

Development of Dusun Traditional Fermented Fish (*Bosou Ikan*) Using Different Concentrations of Tuhau (*Etlingera coccinea*)

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ABSTRACT

This study aimed to determine the best formulation of Dusun traditional fermented fish (*Bosou ikan*) through sensory evaluation employing a 9-point hedonic test. Various concentrations of *Etlingera coccinea*, ranging from 0% to 8% w/w, were incorporated into fermented fish samples. Results revealed that the formulation containing 2% *E. coccinea* (F1) consistently exhibited superior sensory attributes, maintaining the traditional appearance while enhancing aroma, taste, and overall acceptability. Statistical analysis using the Friedman test confirmed F1's superiority, showing the lowest mean rank among alternatives ($p < 0.05$). Proximate analysis of F1 demonstrated notable increases in ash, crude fat, crude fiber, and crude protein content compared to Control *Bosou ikan* formulations, indicating enhanced nutritional profiles. Shelf-life analysis demonstrated a more controlled trend in reducing total viable count and total yeast and mold counts for the F1 formulation compared to the control, suggesting a potential influence of *E. coccinea* in inhibiting excessive microbial proliferation. Comparison of microbial loads between raw and cooked samples revealed that cooking effectively eliminated microbial counts, reaching safety consumption levels of 4 log₁₀ CFU/g (total yeast and mold) and 6 log₁₀ CFU/g (total viable count). The decrease in pH of raw and cooked samples over one month was attributed to increased acidity resulting from the activities of *Lactobacillus* sp., which utilizes carbohydrates in the medium to produce lactic acid. The study highlights that the F1 formulation with 2% *Etlingera coccinea* offers the most favourable sensory characteristics, proximate analysis, and microbial quality, providing valuable insights for product development in *Bosou ikan* production.

INTRODUCTION

Traditional fermented foods, passed down through generations, carry cultural and historical importance with unique sensory qualities and nutritional benefits [6]. Fermented foods have been integral to human nutrition for centuries, offering enhanced flavour, texture, and health benefits such as reduced cancer risk and improved gut health. Fermented fish, a globally significant delicacy, undergoes a natural fermentation process where microorganisms convert sugars and carbohydrates, preserving the fish and enriching its flavour. This traditional dish is a vital protein source, bearing cultural significance as a community staple. *Bosou ikan*, a fermented fish dish originating from the Kadazan-Dusun ethnic in Sabah, Malaysia, is an example of such a traditional delicacy [3]. Prepared by fermenting small freshwater fish with rice bran and salt, *Bosou ikan* undergoes a

fermentation process that results in its characteristic sour flavour and preservation. Adding *E. coccinea*, or red ginger, to some traditional recipes further enhances fermented fish's sensory and nutritional properties by inhibiting spoilage microorganisms and preserving quality, as *E. coccinea* may contain anti-microbial properties [5]. The research objectives include developing the best formulation of Dusun traditional fermented fish with optimal *E. coccinea* concentration, assessing its nutritional composition through proximate analysis, and evaluating its shelf life using microbial analysis and pH determination.

MATERIALS AND METHODS

Preparation of *Bosou ikan*

The preparation of *Bosou ikan* involved rigorous steps to ensure its quality. Initially, glass jars were meticulously sterilized, while

fragrant rice was perfectly cooked. Fresh river fish (*Ikan Serawi*) were carefully cleaned and cut, followed by processing *Pangium edule* seeds into a fine powder. Additionally, *E. coccinea* (tuhau) was finely chopped. Traditional recipes and local expertise guided the formulation, which included varying concentrations of *Etilingera coccinea* from 0% to 8%. The thoroughly mixed ingredients were then placed in sterilized jars for two weeks of fermentation.

