

# Development Strategy for Snakehead Fish (*Channa striata*) Albumin Agroindustry in South Kalimantan: SWOT Analysis and IE Matrix

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## Abstract

Snakehead fish albumin is a product based on South Kalimantan fishery resources that has the potential to be developed as a value-added agro-industrial product, but its development still faces various strategic obstacles. This study aims to formulate a strategy for developing snakehead fish albumin through an analysis of internal and external factors using the SWOT approach combined with the IFAS, EFAS, and IE matrices. The study used a descriptive analytical method with data collection through interviews, observations, and questionnaires to relevant stakeholders. Approximately 250 respondents were involved, including producers and MSME actors, representatives of government and technical institutions, private-sector actors, and other stakeholders within the selected institutional network in South Kalimantan. The analysis results show an IFAS value of 2.87 and an EFAS value of 2.76, which places the development of snakehead fish albumin in Cell V of the IE Matrix. This condition indicates an average internal position and a medium external position. The development strategy is directed at strengthening supply stability, product quality, production efficiency, and selective market development. This research provides a conceptual contribution through the integration of SWOT analysis and IE Matrix in formulating strategies for developing local resource-based agro-industrial products, while also providing an applied science context that integrates biological resources, production systems, stakeholder assessment, and evidence-based decision-making relevant to science learning and fisheries processing education.

**Keywords:** Snakehead Fish Albumin; Development Strategy; SWOT; IE Matrix

## INTRODUCTION

The increasing convergence of food science, biotechnology, aquaculture, and health-oriented consumer markets has intensified interest in transforming aquatic biological resources into higher-value functional foods and nutraceutical products. Fish and seafood resources are no longer regarded exclusively as conventional sources of dietary protein; they are increasingly investigated as reservoirs of bioactive proteins, peptides, fatty acids, minerals, and other compounds with potential applications in food, pharmaceutical, and biomedical systems. This transition is particularly relevant for emerging economies endowed with substantial aquatic biodiversity but still facing challenges in translating biological resources into standardized, competitive, and sustainable agro-industrial products. Recent research has demonstrated that seafood-derived proteins can provide substantial opportunities for value addition when supported by appropriate recovery, purification, stabilization, processing, and quality-control technologies (Hutapea et al., 2023; Nirmal et al., 2022; Smaoui et al., 2024). At the same time, global agri-food transformation increasingly requires the integration of biological-resource utilization with technological upgrading, sustainable production, resilient supply chains, and evidence-based commercialization rather than relying solely on the intrinsic value of raw commodities (Annosi et al., 2023; Hassoun et al., 2023; Wang et al., 2024). Consequently,

developing local fish resources into commercially viable nutraceutical or functional-food commodities requires a multidimensional strategy encompassing resource availability, processing technology, institutional capacity, product standardization, regulation, and market readiness.

Within this broader context, snakehead fish (*Channa striata*) represents a strategically important freshwater commodity in South and Southeast Asia. The species has long attracted scientific and commercial attention because of its nutritional profile and the presence of albumin and other bioactive constituents. Albumin is a water-soluble protein with diverse biomedical and pharmaceutical applications, while *C. striata* has been investigated in relation to nutritional support, tissue repair, inflammatory processes, and other health-related applications (Hutapea et al., 2023; Lee et al., 2022; Hapsari & Tjandrawinata, 2025). Experimental and systematic-review evidence indicates that *C. striata* possesses promising nutritional and biological characteristics; however, the strength of evidence varies considerably across applications, and biological potential should not automatically be interpreted as definitive therapeutic efficacy (Lee et al., 2022; Taslim et al., 2022; Hapsari & Tjandrawinata, 2025). This distinction is crucial for agro-industrial development because commercialization of health-oriented fish products increasingly depends not only on consumer perceptions of naturalness but also on scientifically defensible claims, reproducible product quality, regulatory compliance, and appropriate market positioning. Thus, the strategic value of snakehead fish albumin lies not merely in its biochemical characteristics but in the capacity of the surrounding production system to convert those characteristics into standardized and credible value-added products.

Despite this potential, expansion of *C. striata*-based production faces important biological and supply-side constraints. Much of the species' supply in Asian contexts has historically depended on capture fisheries, while commercial aquaculture continues to encounter challenges related to captive breeding, seed availability, larval survival, cannibalism, feed adaptation, and production management (Kumar et al., 2022; Raizada et al., 2022). These limitations create a structural tension between increasing demand for value-added snakehead products and the reliability of upstream raw-material supply. Where agro-industrial expansion is pursued without strengthening cultivation systems, greater demand may increase pressure on natural stocks and expose processors to unstable availability, inconsistent raw-material characteristics, and fluctuating prices. Studies on captive breeding and hatchery management therefore suggest that controlled cultivation and improved aquaculture systems are critical for transforming *C. striata* from a predominantly opportunistic natural resource into a predictable agro-industrial input (Kumar et al., 2022; Raizada et al., 2022). This issue is especially relevant in Indonesian regions where snakehead fish occur naturally and already possess social and commercial value. Consequently, raw-material availability must be interpreted not simply as a current strength but as a strategic resource whose sustainability depends upon upstream production governance.

Processing technology constitutes a second critical challenge. The value of albumin products is strongly influenced by extraction conditions and post-extraction handling because proteins are sensitive to temperature, pH, processing duration, purification procedures, and storage conditions. Indonesian studies demonstrate that different extraction techniques can produce materially different albumin yields and product characteristics. Hidayatullah et al. (2023), for example, compared conventional boiling, microwave-assisted extraction, and ultrasonic-assisted extraction and demonstrated that extraction conditions influence recovered albumin levels. Yuniati et al. (2024) similarly showed that heating duration and acidification affect albumin concentrations, while Maulid et al. (2024) reported that extraction temperature affects extract yield, protein and albumin content, and sensory characteristics. These findings are consistent with wider evidence showing that seafood-protein valorization requires carefully controlled extraction, stabilization, and processing technologies if biological materials are to be converted into reproducible commercial ingredients (Nirmal et al., 2022; Hutapea et al., 2023; Smaoui et al., 2024). Therefore, traditional or heterogeneous processing practices can become an important internal weakness for developing snakehead fish albumin agroindustry,

particularly when producers seek entry into markets in which safety, composition, shelf life, authenticity, and standardized specifications determine commercial legitimacy.

