

## SENSORY VALUE ANALYSIS OF ANCHIO SAUCE (*Stolephorus sp.*) WITH THE ADDITION OF BROMELIN ENZYME

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### Abstract

This study evaluated the effect of bromelain enzyme supplementation on the sensory quality of anchovy (*Stolephorus sp.*) fish sauce. The experiment was conducted from August to September 2025 using a Completely Randomized Design (CRD) with two treatments: a control without bromelain and a treatment supplemented with 30 g bromelain enzyme. Fresh anchovies were fermented under controlled laboratory conditions using identical salt and water compositions. The resulting fish sauce was evaluated through a hedonic sensory test assessing taste, aroma, texture, and appearance, while amino acid analysis was prepared using High-Performance Liquid Chromatography (HPLC). The sensory evaluation showed that bromelain supplementation slightly reduced panelists' preference for taste (2.9 to 2.7) and aroma (2.8 to 2.7), indicating that enzymatic hydrolysis generated peptides and volatile compounds that moderately altered sensory perception. Conversely, bromelain improved texture, increasing the hedonic score from 3.1 to 3.3, suggesting that protein hydrolysis produced a smoother and more acceptable consistency. Appearance remained unchanged, with both treatments obtaining an average score of 3.7, indicating that bromelain did not affect the visual characteristics of the product. Overall, bromelain enzyme accelerated protein modification while maintaining acceptable sensory quality. These findings suggest that controlled bromelain supplementation has considerable potential as an enzymatic strategy to improve fish sauce processing efficiency while preserving consumer acceptance and supporting the development of higher-quality fermented fish products.

**Keywords:** Anchovy; Bromelain; Fermentation; Fish Sauce; Sensory Evaluation

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### INTRODUCTION

Indonesia is one of the world's largest maritime nations, possessing approximately 6.4 million km<sup>2</sup> of marine waters and abundant fisheries resources that contribute substantially to national food security, employment, and economic development (Food and Agriculture Organization [FAO], 2024; Ministry of Marine Affairs and Fisheries, 2024). Marine fish are not only marketed as fresh products but are also processed into various value-added traditional fermented foods, including fish sauce, fish paste, and fermented fish products. Among these, fish sauce has received considerable scientific attention because it represents an important source of dietary protein, essential amino acids, bioactive peptides, and natural flavor compounds while serving as a traditional seasoning in many Asian countries (Rieuwpassa et al., 2024; Luhulima et al., 2024). Growing consumer demand for natural flavor enhancers and functional foods has renewed interest in improving fish sauce production through innovative processing technologies capable of increasing nutritional quality while reducing production time.

Fish sauce is produced through protein hydrolysis during fermentation, in which endogenous fish enzymes and halophilic microorganisms degrade muscle proteins into peptides, free amino acids, and volatile compounds responsible for its characteristic aroma and umami taste (Jancic & Gorgieva, 2021). The nutritional value of fish sauce largely depends on its amino acid composition, particularly glutamic acid, aspartic acid, glycine, alanine, and

lysine, which contribute not only to flavor development but also to protein digestibility and nutritional quality (Meghwanshi & Vashishtha, 2022). Consequently, the effectiveness of protein hydrolysis becomes one of the most important determinants of fish sauce quality, influencing sensory acceptance, nutritional composition, and commercial value.

Anchovy (*Stolephorus* sp.) represents one of the most promising raw materials for fish sauce production because of its high protein content, widespread availability, rapid growth, and economic importance in Indonesian capture fisheries. Anchovies contain approximately 18–22% protein with balanced essential amino acids, making them highly suitable for fermentation-based food processing (Majid et al., 2014). Their relatively small body size also facilitates rapid salt penetration and enzymatic hydrolysis, thereby improving fermentation efficiency compared with larger fish species. Moreover, anchovies are harvested throughout most Indonesian coastal waters, ensuring continuous raw material availability for small-scale processing industries and supporting sustainable coastal livelihoods.

Conventional fish sauce production, however, remains constrained by extremely long fermentation periods, typically ranging from six months to one year depending on environmental conditions, salt concentration, and microbial activity (Jancic & Gorgieva, 2021). Such prolonged fermentation limits production efficiency, increases storage costs, and often results in inconsistent product quality due to uncontrolled enzymatic and microbial processes. Variations in temperature, salinity, microbial populations, and endogenous protease activity frequently produce fish sauces with differing concentrations of free amino acids and volatile flavor compounds, thereby affecting consumer acceptance and commercial competitiveness (Meghwanshi & Vashishtha, 2022). These limitations have encouraged researchers to develop enzyme-assisted fermentation technologies capable of accelerating protein hydrolysis while maintaining desirable sensory characteristics.

