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Value-Added Analysis of Mackerel Tuna (*Euthynnus affinis*) Processing into Keumamah: A Household Enterprise Case Study in Lhokseumawe, Aceh

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Abstract
Mackerel tuna (*Euthynnus affinis*) is an economically important fishery commodity but is highly perishable, making processing necessary to extend shelf life and increase product value. In Aceh, mackerel tuna is traditionally processed into keumamah, an Acehnese dried-smoked fish product. This study aims to analyze the value added, value-added ratio, and margin distribution of mackerel tuna processing into keumamah in a household-scale enterprise in Lhokseumawe City, Aceh. This study was designed as a descriptive case study with a quantitative descriptive approach. One household enterprise was purposively selected, and data were collected through semi-structured interviews, direct observation, and business documentation during one production cycle. The data were analyzed using the Hayami method. The results show that 50 kg of fresh mackerel tuna produced 17.5 kg of keumamah, with a conversion factor of 0.35. The value added was IDR 11,500 per kg of raw material, with a value-added ratio of 27.38%, categorized as medium. Labor remuneration was IDR 2,000 per kg of raw material, while owner profit was IDR 9,500 per kg. Margin distribution consisted of owner profit at 55.88%, other input contribution at 32.35%, and labor income at 11.76%. These findings indicate that the case enterprise generated economic value through keumamah processing, although value-added improvement requires better input efficiency, processing techniques, packaging, legality, and market access. Because this study examined one enterprise and one production cycle, the findings are not intended for generalization.

Keywords: Hayami method, Household enterprise, Keumamah, Value added, Mackerel tuna.

1. INTRODUCTION

Mackerel tuna (*Euthynnus affinis*) is one of the pelagic fish commodities commonly utilized in coastal fishery economies. The species is marketed in fresh, dried, salted, smoked, canned, and frozen forms, indicating its importance both as a fresh fish commodity and as a raw material for processed products (FishBase, 2026). In Indonesia, including Aceh, mackerel tuna contributes to the supply of animal protein and to income generation for fishers, traders, and fish-processing households.

Despite its economic value, fresh fish is highly perishable. Under tropical conditions, quality deterioration can occur rapidly if handling, preservation, and distribution are not managed properly. Fishery-product processing is therefore important not only to extend shelf life but also to reduce post-harvest losses, stabilize income during periods of fluctuating fresh-fish supply, and increase the value captured by small-scale processing enterprises (Food and Agriculture Organization [FAO], 2011; Cortés-Sánchez et al., 2024).

Keumamah, locally known as wooden fish, is a traditional Acehnese processed fish product made through sequential handling, boiling, smoking, and drying. This product has economic and cultural value because it is linked to local food practices and has better storability than fresh fish. From an agroindustry perspective, keumamah processing represents a form of downstream fishery activity that transforms a perishable raw material into a more durable product with a higher unit selling price.

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Lhokseumawe City is located on the northeastern coast of Aceh and has fish-landing and fish-processing activities that support household-scale fishery enterprises (Badan Pusat Statistik Kota Lhokseumawe, 2024; Dinas Kelautan dan Perikanan Provinsi Aceh, 2023). Previous research in the Pusong area of Lhokseumawe showed that processed-fish businesses remain mostly household-based and face constraints related to technology, business management, raw-material supply, and marketing (Arifai et al., 2016). These conditions make Lhokseumawe relevant for examining how traditional fish processing creates value added at the micro-enterprise level.

Value-added analysis is needed because the economic performance of household fish processing is determined not only by selling price but also by conversion rate, raw-material cost, supporting input cost, labor use, and the distribution of processing margin. The Hayami method is widely used in agroindustry studies because it decomposes processing results into output value, value added, labor remuneration, owner profit, and margin distribution (Hayami et al., 1987). In fishery agroindustry, this method has been applied to products such as lemuru fish processing and salted-fish processing (Aji et al., 2018; Wachdijono et al., 2021).

Previous studies have shown that processed fish products can generate additional economic value compared with selling raw fish. Rizky et al. (2024), for example, analyzed the value added of processed mackerel tuna products in a small enterprise, while Nabilasari et al. (2022) showed that dried-fish processing can create positive value added. However, studies that specifically examine keumamah processing from mackerel tuna at the household-enterprise scale in Lhokseumawe are still limited. In addition, many value-added studies report the magnitude of value added but provide less diagnostic discussion on the cost components and margin distribution that shape enterprise performance.