Product development is also inseparable from consumer acceptance and downstream value creation. Research in Indonesia has begun to explore snakehead-derived products beyond raw fish consumption, including albumin preparations and health-oriented beverages. Baehaki and Azzahra (2024) demonstrated that formulation choices influence organoleptic characteristics of snakehead-fish albumin, whereas Maulid et al. (2024) connected extraction temperature not only with biochemical composition but also with sensory acceptance. Such findings illustrate that technological optimization and market development cannot be treated as independent processes. A technically efficient extraction system will have limited commercial value if the resulting product is unstable, unacceptable to consumers, prohibitively expensive, or difficult to certify. Conversely, aggressive marketing without reproducible production and quality systems may expose businesses to reputational and regulatory risks. For small and medium enterprises, this interdependence is particularly significant because limited capital, uneven technological capability, and fragmented supply networks can make simultaneous improvement of production, certification, marketing, and distribution difficult. Agro-industrial development must therefore be sequenced according to strategic priorities rather than assuming that every identified market opportunity should immediately be pursued.

The Indonesian agrifood environment further reinforces the importance of institutional and digital capabilities. Digitalization has expanded opportunities for agrifood actors to connect producers, consumers, markets, and supporting services, but technological adoption remains heterogeneous and is mediated by organizational capability, infrastructure, knowledge, and institutional support (Mayang Mangurai et al., 2024; Annosi et al., 2023; Hassoun et al., 2023). Internationally, research suggests that digital transformation in food supply chains is most effective when digital technologies are integrated with data management, organizational routines, supply-chain coordination, and operational readiness rather than adopted as isolated marketing instruments (Wang et al., 2024; Annosi et al., 2023). For Indonesian MSMEs, market development may additionally intersect with regulatory and certification requirements. Sada et al. (2026), for instance, found that regulatory literacy and localized institutional assistance were important in strengthening halal-certification readiness among Indonesian MSMEs. Although their study addressed a different sectoral setting, its implications are relevant to snakehead-fish enterprises because the commercialization of animal-derived functional products similarly depends on the ability of small producers to navigate formal standards, certification requirements, administrative procedures, and consumer trust. Digital marketing, halal positioning, and wider distribution therefore represent potential opportunities, but their benefits depend on prior or simultaneous improvements in supply assurance, quality consistency, and regulatory readiness.

These interconnected challenges require a strategic analytical framework capable of simultaneously examining internal organizational conditions and external environmental pressures. SWOT analysis provides a widely recognized framework for classifying strengths, weaknesses, opportunities, and threats, while the TOWS logic introduced by Weihrich (1982) enables these factors to be combined into SO, WO, ST, and WT strategic alternatives. Nevertheless, conventional SWOT analysis has been criticized because factor identification can become subjective and because descriptive lists do not automatically establish the relative importance or implementation priority of proposed strategies (Hill & Westbrook, 1997; Gürel & Tat, 2017). More recent applications in agriculture and agribusiness consequently combine SWOT with quantitative or semi-quantitative strategic tools to improve prioritization and decision transparency. Indonesian agribusiness studies have employed internal-external evaluation, SWOT, and related priority matrices to translate environmental assessments into more operational strategic directions. Such integration is particularly appropriate for resource-based agroindustries because their competitiveness depends on interactions among biological resources, processing capacity, markets, institutions, and external regulation rather than on a

single technological or economic variable.

In this regard, the Internal Factor Analysis Summary (IFAS), External Factor Analysis Summary (EFAS), and Internal–External (IE) Matrix provide a useful extension of descriptive SWOT analysis. IFAS and EFAS enable identified strategic factors to be weighted and rated, whereas the IE Matrix converts the resulting internal and external scores into a strategic position that can guide decisions concerning growth, consolidation, or defensive action (David & David, 2017). Recent strategic studies continue to demonstrate the practical utility of combining qualitative factor identification with structured internal and external evaluation, particularly where decision makers must allocate limited resources among multiple development options. The importance of this approach lies not in claiming mathematical objectivity for stakeholder judgments but in making those judgments more explicit, comparable, and strategically interpretable. For snakehead fish albumin agroindustry, such a framework can reveal whether favorable biological attributes and market opportunities are sufficiently supported by production technology, supply continuity, institutional capacity, and quality systems to warrant aggressive expansion or whether consolidation should precede market growth.

However, the existing literature remains fragmented. Biomedical and food-science research predominantly investigates the biochemical composition, extraction conditions, nutritional functionality, anti-inflammatory potential, wound-related applications, or formulation characteristics of *C. striata* (Hutapea et al., 2023; Lee et al., 2022; Hidayatullah et al., 2023; Yuniati et al., 2024; Hapsari & Tjandrawinata, 2025). Aquaculture research, in contrast, emphasizes captive breeding, hatchery seed production, feeding, and cultivation constraints (Kumar et al., 2022; Raizada et al., 2022). Another body of literature addresses digitalization and organizational transformation in agrifood SMEs and food supply chains but does not specifically examine snakehead-fish albumin production (Annosi et al., 2023; Hassoun et al., 2023; Mayang Mangurai et al., 2024; Wang et al., 2024). These streams of scholarship collectively demonstrate biological potential, technical challenges, and emerging market opportunities, but they do not establish how these factors interact at the regional agro-industrial level. In particular, limited empirical research has integrated producer, MSME, government, technical-institution, and private-sector perspectives to determine the strategic readiness of snakehead fish albumin development in South Kalimantan through a combined SWOT–IFAS–EFAS–IE framework.

This gap is substantive because the existence of a promising biological resource does not by itself demonstrate the readiness of an industry for expansion. A region may possess raw materials and promising product attributes while simultaneously experiencing unstable supply, traditional processing methods, quality-control limitations, fragmented institutional coordination, or uncertain market readiness. Likewise, opportunities created by health-product demand, aquaculture development, technological innovation, halal markets, and digital distribution may produce limited benefits if internal capabilities remain insufficient. Existing studies tend to isolate individual elements of this system rather than evaluate the strategic relationship among them. Consequently, there is a need for stakeholder-based evidence capable of positioning the agroindustry as a whole and translating identified factors into development priorities that distinguish immediate actions from medium- and long-term interventions. Such an approach also provides a more cautious basis for development planning by preventing biological potential or perceived market demand from being treated automatically as evidence that aggressive commercialization is already feasible.

