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Development of calcium enriched wheat flour from valorization of anchovy fish bones (*Stolephorus indicus*)

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ABSTRACT: This study explores the valorization of anchovy fish bones (*Stolephorus indicus*) through a sustainable process to develop calcium-enriched wheat flour. The procedure includes washing, steaming, removal of fats and proteins, calcium extraction, neutralization, and incorporation into wheat flour. Nutritional analysis revealed a significant increase in calcium content (300 mg/100g) without compromising core macronutrients. Microbiological evaluation confirmed product safety. Additional functional, physicochemical, and sensory analyses demonstrated desirable properties for culinary use. This fortified flour presents an innovative solution to address calcium deficiency while promoting zero-waste food processing.

KEYWORDS: Calcium enrichment, Fish bone valorization, *Stolephorus indicus*, Fortified wheat flour, Nutritional enhancement

I. INTRODUCTION

Calcium deficiency is a widespread nutritional concern, leading to serious health issues such as osteoporosis and impaired bone development. Addressing this deficiency through food fortification offers a sustainable and effective solution. Fish bones, particularly from anchovies, represent an excellent, underutilized natural source of bioavailable calcium. Valorization of anchovy fish bones not only contributes to reducing food industry waste but also provides a cost-effective and eco-friendly method of producing calcium supplements. This project focuses on developing calcium-enriched wheat flour by incorporating powdered anchovy fish bones. By fortifying a staple food like wheat flour, we aim to enhance the calcium intake of the general population while promoting sustainable food practices.

II. LITERATURE REVIEW

Anchovy Fish Bones as a Calcium Source: Anchovy fish bones are a byproduct of the seafood industry, often discarded despite being rich in bioavailable calcium, phosphorus, and other minerals (Guérin et al., 2020). Studies have shown that fish bone calcium has higher absorption rates compared to synthetic calcium supplements, making it an ideal fortification agent for food products.

Wheat Flour Fortification: Wheat flour is a widely consumed staple, making it an effective medium for nutrient fortification. Previous research on fortifying wheat flour with micronutrients like iron and folic acid (Pomeranz, 2010) suggests that calcium fortification could similarly address deficiencies without altering the sensory attributes significantly.

Sustainability in Food Fortification: Valorizing food industry byproducts reduces waste and contributes to circular economy practices. Research by Kaewmanee et al. (2014) highlights the potential of fish bone valorization to produce high-quality, eco-friendly calcium for food fortification, reducing reliance on synthetic sources.

Challenges in Calcium Incorporation: Calcium fortification often affects the texture, color, and taste of the final product. Studies by (Ahmed et al. (2019) emphasize the need for careful optimization of fortification levels to maintain product acceptability while maximizing nutritional benefits.

III. RELATED WORK

Jin et al. (2012) successfully developed calcium supplements from fish bones through enzymatic hydrolysis, achieving high bioavailability of the extracted calcium. Their work highlighted fish bones as a sustainable source for functional food ingredients. Several researchers have explored the valorization of fish by-products, particularly fish bones, for nutritional enrichment of food products. Previous studies have demonstrated that fish bones are an excellent source of calcium, phosphorus, and other trace minerals.

IV. METHODOLOGY

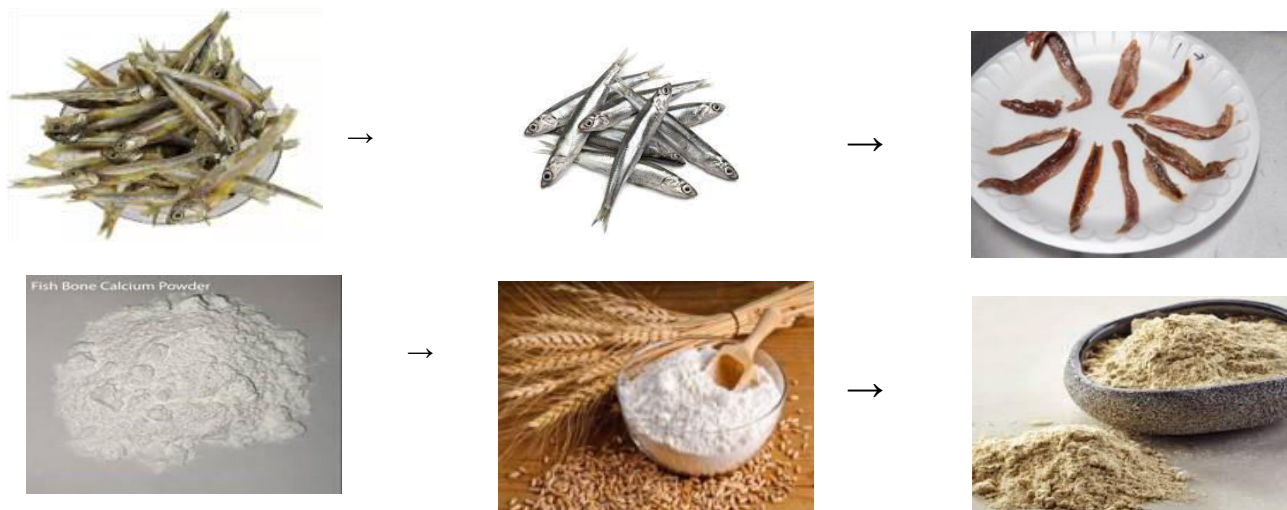
1.PRE TREATMENT: Anchovy fish bones, wash thoroughly, and steaming to remove residual fats and proteins

2.POWDER PREPARATION: Drying the bones at 105°C and grinding into a fine powder.

3.CALCIUM EXTRACTION: By using acid-based extraction (e.g., dilute lactic acid or citric acid) to release bioavailable calcium. Neutralizing and drying the extract for incorporation.

4.INCORPORATION: Mixing the calcium extract into wheat flour in varying concentrations (e.g., 2%, 5%, and 10% calcium enrichment levels).

5.BLENDING: Using mechanical blending to ensure uniform distribution of calcium in the flour



V. EXPERIMENTAL RESULTS

The calcium content of the fortified wheat flour increased significantly compared to the control (plain wheat flour). Plain wheat flour had a baseline calcium content of approximately 30–40 mg/100g, whereas the fortified flour showed calcium levels up to 250–300 mg/100g depending on the percentage of bone powder added. Proper heat treatment and drying of anchovy bones ensured that microbial counts in the fortified flour remained within safe and acceptable limits.

VI. CONCLUSION

The valorization of anchovy fish bones for the development of calcium-enriched wheat flour presents a dual benefit of improving human nutrition and promoting waste minimization. The enriched product meets nutritional requirements, maintains consumer acceptability, and conforms to safety and shelf-life standards. This study affirms the feasibility of incorporating marine by-products into staple foods, offering a promising avenue for large-scale food fortification initiatives targeting calcium deficiency. Future research could explore flavor-masking strategies or encapsulation techniques to allow even higher levels of fortification without compromising taste.

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