Unlike previous value-added studies that mainly focus on salted fish, smoked fish, or processed mackerel tuna products in other regions, this study provides a micro-level empirical case of keumamah processing in Lhokseumawe and decomposes the processing margin into labor remuneration, non-labor input contribution, and owner profit. The contribution is therefore contextual and diagnostic, particularly for understanding the economic structure of household-scale traditional fish processing. This study aims to analyze the value added, value-added ratio, cost structure, R/C ratio, price sensitivity, and margin distribution of mackerel tuna processing into keumamah in a household-scale enterprise in Lhokseumawe City, Aceh.

2. METHODS

2.1. Research Location and Case Selection

This research was conducted in Mon Gudong Village, Banda Sakti District, Lhokseumawe City, Aceh Province. The research object was one household-scale keumamah processing enterprise owned by Mrs. Suryani. The location and business unit were selected purposively because the enterprise had operated for more than five years, actively processed mackerel tuna into keumamah, had relatively stable production activity, and was willing to provide detailed information on production input, output, cost, and selling price.

The selected enterprise was treated as an accessible and information-rich case rather than a statistically representative case. It was selected because the owner was directly involved in the production and marketing process, had sufficient knowledge of input use and selling prices, and was willing to provide detailed production and cost information. Other similar household enterprises may exist in Lhokseumawe City; however, they were not included because this study was designed as a descriptive case study focusing on an in-depth micro-level calculation of value added in one observed enterprise.

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The study was positioned as a descriptive case study. Therefore, the term “case enterprise” is used throughout the article to emphasize that the findings describe the observed household enterprise rather than all keumamah enterprises in Lhokseumawe City. The case-study design was selected to provide a micro-level diagnostic description of value-added creation and margin distribution in a traditional fish-processing enterprise.

2.2. Research Method and Data Collection

This study used a quantitative descriptive method within a descriptive case-study approach. The quantitative descriptive method was used to present production and cost data systematically and to calculate the economic indicators of keumamah processing (Nazir, 2014).

Data collection was conducted in March 2026 through semi-structured interviews, direct observation, and business documentation. The interview was conducted with one key informant, namely the owner of the case enterprise, because she was directly involved in raw-material procurement, production management, labor payment, and product marketing. The interview lasted approximately 60–90 minutes and focused on raw-material use, product output, labor use, raw-material price, selling price, other input costs, and revenue. Direct observation was carried out during one complete production cycle, from raw-material preparation to boiling, smoking, drying, and final product handling. The business documents examined included records of raw-material purchases, supporting input costs, labor payments, production volume, selling price, and sales revenue. Data validity was strengthened through triangulation by comparing information obtained from interviews, direct observation, and business documentation. When differences were found between interview information and documentary records, clarification was conducted with the business owner to obtain the most consistent data for analysis.

The unit of analysis was one observed production cycle, namely the processing of 50 kg of fresh mackerel tuna into keumamah. The observed cycle reflected the normal production practice of the case enterprise at the time of data collection. However, because fish prices may vary across seasons and market conditions, the analysis also includes simple price-sensitivity scenarios to show how changes in raw-material and selling prices may affect value added.

The observed production cycle was treated as a snapshot of the case enterprise’s production condition during the data-collection period. The cycle was conducted in March 2026 under the normal production situation of the enterprise. However, the results of one production cycle are sensitive to several factors, including fresh mackerel tuna price fluctuation, weather conditions during sun-drying, variation in fish size, and differences in moisture reduction during boiling, smoking, and drying. Therefore, the calculated value added, conversion factor, profit, and margin distribution should be interpreted as case-specific and time-specific results rather than as fixed values for all production cycles.

2.3. Cost Components and Analytical Scope

The cost components included in the analysis were explicit costs directly observed in one production cycle: fresh mackerel tuna, salt, firewood, and paid labor. Labor was measured in person-days, locally referred to as HOK. One person-day refers to one worker’s labor contribution in one working day.

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Several implicit and supporting costs were not fully included because they were not recorded separately by the case enterprise. These include depreciation of processing equipment, water, electricity, transport, packaging, marketing costs, rent, and unpaid family labor. This limitation is explicitly considered in interpreting the results because excluding these costs may cause calculated profit and value added to be higher than the value that would be obtained under full-cost accounting.