The novelty of the present study therefore lies in integrating the biological-resource, production, institutional, technological, and market dimensions of snakehead fish albumin within a stakeholder-based strategic assessment of South Kalimantan. Rather than investigating albumin concentration, extraction performance, biological efficacy, or consumer response in isolation, the study combines qualitative stakeholder evidence with quantitative weighting and rating of internal and external strategic factors. SWOT analysis is subsequently integrated with IFAS, EFAS, and the IE Matrix to determine the industry's strategic position and to formulate SO, WO, ST, and WT alternatives according to the actual balance between internal capability and

environmental opportunity. This framework is expected to contribute conceptually to local resource-based agroindustry research and practically to the design of more realistic interventions concerning raw-material security, processing modernization, standardization, institutional collaboration, digital distribution, and selective market development.

Accordingly, this study aims to formulate a development strategy for the snakehead fish (*Channa striata*) albumin agroindustry in South Kalimantan by identifying and evaluating its principal internal strengths and weaknesses and external opportunities and threats; quantifying these factors through IFAS and EFAS; determining the industry's strategic position using the IE Matrix; and translating the resulting position into prioritized SO, WO, ST, and WT strategic alternatives. By integrating multiple stakeholder perspectives and structured strategic assessment, the study seeks to provide an evidence-based foundation for strengthening the sustainability, technological readiness, product quality, and competitiveness of a regional fishery-based agroindustry.

## METHODS

This study employed a descriptive mixed-methods strategic assessment to formulate development strategies for the snakehead fish (*Channa striata*) albumin agroindustry in South Kalimantan. A mixed-methods approach was appropriate because the research integrated qualitative evidence from semi-structured interviews, field observations, and stakeholder explanations with quantitative assessments used to weight and rate internal and external strategic factors. The integration of qualitative contextual evidence with numerical evaluation can provide more comprehensive strategic inferences than either form of evidence used independently (Creswell & Creswell, 2018; Creswell & Plano Clark, 2018; Plano Clark, 2019). The study was conducted purposively at institutions and production-related units involved in snakehead-fish development, including the Fisheries Product Processing and Quality Center (BPMHP) in Cempaka, Banjarbaru City; the Freshwater Aquaculture Center (BPBAT) in Mandiangin, Karang Intan District, Banjar Regency; relevant government agencies, including the Health, Manpower, and Cooperative Offices; MSMEs; and private-sector actors. These settings were selected to capture production, technical, institutional, and commercial perspectives within the regional agroindustrial system.

Approximately 250 stakeholders participated: 150 producers and MSME actors, 45 representatives of government and technical institutions, 30 private-sector actors, and 25 other stakeholders associated with snakehead-fish albumin development. Participants were selected purposively according to their direct involvement, experience, or knowledge concerning production, institutional support, technical activities, marketing, or strategic decision-making. Purposive sampling was considered appropriate because strategic assessment requires information-rich participants whose experience corresponds directly to the research objectives (Campbell et al., 2020). Primary data were generated through semi-structured interviews, field observations, expert/stakeholder assessments, and questionnaires, while secondary information was obtained from scientific publications and institutional documents relevant to fisheries-based agroindustry. The interview guide addressed raw-material availability, production characteristics, extraction technology, product quality, institutional involvement, marketing, regulation, and broader development constraints and opportunities. The questionnaire combined structured assessments of strategic-factor importance and condition with opportunities for respondents to provide contextual information; it was used as a strategic assessment instrument rather than as a psychometric scale.

Data collection and analysis were undertaken sequentially at the analytical level. First, interview, observational, documentary, and questionnaire evidence was reviewed to identify recurrent internal factors (strengths and weaknesses) and external factors (opportunities and threats). Qualitative information was grouped according to strategically relevant themes, and candidate factors were retained when they demonstrated substantive relevance and recurring support across data sources. Second, respondents assessed the relative importance and condition of the retained factors. The mean significance score of each factor was divided by the

total significance score to obtain a normalized weight, with the weights within each internal or external matrix summing to 1.00. Each normalized weight was then multiplied by its corresponding mean rating to obtain a weighted score. The resulting scores were aggregated to construct the IFAS and EFAS matrices. This procedure transformed contextual stakeholder evidence into a structured quantitative strategic assessment while retaining qualitative evidence for interpretation, consistent with the principle that meaningful mixed-methods research requires explicit integration of qualitative and quantitative evidence (Plano Clark, 2019; Timans et al., 2019).

The total IFAS and EFAS scores were subsequently plotted in the nine-cell Internal-External Matrix to determine whether the agroindustry occupied a growth, hold-and-maintain, or harvest/divest strategic position (David & David, 2017). Alternative strategies were then formulated by cross-matching Strength-Opportunity (SO), Weakness-Opportunity (WO), Strength-Threat (ST), and Weakness-Threat (WT) factors following the TOWS logic (Weihrich, 1982). Source triangulation was used to strengthen analytical credibility by comparing questionnaire results with interview accounts and field observations; markedly divergent assessments across producer/MSME, government, technical, and private-sector groups were considered during interpretation rather than relying exclusively on the aggregated mean. This approach is consistent with contemporary mixed-methods principles emphasizing purposeful integration and multiple-perspective interpretation (Creswell & Plano Clark, 2018; Plano Clark, 2019). No inferential statistical modelling was undertaken because the numerical component was designed for strategic weighting and positioning rather than population-level hypothesis testing.

## RESULT AND DISCUSSION

### *Result*

This section presents the results of an analysis of internal and external factors influencing the development of the snakehead fish albumin agro-industry, along with a discussion based on the SWOT approach. The internal analysis results are presented using the IFAS matrix, while external factors are analyzed using the EFAS matrix. These two results are then integrated to determine strategic positions in the IE Matrix and used as a basis for formulating alternative development strategies using the SWOT matrix.

