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Valorization of Trash Fish Through Drying Innovations: Nutrient Stability of Protein, Calcium, and Phosphorus

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ABSTRACT

Trash fish, often regarded as low-value bycatch, actually holds significant potential as a source of protein and essential minerals such as calcium and phosphorus. This study aims to evaluate the effect of different drying methods—oven drying at varying temperatures (40°C, 60°C, 80°C, and 100°C) and sun drying on the protein, calcium, and phosphorus content of trash fish. Laboratory analyses were conducted using the Kjeldahl method for protein determination and atomic absorption spectrophotometry (AAS) for calcium and phosphorus content. The results revealed that increasing oven drying temperatures significantly reduced protein levels, while sun drying maintained a protein content close to the optimal range. In contrast, calcium and phosphorus levels showed no significant differences across drying methods. Therefore, low-temperature oven drying or sun drying is recommended to preserve the nutritional quality of trash fish effectively.

Keywords: trash fish, drying methods, protein, minerals, nutrient composition

I. INTRODUCTION

Trash fish, often regarded as low-value bycatch, actually holds great potential as a source of protein and essential minerals such as calcium and phosphorus. With proper processing, trash fish can gain added value and serve as a valuable raw material in the food and animal feed industries.

Drying is one of the most commonly used preservation methods to extend the shelf life of fish. Different drying techniques, such as oven drying and sun drying, can influence the nutritional composition of fish. Several studies have demonstrated that drying methods can affect the levels of protein, calcium, and phosphorus in fish.

For instance, a study by Alahmad et al. (2021) found that oven drying helps retain protein and mineral content in bighead carp. Meanwhile, research by Msusa et al. (2017) showed that sun drying can lead to a reduction in protein content in Mcheni fish.

Furthermore, Viji et al. (2020) reported that drying methods influence the nutritional content of yellow croaker, and a study by Chukwu (2009) confirmed similar effects on tilapia.

Considering the importance of protein, calcium, and phosphorus content in trash fish, as well as the influence of drying methods on these nutrients, this study aims to analyze the effect of oven and sun drying on the protein, calcium, and phosphorus content in trash fish.

III. METHODS

Materials and Equipment

This study used fresh trash fish obtained from local fishermen on the coast of Salomekko sub-district, Bone district, South Sulawesi province, Indonesia. The fish consisted of various small-sized species that generally have low market value. Chemicals used for laboratory analysis included Kjeldahl reagents (H_2SO_4, NaOH, indicators, and catalysts), standard HCl solution, as well as reagents for calcium and phosphorus analysis using Atomic Absorption Spectrophotometry (AAS).

Research Design

The study employed a laboratory experimental design with a quantitative approach. The trash fish samples were divided into two treatment groups based on the drying method:

Treatment A: Oven drying at temperatures of 40, 60, 80, and 100°C for 6 hours

Treatment B: Sun drying for 2–3 days (with sunlight intensity ranging from 25–35°C depending on weather conditions)

Drying Procedure

The fish were thoroughly washed and drained before the drying process. For oven drying, the fish were evenly arranged on stainless-steel trays and placed in a temperature-controlled oven. For sun drying, the fish were spread over wire mesh trays in an open, dust-free area and covered with netting to protect from insects.

After drying, all samples were cooled to room temperature, ground into a fine powder, and stored in sealed containers until further analysis.

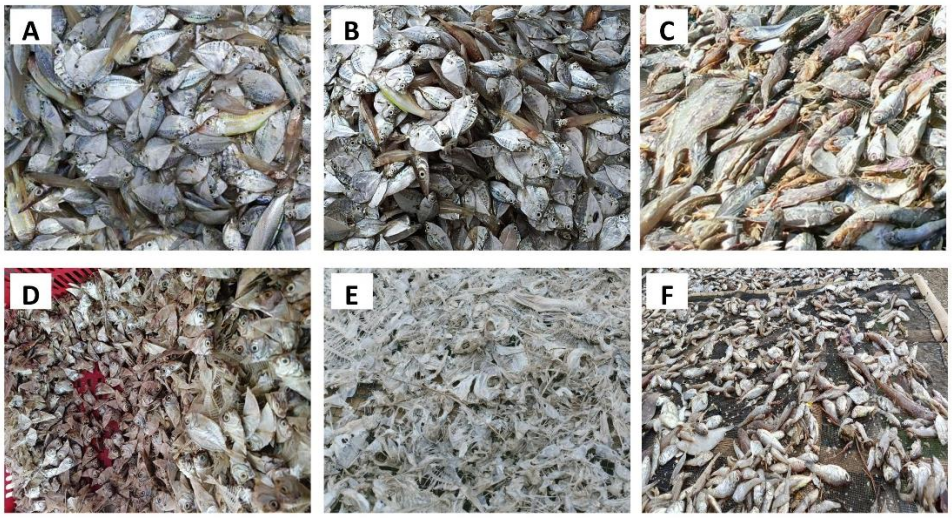

Figure 1. Trash fish: A) fresh, B) oven-dried at 40°C, C) oven-dried at 60°C, D) oven-dried at 80°C, E) oven-dried at 100°C, F) sun-dried

Laboratory Analysis

Protein Content

Protein content was analyzed using the Kjeldahl method. A 0.5 g sample was weighed and digested with concentrated sulfuric acid and a catalyst until a clear solution was obtained. The digest was then neutralized with a base, distilled, and titrated using a standard HCl solution. The nitrogen content was converted to protein using a conversion factor of 6.25.