2.4. Data Analysis

Data were analyzed using the Hayami method to calculate the value added generated from processing fresh mackerel tuna into keumamah. This method was used to calculate the conversion factor, output value, value added, value-added ratio, labor remuneration, owner profit, margin, and distribution of returns to production factors (Hayami et al., 1987).

The Hayami analysis in this study was used as a descriptive accounting approach. Therefore, the results describe the economic structure of the observed production cycle and do not test causal relationships or statistical significance. The value-added classification was used as an interpretive guide to describe the relative level of value added generated by the case enterprise, while the comparison with previous fish-processing studies was used to strengthen the relevance of the interpretation in the fishery agroindustry context.

Value added was calculated by subtracting raw-material costs and non-labor input contributions from output value. The value-added ratio was obtained by comparing value added with output value and multiplying the result by 100%. Interpretation of the value-added ratio refers to the classification used by Azmita et al. (2019): low if the value-added ratio is less than 15%, medium if it is within the range of 15-40%, and high if it is greater than 40%.

Additional analysis was conducted using the R/C ratio, raw-material cost share, and price-sensitivity scenarios. The R/C ratio was calculated by dividing total revenue by total production cost. A value greater than 1 indicates that the enterprise generates revenue higher than cost in the observed production cycle. Raw-material cost share was calculated by dividing raw-material cost by total production cost. Sensitivity analysis was conducted by simulating changes in raw-material price and product selling price while holding the conversion factor and other input costs constant.

Table 1. Components and Formulas for Value-Added Calculation Using the Hayami Method

No.	Variable	Symbol	Formula/Description
1	Output produced (kg/production cycle)	A	Observed output
2	Raw material used (kg/production cycle)	B	Observed input
3	Labor (person-days/production cycle)	C	Observed labor use
4	Conversion factor	D	A/B
5	Labor coefficient	E	C/B
6	Output price (IDR/kg)	F	Observed selling price
7	Average labor wage (IDR/person-day)	G	Observed wage
8	Raw-material price (IDR/kg)	H	Observed raw-material price
9	Other input contribution (IDR/kg raw material)	I	Salt, firewood, and other direct non-labor inputs
10	Output value (IDR/kg raw material)	J	D x F
11	Value added (IDR/kg raw material)	K	J - H - I

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No.	Variable	Symbol	Formula/Description
12	Value-added ratio (%)	L	(K/J) x 100
13	Labor remuneration (IDR/kg raw material)	M	E x G
14	Labor share (%)	N	(M/K) x 100
15	Owner profit (IDR/kg raw material)	O	K - M
16	Profit rate (%)	P	(O/K) x 100
17	Margin (IDR/kg raw material)	Q	J - H
18	Labor income to margin (%)	R	(M/Q) x 100
19	Other input contribution to margin (%)	S	(I/Q) x 100
20	Owner profit to margin (%)	T	(O/Q) x 100

Source: Adapted from Hayami et al. (1987).

3. RESULTS AND DISCUSSION

3.1. Keumamah Production Process in the Case Enterprise

The keumamah production process in the case enterprise was carried out through several stages: raw-material selection, gutting and trimming, washing, boiling with salt, smoking, and sun-drying. Fresh mackerel tuna was selected as the main raw material because raw-material quality affects the quality, texture, and storability of the final product.

In the observed production cycle, the case enterprise processed 50 kg of fresh mackerel tuna of relatively medium size. The production process was carried out under normal household-scale processing conditions in March 2026. After raw-material selection, the fish were gutted, trimmed, and washed before boiling. Approximately 5 kg of salt was used in the boiling stage. Boiling was carried out for about 60–90 minutes to support preservation, improve taste, and prepare the fish for smoking and drying. After boiling, the fish were smoked using firewood for approximately 5–6 hours. The smoked fish were then sun-dried for around one production day, depending on sunlight intensity and weather conditions. In the observed cycle, sun-drying was conducted under relatively favorable weather conditions. The final output was 17.5 kg of keumamah. The reduction from 50 kg of fresh fish to 17.5 kg of final product was calculated from the observed input-output difference and may be associated with trimming loss, moisture reduction during boiling, smoking, and drying, and variation in fish size.