### *Internal Factor Analysis (IFAS)*

The results of the internal factor identification indicate that the development of the snakehead fish albumin agro-industry is influenced by several key strengths and weaknesses stemming from resources, production processes, and institutional capacity. This analysis was conducted to understand the internal conditions that form the basis for formulating development strategies.

Based on the IFAS matrix, the main strengths stem from the potential of local raw materials, the functional value of products, and the opportunities for health-based market development. Meanwhile, identified weaknesses include limited processing technology, varying quality standards, and limited production capacity. The total IFAS score indicates that the agro-industry has an average internal position, reflecting a balance between existing strengths and areas requiring further improvement.

The total IFAS score indicates that the agro-industry's internal position is in the average category. This indicates that existing strengths can serve as strategic assets for development, although improvements to technical and managerial weaknesses are still needed. Therefore, the formulated development strategy should focus on maximizing internal strengths while gradually increasing production capacity and product quality management.

Internal factors (Strength & Weakness) in the IFAS matrix for Snakehead Fish Albumin products can be seen in Table 2.

**Table 2.** Internal Factors (Strength & Weakness)

| No.               | Strategic Factors                                                                         | Significance Level | Weight | Rating | Score |
|-------------------|-------------------------------------------------------------------------------------------|--------------------|--------|--------|-------|
| <b>Strengths</b>  |                                                                                           |                    |        |        |       |
| 1                 | The high albumin content in snakehead fish                                                | 2.78               | 0.11   | 3.26   | 0.36  |
| 2                 | Current availability of snakehead fish raw materials                                      | 2.85               | 0.12   | 3.51   | 0.42  |
| 3                 | Institutional support is quite strong                                                     | 2.51               | 0.10   | 3.17   | 0.32  |
| 4                 | Easy albumin production process                                                           | 2.66               | 0.11   | 3.93   | 0.43  |
| 5                 | Perceived potential of snakehead fish albumin for post-operative nutritional applications | 2.98               | 0.12   | 3.79   | 0.45  |
| Sub-total         |                                                                                           |                    | 0.56   |        | 1.98  |
| <b>Weaknesses</b> |                                                                                           |                    |        |        |       |
| 1                 | Instability of raw material supply due to dependence on natural catch                     | 2.34               | 0.09   | 2.17   | 0.20  |
| 2                 | The majority of extraction technology is still traditional                                | 2.67               | 0.11   | 2.25   | 0.25  |
| 3                 | Risk of contamination and short shelf life                                                | 2.81               | 0.11   | 1.74   | 0.19  |
| 4                 | Expensive prices and less competitive than synthetic products                             | 1.78               | 0.07   | 1.80   | 0.13  |
| 5                 | There is no specific national standard                                                    | 1.39               | 0.06   | 2.18   | 0.13  |
| Sub-total         |                                                                                           |                    | 0.44   |        | 0.89  |
| <b>TOTAL</b>      |                                                                                           | 24.77              | 1.00   |        | 2.87  |

Based on these results, it is clear that the successful development of the snakehead fish albumin agro-industry depends not only on product potential but also on the ability of business actors to effectively manage internal resources. Therefore, the IFAS analysis provides an important foundation for understanding the industry's internal readiness to respond to external opportunities, which will be analyzed in the following section.

### **External Factor Analysis (EFAS)**

In addition to internal factors, an external factor analysis was conducted to identify opportunities and threats that could impact the sustainable development of the snakehead fish albumin agro-industry. The EFAS matrix results indicate that the primary opportunities stem from the increasing demand for natural-based health products and support for the development of industries based on local resources.

On the other hand, several external threats also impact the development process, including competition from substitute products, unstable raw material supplies, and market dynamics that demand consistent quality and production efficiency. These threats demonstrate that even when market opportunities exist, businesses still need to prioritize adapting to changes in the business environment to maintain product competitiveness.

The external factors were derived from stakeholder questionnaires, interviews, field observations, and supporting institutional information. Market-related opportunities were retained when consistently identified across stakeholder groups, while regulatory, supply, and competitive factors were included when they were repeatedly reported as affecting the development of snakehead fish albumin products in the study area. External factors (Opportunities & Threats) in the EFAS matrix for Snakehead Fish Albumin products can be seen in Table 3.

**Table 3.** External Factors (Opportunities & Threats)

| No.                  | Strategic Factors                                    | Significance Level | Weight | Rating | Score |
|----------------------|------------------------------------------------------|--------------------|--------|--------|-------|
| <b>Opportunities</b> |                                                      |                    |        |        |       |
| 1                    | Perceived demand for snakehead fish albumin products | 2.34               | 0.10   | 3.93   | 0.39  |

| No.            | Strategic Factors                                                                                    | Significance Level | Weight Rating Score |      |      |
|----------------|------------------------------------------------------------------------------------------------------|--------------------|---------------------|------|------|
|                | for wound-healing and post-operative applications                                                    |                    |                     |      |      |
| 2              | Stakeholder-observed consumer interest in natural health products relevant to snakehead fish albumin | 2.56               | 0.11                | 3.48 | 0.38 |
| 3              | Potential for developing snakehead fish cultivation (Aquaculture)                                    | 2.77               | 0.12                | 3.40 | 0.41 |
| 4              | Support research and technological innovation                                                        | 2.90               | 0.13                | 3.03 | 0.39 |
| 5              | Potential market expansion into the functional food industry                                         | 1.96               | 0.08                | 3.40 | 0.27 |
|                | Sub-total                                                                                            |                    | 0.54                |      | 1.84 |
| <b>Threats</b> |                                                                                                      |                    |                     |      |      |
| 1              | Competition with synthetic albumin products and commercial supplements in the target market          | 2.53               | 0.11                | 1.90 | 0.21 |
| 2              | Fluctuations in snakehead fish raw-material availability within the study area                       | 2.24               | 0.10                | 1.91 | 0.19 |
| 3              | Regulatory and standardization requirements affecting snakehead fish albumin products                | 2.17               | 0.09                | 2.13 | 0.19 |
| 4              | Consumer acceptance concerns related to animal-derived health products                               | 1.63               | 0.07                | 1.67 | 0.12 |
| 5              | Risk of product imitation and price competition among comparable health products                     | 1.97               | 0.09                | 2.33 | 0.21 |
|                | Sub-total                                                                                            |                    | 0.46                |      | 0.92 |
|                | <b>TOTAL</b>                                                                                         | 23.07              | 1.00                |      | 2.76 |

The identification of these external factors was supported by recurring patterns across respondent assessments and field information, particularly regarding raw-material fluctuations, regulatory requirements, competing products, and market acceptance. The total EFAS score indicates that opportunities are relatively more dominant than threats. This indicates that the external environment remains supportive of the development of the snakehead fish albumin agro-industry, although strategies that anticipate market risks and maintain a sustainable supply of raw materials are required. The results of this analysis are then used in conjunction with the IFAS results to determine strategic positioning within the Internal–External (IE) Matrix.