Sensory evaluation

Sensory evaluation, employing a 9-point hedonic test and ranking, assessed attributes like color, taste, and texture [9]. Following AOAC standards, proximate analysis determined nutritional composition such as ash, moisture, crude fat, crude protein, and carbohydrate [2]. Microbiological analysis, including Total Viable Count (TVC) and Total Yeast and Mold Count (TYMC), was conducted over 28 days to monitor microbial growth.

Statistical analyses

Statistical analyses, including ANOVA with a 95% confidence interval, were employed using IBM SPSS Statistics Version 29.0 for robust data analysis, ensuring a comprehensive evaluation of the fermented fish product's quality and characteristics.

RESULT AND DISCUSSION

Table 1 exhibits the Bosou ikan's sensory analysis based on the common attributes and overall acceptance. **Table 1** illustrates consistent colour mean scores across various Dusun traditional fermented fish formulations, suggesting minimal influence from varying *Etilingera coccinea* concentrations. Glutamic acid significantly shapes flavour, notably enhancing aroma in F1 [4]. Taste predominantly features salty and sour notes, with F1 preferred overall. Texture remains stable across formulations with *Etilingera coccinea*. F1 consistently garners the highest acceptability scores, indicating optimal sensory attributes while preserving traditional expectations.

Table 1. Sample means scores with standard deviation for colour, aroma, taste, texture, and overall acceptance.

Attributes	Control	F1	F2	F3	F4
Colour	6.75±2.06 ^a	6.90±1.77 ^a	6.67±2.02 ^a	6.48±2.08 ^a	6.46±2.26 ^a
Aroma	6.42±2.31 ^a	7.13±1.61 ^b	6.23±2.28 ^a	5.58±2.35 ^a	5.04±1.78 ^a
Taste	6.48±2.31 ^a	6.92±1.28 ^b	6.69±2.03 ^a	5.79±2.29 ^a	4.77±2.14 ^a
Texture	6.87±2.06 ^a	6.75±1.52 ^a	6.60±2.18 ^a	5.98±2.33 ^a	6.06±2.13 ^a
Overall	5.79±2.20 ^a	6.98±1.44 ^b	5.71±2.24 ^a	5.46±2.31 ^a	4.36±2.00 ^a

Acceptance

Note:

¹Values are shown in the form of mean ± standard deviation.

²Different letters in the same row indicate a significant difference ($p < 0.05$), while similar letters indicate no significant difference ($p > 0.05$).

³Different concentrations of *Etilingera coccinea* are used for formulation of Bosou ikan which are control at 0%; F1 at 2%; F2 at 4%; F3 at 6%; F4 at 8%.

⁴No significant difference ($p > 0.05$) between all formulations in colour and texture.

⁵F1 differs significantly ($p < 0.05$) from control, F2, F3 and F4 in aroma, taste, and overall acceptance attributes.

Table 2 compares proximate analysis between control (0% *Etilingera coccinea*), and experimental (2% *Etilingera coccinea*, F1) Dusun Traditional Fermented Fish formulations reveal notable findings. F1 shows a significant increase in ash content, indicating higher mineral levels than the control. Moisture content remains consistent between formulations due to the constantly fragrant cooked rice presence. Substantial rises in crude fat and protein content in F1 suggest antioxidant compounds in *Etilingera coccinea* and metabolites released during fermentation contribute. F1 also exhibits higher crude fiber, implying potential digestive health benefits, while carbohydrate content decreases, influenced by fermentation and carbohydrate sources [8]. These findings highlight *Etilingera*

coccinea's potential to enhance the fermented fish product's nutritional profile while adjusting carbohydrate composition.

Table 2. Proximate Composition of Dusun Fermented Fish (n=3±SD).

Nutrient Composition (%)	Control	F1
Ash	6.34±0.40 ^a	7.48±0.89 ^b
Moisture	40.53±0.18 ^c	40.65±0.76 ^c
Crude Fat	5.21±0.21 ^c	8.40±0.02 ^f
Crude Protein	8.76±0.06 ^e	9.23±0.09 ^h
Crude Fiber	12.43±0.18 ⁱ	14.09±0.54 ^j
Carbohydrate	26.73±0.86 ^k	20.15±1.48 ^l

Note:

¹Mean±Standard deviation; Control, formulation with 0% of *Etilingera coccinea*. F1, formulation with 2% of *Etilingera coccinea*.