During gutting and trimming, the head, viscera, and unused parts were removed. The fish were then washed and boiled with salt. Boiling supports preservation and flavor formation before the fish enter the smoking and drying stages. Smoking and sun-drying reduce water content and produce a dense, dry texture, which is the basis for the local name “wooden fish”. This process shows that keumamah is not only a preserved product but also a traditional downstream fishery product that increases the economic value of fresh mackerel tuna.

3.2. Cost Structure, Revenue, and R/C Ratio

In one production cycle, the case enterprise used 50 kg of fresh mackerel tuna at IDR 25,000/kg, resulting in a raw-material cost of IDR 1,250,000. Other direct non-labor input costs consisted of salt and firewood. In the observed production cycle, the enterprise used approximately 5 kg of salt at IDR 5,000/kg, resulting in a salt cost of IDR 25,000. Firewood use was estimated at 5 bundles at

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IDR 50,000/bundle, resulting in a firewood cost of IDR 250,000. Thus, total direct non-labor input cost was IDR 275,000 per production cycle, equivalent to IDR 5,500/kg of raw material. Packaging, transport, water, electricity, marketing costs, rent, equipment depreciation, and unpaid family labor were not separately recorded by the enterprise and were therefore not included in the observed direct production cost.

The cost structure indicates that raw materials were the dominant cost component, accounting for 76.92% of total production cost. This means that the case enterprise is highly sensitive to the price of fresh mackerel tuna. If raw-material prices increase while the selling price and conversion factor remain unchanged, value added and profit will decline. This finding reinforces the importance of raw-material cost as a major risk factor in household-scale keumamah processing.

The enterprise produced 17.5 kg of keumamah and sold it at IDR 120,000/kg, generating total revenue of IDR 2,100,000. The observed operating profit per production cycle was IDR 475,000, and the R/C ratio was 1.29. This indicates that every IDR 1.00 of production cost generated IDR 1.29 of revenue in the observed cycle. Although the business was profitable in the observed condition, the relatively high raw-material cost share indicates that profitability may weaken when raw-material prices increase.

Table 2. Cost Structure, Revenue, Observed Operating Profit, and R/C Ratio per Production Cycle

Cost/Revenue Component	Unit/Volume	Unit Price (IDR)	Total Value (IDR)	Share of Total Cost (%)
Fresh mackerel tuna	50 kg	25,000/kg	1,250,000	76.92
Salt	5 kg	5,000/kg	25,000	1.54
Firewood	5 bundles	50,000/bundle	250,000	15.38
Labor	2 person-days	50,000/person-day	100,000	6.15
Total direct production cost	-	-	1,625,000	100.00
Revenue	17.5 kg keumamah	120,000/kg	2,100,000	-
Observed operating profit per cycle	-	-	475,000	-
R/C ratio	-	-	1.29	-

Source: Primary data (processed), 2026.

The profit reported in this study should be interpreted as observed operating profit per production cycle because it was calculated from explicit costs recorded and confirmed during field data collection, including raw-material cost, salt, firewood, and paid labor. It does not represent full accounting profit because several implicit and supporting costs, such as equipment depreciation, packaging, transport, water, electricity, rent, marketing costs, and unpaid family labor, were not fully recorded or included in the calculation.

3.3. Value-Added Analysis Using the Hayami Method

Processing 50 kg of fresh mackerel tuna produced 17.5 kg of keumamah. The conversion factor was 0.35, meaning that every 1 kg of fresh mackerel tuna produced 0.35 kg of keumamah. The 65%

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weight loss was calculated from the difference between raw-material input and final-product output in the observed cycle. This reduction may be associated with gutting and trimming, boiling, smoking, and drying, which remove unused parts and reduce moisture content. This shrinkage is normal in dried and smoked fish processing, but it also becomes a key determinant of value added because lower output volume must be compensated by a higher selling price.

The output value was IDR 42,000 per kg of raw material, calculated by multiplying the conversion factor of 0.35 by the selling price of IDR 120,000/kg. After subtracting the raw-material price of IDR 25,000/kg and other input contribution of IDR 5,500/kg of raw material, the value added was IDR 11,500/kg of raw material. The value-added ratio was 27.38%, which falls into the medium category based on the classification of Azmita et al. (2019).