### ***Internal-External (IE) Matrix***

The IE Matrix is widely used in management and industrial development studies due to its ability to simplify the complexity of strategic factors into operational strategy classifications, such as growth, stabilization, or divestment. Several studies have shown that position mapping through the IE Matrix helps ensure consistency between the actual condition of the organization and the recommended strategic direction, thereby minimizing the risk of inappropriate development policies (Gürel & Tat, 2017; Oreški, 2012). Therefore, the IE Matrix analysis in this study is used to confirm the strategic position of snakehead fish albumin product development as a basis for formulating a more targeted follow-up strategy.

The results of the internal and external factor analysis were then integrated through the Internal–External (IE) Matrix to determine the strategic position for developing the snakehead fish albumin agro-industry. The total IFAS score of 2.87 represents the aggregated weighted perception of respondents regarding the internal condition of the agro-industry and places it in the average category. Meanwhile, the total EFAS score of 2.76 indicates a moderate external position based on respondents' weighted assessments of opportunities and threats.

Based on the combination of these two values, the snakehead fish albumin agroindustry is positioned in Cell V of the IE Matrix. This position reflects an average internal condition and a

medium external position, indicating the importance of maintaining existing capabilities while selectively improving production efficiency, supply stability, product quality, and market development. The relatively close IFAS and EFAS values also suggest that internal and external considerations should be addressed in an integrated manner.

**Table 4.** IE Matrix of Snakehead Fish Albumin

| External / Internal | Strong (3.00–4.00)    | Average (2.00–2.99) | Weak (1.00–1.99)      |
|---------------------|-----------------------|---------------------|-----------------------|
| High (3.00–4.00)    | I Growth              | II Growth           | III Hold and Maintain |
| Medium (2.00–2.99)  | IV Growth             | V Hold and Maintain | VI Harvest/Divest     |
| Low (1.00–1.99)     | VII Hold and Maintain | VIII Harvest/Divest | IX Harvest/Divest     |

The IFAS score of 2.87 and EFAS score of 2.76 place the snakehead fish albumin agro-industry in Cell V of the IE Matrix, indicating an average internal position and a medium external position. This position suggests that strategic development should emphasize the consolidation of existing capabilities, improvement of operational efficiency, and selective strengthening of market and production functions. The nine-cell IE Matrix was applied using a 1.00–4.00 rating range to classify internal and external strategic positions. As a sensitivity check, individual factor weights were varied by approximately  $\pm 10\%$  and renormalized while holding the corresponding ratings constant. The resulting IFAS scores remained approximately between 2.85 and 2.88, while the EFAS scores remained approximately between 2.76 and 2.78. These variations did not shift either score across the 2.00 or 3.00 thresholds; therefore, the strategic position remained in Cell V.

More specifically, the position in Cell V indicates that strategic development should emphasize maintaining existing capabilities while improving production capacity, product quality, and supply stability. This is crucial considering that several external factors, such as competition from substitute products and market dynamics, still have the potential to affect business sustainability. Therefore, development strategies should prioritize feasible capacity-strengthening actions while selectively utilizing available market opportunities.

The results of determining the position in the IE Matrix are the basis for compiling alternative strategies through the SWOT matrix, so that the strategies formulated are not only based on factor identification, but also consider the strategic position of the industry quantitatively.

### **SWOT Strategy**

The integrated analysis of IFAS, EFAS, and the IE Matrix places the development of the snakehead fish albumin agro-industry in a strategic position that emphasizes consolidation and selective development. This position indicates that existing capabilities should be maintained while internal limitations and external opportunities are addressed through prioritized and feasible strategies. Therefore, the SWOT analysis serves not only to develop alternative strategies but also as an interpretive framework for translating this strategic position into a more operational and long-term development direction.

The SWOT matrix below provides a general overview of the strategies used, which can be seen in Table 5.

**Table 5.** SWOT Matrix Table

| Strategy | Proposed Action                                       | Priority | Feasibility | Cost     | Primary Ownership                                          | Time Horizon      |
|----------|-------------------------------------------------------|----------|-------------|----------|------------------------------------------------------------|-------------------|
| SO       | Strengthen market position through targeted expansion | High     | High        | Moderate | Producers/MSMEs and private-sector actors                  | Short-medium term |
| SO       | Pharmaceutical market penetration as import           | Medium   | Moderate    | High     | Private-sector actors and relevant government institutions | Long term         |

