Based on the results of this study, the acid extraction method was identified as the most effective technique for producing alginate from *Turbinaria murayana* seaweed compared to the alkaline and calcium methods. The alginate extracted using the acid method met the quality standards established by the Food Chemicals Codex (FCC, 2004), with a dry matter content of 86.57%, a pH value of 9.17, and a purity level of 36.28%.

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