Table 3. Results of the Value-Added Analysis of Mackerel Tuna Processing into Keumamah

No.	Component	Symbol/Formula	Value
1	Keumamah output	A	17.50 kg
2	Mackerel tuna raw-material input	B	50.00 kg
3	Labor input	C	2.00 person-days
4	Conversion factor	D = A/B	0.35
5	Labor coefficient	E = C/B	0.04
6	Output price	F	IDR 120,000/kg
7	Average labor wage	G	IDR 50,000/person-day
8	Raw-material price	H	IDR 25,000/kg
9	Other input contribution	I	IDR 5,500/kg raw material
10	Output value	J = D x F	IDR 42,000/kg
11	Value added	K = J - H - I	IDR 11,500/kg
12	Value-added ratio	L = K/J x 100%	27.38%
13	Labor remuneration	M = E x G	IDR 2,000/kg
14	Labor share	N = M/K x 100%	17.39%
15	Owner profit	O = K - M	IDR 9,500/kg
16	Profit rate	P = O/K x 100%	82.61%
17	Margin	Q = J - H	IDR 17,000/kg
18	Labor income to margin	R = M/Q x 100%	11.76%
19	Other input contribution to margin	S = I/Q x 100%	32.35%
20	Owner profit to margin	T = O/Q x 100%	55.88%

Source: Primary data (processed), 2026.

Note: Output value, value added, labor remuneration, owner profit, and margin are calculated per kilogram of raw material, not per kilogram of final product.

3.4. Price-Sensitivity Analysis

Sensitivity analysis was conducted to examine how changes in raw-material price and product selling price affect value added. The simulation held the conversion factor at 0.35 and other input contribution at IDR 5,500/kg of raw material. The base condition used a raw-material price of IDR 25,000/kg and a selling price of IDR 120,000/kg.

The results show that raw-material price fluctuation has a strong effect on value added. If the raw-material price decreases to IDR 22,000/kg, value added increases to IDR 14,500/kg and the value-added ratio increases to 34.52%. Conversely, if the raw-material price increases to IDR 30,000/kg,

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value added declines to IDR 6,500/kg and the value-added ratio falls to 15.48%, close to the lower boundary of the medium category. This indicates that raw-material procurement stability is a strategic issue for the case enterprise.

The sensitivity scenario also shows that improving the selling price through better packaging, product identity, halal certification, business legality, and wider market access can increase the value-added ratio. If the selling price increases to IDR 130,000/kg while raw-material price remains IDR 25,000/kg, value added increases to IDR 15,000/kg and the value-added ratio rises to 32.97%. This supports the practical implication that product differentiation and market access are important pathways for improving value added.

Table 4. Sensitivity of Value Added to Raw-Material and Selling Price Changes

Scenario	Raw-Material Price (IDR/kg)	Selling Price (IDR/kg)	Output Value (IDR/kg raw material)	Value Added (IDR/kg raw material)	Value-Added Ratio (%)
Lower raw-material price	22,000	120,000	42,000	14,500	34.52
Base condition	25,000	120,000	42,000	11,500	27.38
Higher raw-material price	30,000	120,000	42,000	6,500	15.48
Higher selling price	25,000	130,000	45,500	15,000	32.97
Higher selling price + lower raw-material price	22,000	130,000	45,500	18,000	39.56

Source: Primary data simulation (processed), 2026.

Note: Conversion factor = 0.35; other input contribution = IDR 5,500/kg raw material.

3.5. Discussion

The medium value-added ratio indicates that keumamah processing has created additional economic value, but its performance remains constrained by high raw-material costs and substantial weight loss during processing. Since raw materials accounted for more than three quarters of total production costs, price fluctuation of fresh mackerel tuna becomes the most critical risk factor. Therefore, improving value added should not only focus on increasing selling price through better packaging and certification, but also on stabilizing raw-material procurement and improving drying and smoking efficiency.

The conversion factor of 0.35 reflects the physical transformation of fresh fish into a dried and smoked product. A high level of shrinkage is expected because water content and unused fish parts are reduced during processing. However, this shrinkage also means that the enterprise must obtain a sufficiently high selling price to compensate for the reduced output volume. If product quality, packaging, and market positioning do not improve, the enterprise may find it difficult to move from the medium to high value-added category.

The labor share was 17.39% of value added, while owner profit accounted for 82.61%. This does not necessarily indicate an imbalance in a large-scale industrial sense because the case enterprise

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is household-based and the owner performs multiple roles: capital provider, raw-material buyer, production manager, risk bearer, and marketing actor. Nevertheless, the relatively small labor share indicates that the enterprise uses simple technology and limited paid labor. This pattern is consistent with the characteristics of many household micro and small enterprises, which rely on family management, small production volume, and local market orientation (Tambunan, 2012).