|    |                                                                           |        |                  |                  |                                                                              |                          |
|----|---------------------------------------------------------------------------|--------|------------------|------------------|------------------------------------------------------------------------------|--------------------------|
| SO | substitution<br>Halal market<br>expansion based<br>on supply<br>guarantee | High   | Moderate         | Moderate         | Producers/MSMEs<br>and relevant<br>institutions                              | Medium<br>term           |
| SO | Downstreaming<br>of premium<br>value-added<br>products                    | Medium | Moderate         | High             | Producers/MSMEs,<br>private sector, and<br>technical institutions            | Medium–<br>long term     |
| SO | Integrated digital<br>distribution<br>acceleration                        | High   | High             | Low–<br>moderate | Producers/MSMEs<br>and private-sector<br>actors                              | Short<br>term            |
| WO | Transition to<br>controlled<br>cultivation                                | High   | Moderate         | High             | Producers and<br>aquaculture-related<br>institutions                         | Medium–<br>long term     |
| WO | Modernization of<br>extraction<br>technology                              | High   | Moderate         | High             | Producers/MSMEs<br>and technical<br>institutions                             | Medium<br>term           |
| WO | Quality<br>standardization<br>towards a formal<br>supply chain            | High   | Moderate         | Moderate         | Producers, technical<br>institutions, and<br>relevant government<br>agencies | Medium<br>term           |
| WO | Price efficiency<br>via digital<br>distribution                           | High   | High             | Low–<br>moderate | Producers/MSMEs                                                              | Short<br>term            |
| WO | Structural<br>transformation of<br>industry                               | Medium | Low–<br>moderate | High             | Government<br>institutions, private<br>sector, and producer<br>networks      | Long<br>term             |
| ST | Natural-based<br>evidence-based<br>value<br>differentiation               | High   | High             | Moderate         | Producers/MSMEs<br>and technical<br>institutions                             | Short–<br>medium<br>term |
| ST | Product<br>positioning as a<br>natural health-<br>related product         | Medium | Moderate         | Moderate         | Producers and<br>private-sector actors                                       | Medium<br>term           |
| ST | Regulation as an<br>instrument of<br>market selection                     | Medium | Moderate         | Moderate         | Relevant<br>government and<br>regulatory<br>institutions                     | Medium–<br>long term     |
| ST | Barrier to entry<br>raising                                               | Medium | Moderate         | Moderate         | Regulatory<br>institutions and<br>industry actors                            | Medium–<br>long term     |
| ST | Defense through<br>quality<br>authenticity                                | High   | High             | Moderate         | Producers/MSMEs<br>and quality-control<br>institutions                       | Short–<br>medium<br>term |
| WT | Focus on survival<br>and maintaining<br>business<br>continuity            | High   | High             | Low–<br>moderate | Producers/MSMEs                                                              | Short<br>term            |
| WT | Secure raw<br>material stock                                              | High   | High             | Moderate         | Producers and<br>suppliers                                                   | Short<br>term            |
| WT | Maintain basic<br>hygiene<br>standards                                    | High   | High             | Low–<br>moderate | Producers/MSMEs                                                              | Short<br>term            |
| WT | Save and avoid                                                            | High   | High             | Low              | Producers/MSMEs                                                              | Short                    |

|    |                                                  |        |          |          |                                                   |                        |
|----|--------------------------------------------------|--------|----------|----------|---------------------------------------------------|------------------------|
| WT | waste<br>Strengthen<br>operational<br>resilience | Medium | Moderate | Moderate | Producers/MSMEs<br>and supporting<br>institutions | term<br>Medium<br>term |
|----|--------------------------------------------------|--------|----------|----------|---------------------------------------------------|------------------------|

High-priority strategies were defined as actions with relatively high feasibility and immediate relevance to production continuity, quality, market access, or supply stability. Medium-priority strategies generally require greater investment, institutional coordination, or a longer implementation period. Cost categories represent relative implementation requirements rather than monetary estimates.

Conceptually, SWOT analysis combined with the IE matrix approach allows for more targeted strategy formulation than using SWOT solely descriptively. Gürel and Tat (2017) emphasizes that SWOT will be more effective when linked to an analysis of the organization's strategic position, so that the resulting strategy does not stop at factor identification, but has clear implementation implications. In this study, the Cell V position indicates that strategic priorities should focus on maintaining existing capabilities while selectively improving supply stability, product quality, production efficiency, and market access. Accordingly, the SWOT alternatives are interpreted according to their feasibility and contribution to strengthening current capacity rather than being treated as equally immediate expansion options.

The interplay of internal strengths and external opportunities demonstrates that the snakehead fish albumin agroindustry has ample room for development, primarily driven by the product's strong biological characteristics and the growing trend of consuming natural-based health products. The product's high albumin content and potential health-related applications represent strategic attributes in responding to the nutraceutical and functional food markets (Hutapea et al., 2023; Taslim et al., 2022).

The pharmaceutical market penetration strategy is also relevant to the national agenda of independence in pharmaceutical raw materials which encourages increased utilization of local resources as a substitute for imported products, so that the development of snakehead fish albumin can be positioned as part of strengthening the national pharmaceutical supply chain (Ministry of Industry of the Republic of Indonesia, 2021).

From a selective development perspective, these strengths need to be directed toward strengthening the product's positioning as a locally sourced health product with scientific legitimacy. This strategy focuses not only on increasing production volume but also on enhancing perceived value through quality standardization and strengthening evidence-based claims. This approach is crucial because the health product market is shifting toward standardized products with strong scientific backing.

Furthermore, the development of snakehead fish aquaculture offers a strategic opportunity to strengthen raw material continuity while reducing the risk of dependence on wild catches. Strengthening the aquaculture-based supply chain also aligns with a sustainable agro-industrial development approach that emphasizes integration between upstream and downstream sectors.

Despite the relatively large market opportunity, internal weaknesses such as traditional extraction technology, limited quality standards, and the risk of product contamination point to the need for a transformational strategy. A WO strategy, in this context, goes beyond simply addressing weaknesses and driving the industry's transition to a more modern and efficient production system.

Modernizing processing technology is a top priority because extraction quality directly impacts product stability and market competitiveness. Controlled extraction methods can influence albumin yield and extraction performance, supporting improvements in processing efficiency (Hidayatullah et al., 2023). Therefore, opportunities for research support and technological innovation need to be utilized as catalysts to simultaneously increase production capacity and product quality.

On the other hand, the opportunity to develop digital marketing channels offers a solution

to the weakness of price competitiveness. Digital distribution allows for streamlining the distribution chain, thereby reducing marketing costs without compromising product quality. This strategy is a relevant transitional step as the industry undertakes structural improvements in technology and standardization.

The ST strategy serves to ensure that internal strengths can be used as mitigation tools against external threats, particularly competition from substitute products and increasing regulatory demands. Snakehead fish albumin has characteristics that may support differentiation from synthetic products, making a natural, evidence-based positioning approach a relevant strategic option.