²Difference in lettering of the same row indicates that there is a significant difference ($p < 0.05$), and similar lettering of the same row indicates no significant difference ($p > 0.05$).

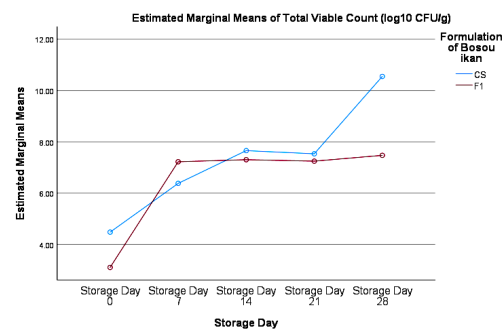


Fig. 1. Mean plots of total viable counts of Control and F1 between day of storage.

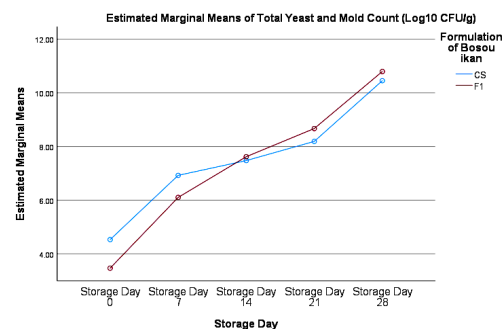


Fig. 2. Mean plots of total yeast and mold for Control and F1 between day of storage.

The analysis in **Fig. 1** focuses on the total viable count (TVC) of raw *Bosou ikan* samples, comparing formulations with and without *Etilingera Coccinea*. The control formulation experiences a significant TVC increase over storage, indicating microbial proliferation and potential hygiene challenges. Conversely, the F1 formulation with 2% *Etilingera Coccinea* shows a more controlled TVC trend, suggesting its role in mitigating microbial proliferation during storage. It's noteworthy that significant differences ($p < 0.05$) in TVC between the Control and F1 formulations highlight the efficacy of *Etilingera Coccinea* in regulating microbial growth, potentially enhancing product hygiene, and extending shelf-life [7].

Fig. 2 provides colony counts for total yeast and mold in control and F1 *Bosou ikan* samples across storage durations. The control formulation demonstrates a significant rise in yeast and mold count over time, indicating microbial proliferation and quality maintenance challenges. In contrast, F1 shows a more controlled increase in yeast and mold count, indicative of

Etilingera Coccinea's inhibitory effect on excessive microbial growth. The significant differences ($p < 0.05$) in yeast and mold counts between the control and F1 formulations underscore *Etilingera Coccinea's* potential in managing yeast and mold proliferation in fermented fish products, providing valuable insights into enhancing microbial quality and safety [7].

CONCLUSION

This study successfully determined the best formulation of Dusun traditional fermented fish, *Bosou ikan*, by varying concentrations of *Etilingera coccinea*, with the formulation containing 2% *Etilingera coccinea* (F1) emerging as the preferable choice. Through a comprehensive evaluation involving a 9-point hedonic test, F1 consistently outperformed other formulations, striking a balance between heightened sensory attributes and traditional expectations. Proximate analysis indicated significant improvements in ash, crude fat, and crude protein content in F1, highlighting its enriched nutritional profile attributed to antioxidant compounds in *Etilingera coccinea*. Furthermore, F1 positively impacted microbial quality during storage, demonstrating substantial reductions in the total viable count, total yeast, and mold counts compared to the control sample, thus enhancing safety and longevity. With its sensory excellence, statistical validation, nutritional enrichment, and enhanced microbial quality, F1 emerges as the preferred choice for consumers seeking the highest quality *Bosou ikan*.

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