Margin distribution further confirms that the benefits of keumamah processing are distributed across several production factors. From the margin of IDR 17,000/kg of raw material, owner profit accounted for 55.88%, non-labor input contribution accounted for 32.35%, and labor income accounted for 11.76%. This means that value-added creation is not received only by the owner but also flows to suppliers of salt and firewood and to labor involved in the production process. Such decomposition is useful because small-scale fisheries value chains include activities from harvesting and handling to processing, transport, marketing, and consumption (FAO, 2020).

Compared with studies on other processed fish products, the value-added ratio of 27.38% indicates moderate performance. Wachdijono et al. (2021) showed that value-added analysis can be used to assess productivity and break-even conditions in salted-fish processing, while Nabilasari et al. (2022) found that dried-fish processing creates positive value added influenced by raw-material characteristics, processing methods, and cost structure. The present study strengthens this evidence in the context of keumamah by showing that value added is primarily shaped by conversion rate, raw-material price, and the ability to increase product selling price.

Recent literature on fish processing emphasizes that processing and preservation are necessary to maintain quality and safety in perishable fishery products (Cortés-Sánchez et al., 2024). In the case of keumamah, the main practical challenge is to improve traditional processing without eliminating product identity. More efficient smoking facilities, cleaner drying practices, improved packaging, and compliance with food-safety and business-legality requirements may increase consumer trust and support access to wider markets. This is in line with the broader fishery downstreaming agenda, which encourages value-added processing rather than only selling raw fish (Kementerian Kelautan dan Perikanan, 2024, 2025).

From a practical perspective, four strategies are most relevant for the case enterprise. First, raw-material procurement should be stabilized through supplier relationships or collective purchasing to reduce exposure to sudden price increases. Second, smoking and drying efficiency should be improved to reduce processing loss and product damage. Third, packaging should be upgraded by using clearer labeling, local product identity, and more hygienic packaging materials. Fourth, business legality, halal certification, and digital marketing should be strengthened so that the product can enter broader consumer segments beyond local markets.

Overall, the analysis confirms that keumamah processing has economic potential as a household-scale fishery agroindustry. However, the observed value-added ratio remains in the medium category because the enterprise faces high raw-material costs, large physical shrinkage, simple technology, and limited market differentiation. The main implication is that increasing value added requires integrated improvements in cost efficiency, processing quality, product presentation, and market access rather than relying only on higher production volume.

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3.6. Study Limitations

This study has several limitations. First, the analysis was based on one household enterprise and one production cycle. Second, the calculation used observed explicit costs and did not fully include depreciation, packaging, marketing costs, transport, water, electricity, rent, or unpaid family labor. Third, raw-material and selling prices were observed during the data-collection period and may vary across seasons. Therefore, future studies should include more enterprises, repeated production cycles, full-cost accounting, and broader sensitivity analysis across different raw-material price and market conditions.

4. CONCLUSION

The processing of mackerel tuna (*Euthynnus affinis*) into keumamah in the case enterprise was able to generate economic value added. In one observed production cycle, 50 kg of fresh mackerel tuna produced 17.5 kg of keumamah with a conversion factor of 0.35. The value added was IDR 11,500/kg of raw material, with a value-added ratio of 27.38%, which falls into the medium category. The R/C ratio was 1.29, indicating that the observed production cycle was profitable. However, raw materials accounted for 76.92% of total production costs, making the enterprise highly vulnerable to fresh-fish price fluctuation. Margin distribution showed that owner profit accounted for 55.88%, non-labor input contribution for 32.35%, and labor income for 11.76% of the processing margin. Sensitivity analysis confirms that higher raw-material prices substantially reduce value added, while a higher selling price can improve the value-added ratio. Therefore, the development of household-scale keumamah processing should prioritize raw-material supply stabilization, improved smoking and drying efficiency, better packaging, business legality, halal certification, and digital marketing. Because this study was based on one enterprise and one production cycle, the results should be interpreted as a case-specific diagnostic analysis rather than a general representation of all keumamah enterprises in Lhokseumawe. Future research should involve more business units, repeated production cycles, and full-cost analysis to provide stronger comparative evidence.

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