Rather than competing on price, a differentiation strategy focuses on enhancing product quality and authenticity. In this study, such differentiation is positioned as a strategic direction rather than as evidence of verified product superiority, as the analysis does not include direct product testing, consumer preference measurement, or independent validation of health claims. This approach aligns with global health market trends, which show a growing preference for natural products supported by scientific evidence. Furthermore, increasingly stringent regulations can be positioned not as an obstacle but as a market selection mechanism that can raise the barrier to entry for non-standard products. Thus, internal strengths serve as instruments for maintaining a long-term competitive position.

The WT strategy is defensive and focuses on mitigating systemic risks arising from a combination of internal weaknesses and external pressures. Dependence on wild-caught raw materials, when combined with supply fluctuations and price competition, has the potential to cause production instability. Therefore, the defensive strategy focuses on strengthening raw material control and more adaptive production management.

Furthermore, the risk of contamination and the lack of uniform quality standards are critical issues when faced with increasingly stringent health product regulations. Implementing minimum quality controls and hygienic production practices are strategic steps to ensure product acceptance in the market. In this context, the WT strategy serves as a stabilization mechanism, ensuring business continuity while awaiting the results of the transformational strategies implemented in the SO and WO groups.

Overall, the discussion indicates that the development strategy for the snakehead fish albumin agro-industry should emphasize consolidation and selective capacity strengthening rather than broad expansion. The Cell V position highlights the importance of maintaining existing capabilities while addressing limitations in supply stability, production technology, quality standardization, and market access. The prioritized SWOT strategies therefore provide a framework for sequencing feasible short-, medium-, and long-term actions according to operational needs and stakeholder capacity.

## Discussion

The present study demonstrates that the development of the snakehead fish (*Channa striata*) albumin agroindustry in South Kalimantan is characterized by considerable product and resource potential, but this potential has not yet been matched by equivalent technological, supply-chain, and quality-management capacity. The IFAS score of 2.87 indicates an average internal position, whereas the EFAS score of 2.76 reflects a moderately favorable external environment. Their intersection in Cell V of the Internal-External Matrix indicates a hold-and-maintain strategic position rather than an aggressive-growth position. Accordingly, the most defensible development pathway is one of selective capacity strengthening: stabilizing raw-material supply, modernizing processing technology, improving quality assurance, reducing operational inefficiencies, and expanding markets only where production readiness can support such expansion. Importantly, the sensitivity analysis also showed that moderate changes in individual factor weights did not shift the industry from Cell V, strengthening confidence that the resulting strategic classification is not merely an artifact of marginal weighting decisions. These findings therefore refine the development objective from simple market expansion toward the consolidation of an agroindustrial system capable of sustaining quality, production continuity,

and credible market positioning.

The findings are consistent with recent international literature emphasizing that the commercial potential of *C. striata* depends on simultaneously addressing biological value and production-system limitations. Kumar et al. (2022) and Raizada et al. (2022) observed that striped snakehead possesses strong commercial and nutritional potential in Asian aquaculture, yet expansion remains constrained by dependence on natural stocks, seed availability, breeding management, and technical limitations in controlled production. This closely parallels the present finding that dependence on naturally available raw materials represents a structural weakness despite currently favorable resource potential. More recent synthesis by Pervin et al. (2026) likewise positions *C. striata* as a promising species for sustainable and health-oriented aquaculture but emphasizes genetically informed broodstock management, controlled cultivation, and technological improvement. Consequently, the WO strategy proposed in the present research particularly the transition toward controlled aquaculture—should be interpreted not merely as a supply intervention but as a structural mechanism for reducing resource uncertainty and improving long-term agroindustrial resilience.

The strategic emphasis on processing modernization is also supported by developments in food-protein technology. Nirmal et al. (2022) demonstrated that process parameters strongly influence the functional properties and stability of fish-derived proteins, while Kumoro et al. (2024) showed that advanced extraction and drying approaches can substantially reshape the technological characteristics of snakehead-fish protein concentrates. Similarly, Smaoui et al. (2024) emphasized that commercially viable seafood-derived proteins require appropriate recovery, purification, stabilization, and product-development technologies, and Zhou et al. (2025) identified protein modification and combined processing technologies as important pathways for expanding the applications of fish proteins in the food industry. These studies substantiate the present finding that traditional extraction technology and inconsistent product quality are not peripheral problems; rather, they represent central constraints on value creation. Thus, modernization should involve controlled extraction conditions, validated processing protocols, hygienic handling, shelf-life management, and reproducible product specifications instead of merely purchasing more sophisticated machinery.

The present results also support cautious differentiation based on natural-resource origin and scientifically credible product attributes. Contemporary evidence confirms the biochemical and nutraceutical relevance of *C. striata*, including its protein, albumin, amino-acid, fatty-acid, and other bioactive components (Hutapea et al., 2023; Lee et al., 2022; Hapsari & Tjandrawinata, 2025). Nevertheless, Hapsari and Tjandrawinata (2025) stress that although preclinical and clinical evidence is promising, the existing clinical evidence base remains insufficient for unrestricted therapeutic generalization. This qualification is important for interpreting the present SWOT results: biological characteristics can support market differentiation, but stakeholder perceptions of health-related potential should not be converted automatically into verified therapeutic claims. Product positioning must therefore be evidence-based and compatible with regulatory requirements, particularly when albumin products are marketed at the boundary between functional foods, nutraceutical products, and health-related products.

The study further extends global food-supply-chain research by showing why digital market expansion should follow, rather than precede, operational readiness. Wang et al. (2024) argue that digital transformation of food supply chains requires an integrated implementation architecture rather than isolated technology adoption, whereas Pal et al. (2024) demonstrate that digitalization contributes to resilience when accompanied by knowledge management and dynamic capabilities in sourcing, operations, and logistics. Annosi et al. (2023) similarly found that digital transformation in agri-food SMEs depends upon organizational routines, cognitive capabilities, and structural readiness. These studies reinforce the present decision to classify integrated digital distribution as a selective, relatively feasible strategy rather than a substitute for production reform. Digital channels may reduce transaction and distribution friction, but expanding demand without improving supply consistency, traceability, and quality control could

increase operational vulnerability rather than competitiveness.