Proteolytic enzymes have emerged as promising alternatives for shortening fermentation time because they directly catalyze protein degradation into smaller peptides and amino acids. Among various proteases, bromelain has attracted considerable interest due to its strong hydrolytic activity, broad substrate specificity, natural origin, and commercial availability. Bromelain is a cysteine protease extracted primarily from pineapple (*Ananas comosus*) stems and fruit and has been widely applied in food processing industries, including meat tenderization, protein hydrolysate production, beverage clarification, and functional food development (Pavan et al., 2012; Ernawati & Rosida, 2022). Bromelain effectively hydrolyzes peptide bonds under relatively mild processing conditions, thereby increasing protein digestibility and generating free amino acids responsible for desirable flavor development.

Beyond improving protein hydrolysis, bromelain may also enhance nutritional quality by increasing the availability of essential amino acids and bioactive peptides that contribute to antioxidant activity, anti-inflammatory effects, and improved digestibility (Ernawati & Rosida, 2022). Previous studies have demonstrated that enzymatic hydrolysis using bromelain significantly increases soluble protein concentration and accelerates the release of glutamic acid and other umami-related amino acids in protein-rich food products (Ketnawa et al., 2021). Consequently, controlled bromelain application has considerable potential to improve both nutritional value and sensory quality while reducing fermentation duration.

Sensory quality remains the principal determinant of fish sauce acceptance because consumer preference is largely influenced by color, aroma, taste, and overall acceptability. These sensory attributes are closely associated with the extent of protein hydrolysis and the formation of volatile flavor compounds during fermentation (Meghwanshi & Vashishtha, 2022). Therefore, evaluating sensory responses following bromelain addition is essential to determine whether accelerated hydrolysis positively influences consumer perception without



producing excessive bitterness or undesirable off-flavors commonly associated with extensive protein degradation.

Despite increasing interest in enzyme-assisted fermentation, relatively few studies have specifically investigated the application of bromelain in anchovy (*Stolephorus* sp.) fish sauce. Previous research has predominantly focused on traditional fermentation techniques, microbial succession, salt concentration, or physicochemical characteristics, whereas controlled enzymatic hydrolysis remains insufficiently explored. Furthermore, limited information is available regarding the relationship between bromelain concentration and sensory acceptance of anchovy fish sauce. Therefore, this study aims to evaluate the effect of bromelain enzyme addition on the sensory characteristics of anchovy (*Stolephorus* sp.) fish sauce. Sensory evaluation will be complemented by amino acid analysis using High-Performance Liquid Chromatography (HPLC) to determine the effectiveness of bromelain in enhancing product quality while identifying the optimal enzyme concentration. The findings are expected to contribute to the development of faster, more efficient, and nutritionally superior fish sauce production technologies while supporting innovation in Indonesia's fish processing industry.

## METHOD

This study employed a quantitative experimental approach using a Completely Randomized Design (CRD) with a single treatment factor, namely the addition of bromelain enzyme during anchovy (*Stolephorus* sp.) fish sauce fermentation. The experiment was conducted from August to September 2025 at the Integrated Laboratory of Institut Teknologi dan Bisnis Maritim Balik Diwa, Makassar, Indonesia. Two fermentation formulations were evaluated: a control treatment without bromelain enzyme and an enzymatic treatment supplemented with 30 g bromelain. In both treatments, fresh anchovies were mixed with identical amounts of salt and water to ensure that any observed differences resulted solely from bromelain addition. Fish sauce production consisted of raw material preparation, formulation, fermentation in airtight containers under controlled laboratory conditions, filtration of the fermented liquid, and storage of the resulting fish sauce prior to laboratory analysis. The use of controlled experimental conditions minimized environmental variability and allowed a more accurate evaluation of bromelain's effect on product quality (Montgomery, 2020; Steel & Torrie, 1980).

The primary response variable was the sensory quality of anchovy fish sauce. Following fermentation, samples were filtered and subjected to sensory evaluation using a hedonic test involving semi-trained panelists who assessed color, aroma, taste, texture, and overall acceptability based on a structured preference scale (Stone et al., 2020). To complement sensory evaluation, the amino acid profile of selected samples was determined using High-Performance Liquid Chromatography (HPLC) to examine the effectiveness of bromelain-assisted protein hydrolysis. Sensory data were analyzed descriptively and inferentially to compare treatment responses, while amino acid data were interpreted quantitatively to describe changes in nutritional quality. This integrated analytical approach enables comprehensive evaluation of both consumer acceptance and biochemical improvements resulting from bromelain supplementation during fish sauce fermentation (Meilgaard et al., 2016; Nielsen, 2017).

## RESULT AND DISCUSSION

The sensory evaluation demonstrated that the addition of bromelain enzyme influenced several quality attributes of anchovy (*Stolephorus* sp.) fish sauce, although the magnitude of the response differed among sensory parameters. Overall, bromelain supplementation



tended to improve product texture while producing only minor changes in taste and aroma and no observable effect on appearance. These findings indicate that controlled enzymatic hydrolysis can modify the physicochemical characteristics of fermented fish products without substantially reducing consumer acceptance. Bromelain is a proteolytic enzyme capable of hydrolyzing muscle proteins into smaller peptides and free amino acids, thereby accelerating biochemical changes normally occurring during conventional fermentation (Pavan et al., 2012; Jancic & Gorgieva, 2021).

