

# Efforts to optimize the processing of chicken liver as a source of protein

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**Abstract.** Protein is an essential nutrient required for growth, tissue repair, and overall health. Chicken liver is a readily available and affordable source of animal protein, but its nutrient content may vary depending on cooking methods. This study aimed to optimize chicken liver processing to preserve protein content using different cooking techniques. Chicken liver samples were subjected to three treatments: raw, boiled, and fried. Proximate analysis was conducted to determine protein levels in each treatment. The results showed that protein content in raw chicken liver was 49.43%. Boiling increased protein levels to 54.33%, whereas frying reduced protein content to 42.81%. The increase observed in boiled liver is likely due to water loss, leading to a concentration effect, while the reduction in fried liver is associated with protein denaturation, peptide bond damage, and leaching into oil at high temperatures. These findings suggest that boiling is a preferable cooking method to maintain protein quality in chicken liver compared to frying. The choice of cooking medium and temperature plays a significant role in determining nutrient retention. Optimizing chicken liver processing is important to ensure its potential as a protein source for addressing nutritional problems such as malnutrition and stunting

## 1 Introduction

One of the persistent nutritional problems in Indonesia is malnutrition. Approximately 45% of under-five child mortality is caused by malnutrition [1]. This issue cannot be underestimated, considering its long-term consequences. In adults, protein intake is essential for maintaining muscle mass. For toddlers, particularly infants under two years of age, protein intake is crucial for optimal growth and development. Protein constitutes the most vital component of cells. Adequate growth and tissue repair require sufficient protein [2].

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Adequate protein intake ensures the availability of amino acids necessary for maintaining the function of vital organs and immune cells [3]. Moreover, protein plays roles as a regulator and transporter at the molecular level. It also contributes significantly to satiety. Therefore, protein intake in the human diet is indispensable. Nevertheless, excessive protein consumption may also exert negative effects on the body [4].

Given its essential role in growth and development, protein intake during the early stages of life warrants special attention. The first critical growth period occurs during infancy and early childhood, when protein requirements are markedly high. This is evidenced by the relatively high protein content of breast milk during its initial production phase compared to carbohydrates and fats. However, the coverage of exclusive breastfeeding in Indonesia remains low, at only 54.3% [5]. This may be one of the contributing factors to the high prevalence of malnutrition among Indonesian children. In addition, inappropriate complementary feeding practices further aggravate this condition.

In Indonesia, the pattern of complementary feeding for infants often emphasizes fruits and vegetables over protein-rich foods, particularly animal-based protein sources. Such feeding practices largely stem from mothers' limited knowledge of nutritional priorities during critical stages of child development.

Malnutrition among toddlers contributes to stunting. Preventing stunting therefore requires ensuring adequate nutrient intake, particularly protein. Adequate animal protein intake is essential for toddler growth and development. Toddlers with low protein intake are 1.87 times more likely to experience stunting compared to those with adequate protein consumption. Inadequate animal protein intake slows growth compared to sufficient intake, as animal protein contains essential amino acids that stimulate growth hormone synthesis, thereby accelerating growth [6]. Consequently, adequate animal protein intake plays a pivotal role in preventing stunting. In addition to mothers' limited knowledge regarding which types of protein are required, food processing methods often lead to the degradation of the nutritional components contained in these foods, particularly their protein composition.

One of the readily available and affordable sources of animal protein is chicken liver. Chicken liver is easy to obtain, relatively inexpensive, and simple to process. Fresh chicken liver contains approximately 15.572% protein [7]. However, improper processing may reduce its protein content. Therefore, this study conducted an optimization of chicken liver processing to obtain the optimal protein content. Previous optimization efforts for chicken liver processing have been carried out by immersing the liver in solutions with acidic and alkaline pH levels. Extreme solubilization of chicken liver under alkaline pH conditions can yield a high protein content [8]. However, this method requires specific technical skills, as it involves preparing both acidic and alkaline solutions. In this study, chicken liver processing was carried out using a simpler approach that can be performed by anyone, while still achieving optimal protein levels.

Therefore, this study aims to optimize chicken liver processing as a source of animal protein.

## **2 Methods**

This study investigated the optimization of protein content in chicken liver processed using three techniques. Prior to processing, chicken liver was cleaned and thoroughly washed with water. The three processing techniques were as follows:

- a. First method: Raw chicken liver was thinly sliced, and then dried in an oven at 60°C until completely dehydrated. The dried liver was subsequently ground using a blender and sieved.
- b. Second method: The chicken liver was fried, then thinly sliced, and oven-dried at 60°C until achieving maximum dryness. The dried liver was then ground using a blender and sieved.