Within Indonesia, the findings are strongly consistent with studies emphasizing the technological sensitivity of snakehead-fish albumin production. Hidayatullah et al. (2023) showed that extraction methods and processing duration substantially affect albumin recovery, while Yuniati et al. (2024) demonstrated that heating and acidification conditions influence albumin concentration. Maulid et al. (2024) likewise reported variation in extract yield, protein content, albumin concentration, and sensory characteristics under different extraction temperatures. These findings provide empirical support for the present identification of traditional extraction technology and variable quality as weaknesses. Product standardization should consequently encompass critical process variables—including raw-material characteristics, temperature, processing duration, hygiene, storage, and final-product specifications—rather than being restricted to packaging or labeling alone.

Local research also supports the strategic value of developing higher-value derivatives from *C. striata*. Baehaki and Azzahra (2024) showed that product formulation influences organoleptic characteristics of snakehead-fish albumin. Together, these studies indicate opportunities for downstream product diversification, but they also illustrate why diversification requires technological control and consumer-oriented product development. The current study therefore advances beyond a simple “high-value product” argument by positioning downstream diversification as a medium- to long-term strategy conditional upon improvements in processing reliability, standardization, and supply continuity.

The Indonesian context additionally makes institutional facilitation particularly important. Mayang Mangurai et al. (2024) found that digitalization has increasingly reshaped the Indonesian agrifood sector, although implementation remains uneven across actors and supply-chain settings. In a complementary MSME context, Sada et al. (2026) demonstrated that regulatory readiness and halal-certification compliance can be strengthened through localized capacity building and participatory assistance. This insight is particularly relevant to the present proposed halal-market and standardization strategies: certification should not be treated solely as an administrative obligation but as part of institutional upgrading that can strengthen legitimacy, market access, and consumer confidence. However, because the present study did not directly measure willingness to pay, halal-market demand, or realized digital sales, these strategies remain evidence-informed development propositions rather than demonstrated market effects.

Theoretically, the findings demonstrate the value of integrating SWOT with IFAS, EFAS, and the IE Matrix because this combination moves strategic analysis beyond descriptive identification toward position-based prioritization: although several SO opportunities appear attractive, Cell V constrains their interpretation by indicating that consolidation should precede aggressive expansion, thereby refining the conventional SWOT logic associated with Weihrich (1982), Gürel and Tat (2017), and David and David (2017). The results also suggest compatibility with a dynamic-capabilities interpretation in which the industry must first strengthen its ability to sense supply and market changes, seize opportunities selectively, and transform production and quality systems before undertaking major expansion. From a pedagogical perspective, the findings are relevant to fisheries-processing education, vocational training, and MSME capacity-building programs: training should integrate controlled albumin extraction, hygiene and quality assurance, aquaculture-based sourcing, digital supply-chain management, regulatory literacy, and evidence-based product communication so that technical knowledge is connected directly to commercial decision-making. At the policy level, provincial and national interventions should prioritize hatchery and aquaculture development, technical upgrading for MSMEs, shared quality-testing facilities, traceability and standardization systems, halal and food-safety certification assistance, research–industry collaboration, and carefully sequenced digital-market development. Such policies would be more appropriate than market promotion alone because the findings show that the binding constraints arise primarily from supply stability, technological capability, quality consistency, and institutional readiness.

The principal novelty of this study lies in connecting the biological and nutraceutical potential of *C. striata* with a stakeholder-based strategic positioning framework at the regional agroindustry level. Previous research has predominantly examined albumin composition, extraction technology, biological functionality, cultivation, or therapeutic potential separately. In contrast, this study integrates producer and MSME perspectives with government, technical-institution, and private-sector assessments through SWOT, IFAS, EFAS, and IE Matrix analyses and translates the resulting Cell V position into prioritized SO, WO, ST, and WT interventions with feasibility, ownership, cost intensity, and implementation horizons. The contribution is therefore not a new claim regarding the biological superiority of snakehead-fish albumin, but a structured explanation of how scientific potential can be converted into a realistic development sequence. The study particularly challenges the assumption that strong product attributes and growing health-product opportunities automatically justify rapid expansion; instead, it demonstrates that selective market growth should be conditional upon the prior strengthening of supply, technology, standardization, and institutional capabilities.

Several limitations should nevertheless constrain interpretation. First, respondents were purposively selected from approximately 250 stakeholders within a defined institutional and business network in South Kalimantan; accordingly, the findings represent stakeholder assessments within this network and should not be generalized automatically to the entire provincial or national snakehead-fish value chain. Second, IFAS and EFAS weights remain perception-based despite triangulation and sensitivity analysis, and aggregation may conceal meaningful differences among producers, regulators, technical institutions, and private firms. Third, the study did not directly measure production costs, extraction efficiency under standardized experimental conditions, consumer willingness to pay, market size, sales performance, shelf life, independent product quality, or clinical effectiveness. Future research should therefore combine the present strategic framework with techno-economic analysis, life-cycle and supply-chain assessment, consumer experiments, market-demand modelling, laboratory-based quality validation, and longitudinal evaluation of implemented strategies. Multi-criteria approaches such as AHP, fuzzy AHP, or QSPM could additionally test the relative robustness of strategic priorities, while comparative studies across South Kalimantan and other Indonesian snakehead-producing regions could determine whether the Cell V position reflects a regional condition or a broader structural pattern in Indonesia's *C. striata* agroindustry.

## CONCLUSION

The stakeholder-based SWOT, IFAS, EFAS, and IE analyses indicate that the snakehead fish albumin agro-industry occupies a moderate strategic position, with an IFAS score of 2.87 and an EFAS score of 2.76 corresponding to Cell V of the IE Matrix. Within this assessment, strategic priorities are directed toward strengthening supply stability, product quality, production efficiency, and selective market development. These strategies should be interpreted as recommended development directions derived from stakeholder assessments rather than as demonstrated improvements in business performance or market outcomes. Development Strategy for Snakeh...

The findings are limited by the purposive selection of stakeholders and the use of subjective weights and ratings, which may reflect differences in the perspectives of producers, institutions, and other actors involved in the agro-industry. Consequently, the results are most appropriately interpreted within the sampled stakeholder network and study locations, while broader application would require validation using wider stakeholder coverage and additional empirical evidence.

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