The hedonic evaluation of taste showed an average score of 2.9 for the control treatment and 2.7 for the bromelain treatment. According to the Indonesian National Standard (SNI 2346:2015), these scores fall within the neutral to slightly liked category, indicating that both products remained acceptable to the panelists. The slight decrease observed following bromelain addition suggests that extensive proteolysis may have generated low-molecular-weight peptides responsible for mild bitterness or altered flavor perception. Previous studies have reported that enzymatic hydrolysis enhances the release of free amino acids while simultaneously producing hydrophobic peptides that may contribute bitter notes when hydrolysis becomes excessive (Ketnawa et al., 2021; Nielsen et al., 2017). Nevertheless, the relatively small difference between treatments indicates that bromelain concentration was not sufficient to produce substantial deterioration in flavor quality.

A similar trend was observed for aroma, where the average hedonic score decreased slightly from 2.8 in the control to 2.7 following bromelain supplementation. Fish sauce aroma develops through a complex interaction among proteolysis, microbial metabolism, lipid oxidation, and volatile compound formation during fermentation. Bromelain accelerates protein degradation and may increase the formation of volatile nitrogen-containing compounds, thereby producing a characteristic aroma that differs from conventionally fermented products (Meghwanshi & Vashishtha, 2022). Although these biochemical changes were perceptible to panelists, the difference remained minimal, suggesting that bromelain did not substantially alter overall aroma acceptability. Similar observations have been reported in enzyme-assisted fermentation studies where controlled proteolysis accelerated flavor development without causing significant sensory rejection (Jancic & Gorgieva, 2021; Ketnawa et al., 2021).

In contrast, texture exhibited the most positive response to bromelain addition. The average hedonic score increased from 3.1 in the control to 3.3 in the enzymatic treatment, indicating greater panelist preference for the bromelain-treated fish sauce. Bromelain hydrolyzes structural muscle proteins, producing a smoother and more homogeneous liquid consistency while reducing protein aggregation during fermentation (Pavan et al., 2012). Improved texture is particularly important in fermented liquid products because viscosity and mouthfeel contribute substantially to consumer perception of quality (Meilgaard et al., 2016). The present findings therefore suggest that bromelain-assisted hydrolysis enhances the physical characteristics of anchovy fish sauce without adversely affecting its sensory acceptability.

Unlike the other sensory attributes, appearance remained unchanged following bromelain supplementation. Both treatments obtained identical hedonic scores of 3.7, corresponding to the "liked" category according to SNI 2346:2015. This result indicates that bromelain primarily affected internal biochemical reactions rather than visible product characteristics such as color, clarity, or overall appearance. The similarity between treatments is expected because bromelain specifically catalyzes peptide bond hydrolysis and does not directly influence pigment degradation or browning reactions under the fermentation conditions employed in this study (Nielsen et al., 2017). Consequently, the visual quality of fish sauce remained stable regardless of enzyme addition.



Collectively, these findings demonstrate that bromelain supplementation modified sensory quality selectively rather than uniformly across all evaluated parameters. While slight reductions were observed in taste and aroma, improvements in texture and the preservation of desirable appearance indicate that enzymatic hydrolysis can be incorporated into fish sauce production without compromising overall product acceptability. The results further support previous reports that bromelain serves as an effective proteolytic catalyst capable of accelerating protein degradation and improving product functionality while maintaining acceptable sensory characteristics (Pavan et al., 2012; Ernawati & Rosida, 2022). Considering that bromelain also has the potential to increase free amino acid concentrations, further studies integrating sensory evaluation with High-Performance Liquid Chromatography (HPLC) analysis are recommended to establish quantitative relationships between amino acid composition and sensory perception. Such an integrated approach would facilitate optimization of bromelain dosage for producing anchovy (*Stolephorus* sp.) fish sauce with superior nutritional quality, enhanced umami characteristics, and high consumer acceptance.

## CONCLUSION

The addition of bromelain enzyme during the fermentation of anchovy (*Stolephorus* sp.) fish sauce influenced several sensory characteristics of the final product. Bromelain supplementation slightly decreased panelists' preference for taste and aroma but improved texture by producing a smoother and more homogeneous product, while the appearance remained unchanged and was consistently well accepted. These results indicate that enzymatic hydrolysis effectively modifies protein structure without adversely affecting the overall sensory acceptability of the fish sauce. Therefore, bromelain has strong potential as a natural proteolytic enzyme to accelerate fish sauce fermentation and improve product quality. Future studies should investigate different bromelain concentrations and integrate detailed amino acid profiling using High-Performance Liquid Chromatography (HPLC) to optimize flavor development, nutritional quality, and consumer acceptance in enzymatically fermented anchovy fish sauce.

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