- c. Third method: The chicken liver was boiled and drained, then oven-dried at 60°C until reaching maximum dryness. The dried liver was subsequently ground using a blender and sieved.

The resulting chicken liver powder was analyzed to determine protein composition for each optimization technique. Protein composition analysis was conducted at the laboratory of Universitas Gadjah Mada (UGM).

### 3 Results And Discussion

#### 3.1 Result

Generally, the proximate analysis of chicken liver reveals changes in macronutrient content following boiling and frying treatments (Table 1).

**Table 1.** Proximate protein content of chicken liver under different cooking methods

Treatment	Protein content (%)
Raw	49.43
Boiled	54.33
Fried	42.81

Proximate analysis shows that the protein content of chicken liver varies depending on the cooking method (Table 1). In raw chicken liver, the protein content is recorded at 49.43%. After boiling, the protein level increases to 54.33%, whereas frying results in a decrease to 42.81%.

#### 3.2 Discussion

Cooking processes lead to the loss of nutritional content in food. This occurs due to heat exposure, which induces both physical and chemical changes in food. Nutrient degradation is influenced by heating temperature, heating duration, and the characteristics of the raw materials [9]. Chemical changes in meat at the molecular level may occur as a result of thermal treatment, added additives, or prolonged storage. Moreover, the nutritional value of food may decline due to denaturation, hydrolysis, and gelation of proteins caused by cooking and extended heating times. Different cooking methods result in varying degrees of nutrient degradation. Previous studies have shown that heating animal-based foods increases protein oxidation in line with longer heating duration [10]. However, cooking does not always reduce nutrient content. As demonstrated in this study, boiling chicken liver actually increased its protein content compared with raw or unprocessed chicken liver. Conversely, frying chicken liver resulted in a decrease in protein content compared with raw chicken liver.

The increase in protein content in boiled chicken liver compared with raw liver is likely due to a concentration effect caused by the reduction of water content during heating. Water loss from liver tissue increases the relative proportion of solid components, including protein. Steaming generally results in lower lipid oxidation than grilling or grilling followed by steaming [11]. The protein content of boiled mackerel was found to be higher than that of steamed mackerel, whereas the protein content of boiled Sardinella lemuru was lower than that of steamed Sardinella lemuru [12]. Boiling beef causes protein denaturation, weakening the bonds between muscle fibers and water, which facilitates water loss. This water loss contributes to the reduction of various components, including protein [13].

In this study, frying caused a reduction in protein content of up to 42.81%. This reduction is closely related to high temperatures that induce protein denaturation, damage peptide

bonds, and potentially cause soluble proteins to leach into the oil. Frying affects protein integrity in surimi, and this is influenced by the frying temperature used [14]. The frying process induces protein denaturation due to high heat, damaging the native structure of proteins. Protein concentration also changes due to moisture loss and oil absorption. Additionally, extreme heat promotes protein oxidation, and repeated use of frying oil may further affect food's nutritional quality, including its protein content. However, frying can also convert high-molecular-weight (HMW) proteins into low-molecular-weight (LMW) proteins that are more easily absorbed [15]. Frying also induces oxidation, which can degrade nutrient quality and generate toxic compounds. Damage or reduction of chicken liver protein quality due to frying is likely associated with high-temperature heating as well as possible chemical interactions with the cooking oil used.

Based on the two optimization methods for chicken liver, boiling can be considered a relatively better cooking method for preserving its protein content compared with frying.

## 4 Conclusion

The cooking process exerts different effects on the protein content of chicken liver. In this study, the boiling method resulted in an increased percentage of protein compared with raw chicken liver. This condition is likely due to the loss of a substantial amount of water during the heating process. In contrast, frying led to a considerable reduction in protein content relative to raw chicken liver. This decrease is likely caused by protein denaturation at high temperatures, the leaching of protein into the oil, and oxidative processes. Therefore, boiling is considered the most suitable method compared with frying for optimizing the nutritional quality of chicken liver.

## Recommendation

Future researchers are encouraged to further investigate which cooking methods contribute most to the loss of other essential nutrients. Such findings will help determine the most appropriate cooking technique for chicken liver to ensure the desired nutritional composition is retained.

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