Calcium and Phosphorus Content

Calcium and phosphorus contents were determined using Atomic Absorption Spectrophotometry (AAS). The sample was dissolved and acidified, then filtered and measured at specific wavelengths (calcium: ~422.7 nm; phosphorus: via blue molybdate complex).

Data Analysis

Data were analyzed using a quantitative descriptive approach. The mean and standard deviation were calculated for each parameter (protein, calcium, and phosphorus) based on the drying method. An independent t-test was performed to determine significant differences between drying methods ($\alpha = 0.05$), using SPSS statistical software.

IV. RESULTS AND DISCUSSION

This study evaluated the effect of drying methods on the nutritional content of trash fish, particularly protein, calcium, and phosphorus levels. Data were obtained from drying treatments using an oven at varying temperatures (40°C, 60°C, 80°C, and 100°C) and sun drying.

The protein content analysis showed a decline in protein levels with increasing drying temperatures. Meanwhile, calcium and phosphorus levels did not show significant variation across treatments.

Table 1. Protein, Calcium, and Phosphorus Content of Trash Fish Based on Drying Method

Drying Method	Temperature (°C)	Protein Content (%)	Calcium Content (%)	Phosphorus Content (%)
Oven	40	69,20	3,86	1,65
Oven	60	65,86	3,45	1,58
Oven	80	62,08	3,05	1,50
Oven	100	57,68	2,52	1,42
Sun drying	-	67,80	3,60	1,55

The analysis indicated that protein content was significantly affected by the drying method and temperature. The highest protein content was recorded at 40°C using oven drying (69.20%), which decreased progressively with higher temperatures, reaching the lowest level at 100°C (57.68%). This trend suggests that higher temperatures tend to reduce protein content, likely due to faster denaturation and degradation of protein compounds under thermal stress.

Sun drying resulted in a protein content of 67.80%, which was higher than oven drying at 60°C, 80°C, and 100°C, but slightly lower than that at 40°C. The decline in protein content at higher temperatures is likely caused by Maillard reactions and thermal damage to the protein structure. In contrast, the slower drying process at lower temperatures during sun drying helps retain a greater portion of the protein content.

Calcium levels across all treatments showed no significant variation, ranging from 2.52% to 3.86%. Both oven and sun drying methods did not cause noticeable differences in calcium levels, suggesting that calcium is relatively stable under the temperature variations applied in this study.

Similarly, phosphorus content exhibited relative stability across different temperatures and drying methods, with values ranging from 1.42% to 1.65%. These small variations were statistically insignificant. As an inorganic mineral, phosphorus tends to be more resistant to thermal degradation compared to organic compounds like proteins.

Drying methods significantly affected protein content, with low-temperature oven drying (40°C) and sun drying yielding the highest levels. Meanwhile, calcium and phosphorus contents remained largely unaffected by the drying temperature or method. Therefore, selecting appropriate drying conditions is crucial to maintaining nutritional quality, particularly protein content. These findings indicate that low-temperature and sun drying are more effective in preserving the protein content of trash fish, while mineral content remains relatively stable under heat treatment.

Effect of Drying Method on Protein Content

The results indicate that drying methods have a significant impact on the protein content of trash fish. Oven drying at 40°C produced the highest protein level (69.20%), which declined as the temperature increased, reaching 57.68% at 100°C. Conversely, sun drying resulted in a protein level of 67.80%, close to the value obtained at low oven temperatures.

The reduction in protein content at higher temperatures can be attributed to heat-induced protein denaturation. This process alters the secondary and tertiary structures of proteins, reducing their solubility and nutritional value (Chen et al., 2022). Additionally, high temperatures can accelerate protein oxidation, leading to the formation of insoluble protein aggregates and a subsequent decline in nutritional quality (Lv et al., 2022).

Although sun drying requires a longer time, it tends to preserve protein structure better than high-temperature oven drying. This is due to the lower drying temperatures, which reduce the risk of protein denaturation and oxidation (Agbo & Awolumate, 2024).

Mineral analysis showed that calcium and phosphorus contents were relatively stable across different drying methods and temperatures, ranging between 2.52–3.86% and 1.42–1.65%, respectively. This stability suggests that these minerals are not easily degraded by heat during the drying process. Alahmad et al. (2021) support this finding, noting that oven and microwave drying did not significantly alter mineral content in bighead carp fillets.

However, certain pre-drying processing steps such as washing and blanching may cause loss of water-soluble minerals like calcium and phosphorus (Kabir et al., 2022). Therefore, to preserve mineral content, water use during trash fish processing should be minimized.

V. CONCLUSION

Based on these findings, drying trash fish at low temperatures (around 40°C) or using sun drying can be effective methods to preserve protein and mineral content. These approaches not only maintain nutritional quality but are also more energy-efficient and environmentally friendly. However, sun drying has limitations, such as dependence on weather conditions and the risk of microbial contamination. Therefore, low-temperature oven drying can serve as a more consistent and hygienic alternative.

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