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Exploring potentials to enhance fish sauce industry in Sri Lanka: A review

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Abstract

Fish sauce, an amber-colored liquid derived from the fermentation of fish with sea salt, is a vital condiment in Southeast Asian and East Asian cuisines. Despite its culinary importance, fish sauce remains underutilized in Sri Lanka, where it is predominantly imported, resulting in high costs and substantial foreign exchange outflows. The technology for fish sauce production is relatively simple, presenting an opportunity for local production using abundant fish resources. Various types of fish, including marine, freshwater, and shellfish, are used globally in fish sauce production, and it could harness the nutritional benefits of fish, transforming underutilized species into a valuable condiment. The production process of fish sauce involves salting, fermenting, maturing, filtering, and blending, resulting in a product rich in hydrolyzed proteins and essential minerals. Quality standards are regulated to ensure safety and purity, with a focus on maintaining the distinctive fishy odor and taste characteristic of pure fish sauce. Establishing a local fish sauce industry in Sri Lanka promises economic growth and culinary enrichment. By leveraging local fish resources and employing cost-effective production methods, Sri Lanka can reduce imports of fish sauce, and can utilize fish in a sustainable manner.

Keywords: Fish sauce; Fish resources; Production potentials; Economic importance

1. Introduction

Fish sauce, an amber-colored liquid derived from the fermentation of fish with sea salt, stands as one of the most important value-added products in the seafood industry. Its significance is deeply rooted in various Southeast Asian and East Asian cuisines, prominently featured in Cambodian, Philippine, Thai, and Vietnamese dishes (1). Despite its culinary importance, fish sauce has not gained widespread popularity among the general populace but remains extensively utilized in hotel catering services and the tourism industry.

In Sri Lanka, fish sauces are predominantly imported, leading to high costs and a substantial outflow of foreign exchange. However, the technology required for producing fish sauce is relatively simple, making local production a viable option. With abundant fish resources, Sri Lanka has the potential to develop fish sauce industry using locally sourced raw materials.

Inland fisheries are a crucial livelihood sector in Sri Lanka, integrated with irrigation and agriculture. The country's commercial-scale inland capture fisheries primarily originate from major irrigation and hydroelectric reservoirs, covering an extent of over 70,000 hectares. Small-scale fisheries operate in medium-sized reservoirs, which constitute about 10% of the total area. These reservoirs are often eutrophic due to nutrient inputs from catchment areas, enhancing their fish production capabilities (2).

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Currently, many farmers sell their catch without adding value, typically on a small scale, leading to considerable wastage. Implementing low-cost value-added methods, such as fish sauce production, could effectively mitigate these losses. Locally produced fish sauce could enjoy high marketability given the expense of imported alternatives and the underutilization of inland fish species for value-added products, despite their substantial potential.

Therefore, this review aims to explore potential to produce fish sauce in Sri Lanka, highlighting its current status, nutrient composition, production steps, and prospects for sustainable local production and economic development.

2. Composition of Fish

The chemical composition of fish varies significantly among species and individuals, influenced by factors such as age, sex, environment, and seasonal variations (3). *Table 1* presents the range of maximum and minimum values observed in fish muscles.

Table 1 Principal constituents of fish

Constituent	Minimum	Normal	Maximum
Protein	6.00%	16- 21%	28.00%
Lipids	0.10%	0.2- 25%	67.00%
Carbohydrate	<0.5%	<0.5%	<0.5%
Ash	0.40%	1.2-1.5%	1.50%
Water	28.00%	66-81%	96.00%

*Source: Fisheries and Aquaculture Department (FI) under the ownership of “FAO” and is part of the “Fisheries Topics: Utilization” data collection.

2.1. The Nutritional Importance of Fish

Fish plays a crucial role in human nutrition, providing essential nutrients that contribute significantly to the health and well-being of populations worldwide. Fish is valued for its high-quality protein content, polyunsaturated fatty acids, and rich array of vitamins and minerals (3).

2.1.1. Protein

Fish is renowned for its high-quality protein content, essential for growth, tissue repair, and the production of enzymes and hormones vital for body functions. Compared to other sources, fish proteins are easily digestible and possess a high biological value, containing all eight essential amino acids, including lysine, methionine, and cysteine (4).

2.1.2. Fats

Fish typically contains less fat than red meats, with fat content varying by species and season, ranging from 0.2% to 25%. Specifically, omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are crucial for cardiovascular health, reducing the risk of coronary heart disease by lowering blood pressure, cholesterol, and triglyceride levels (4). These fats also contribute to energy reserves and aid in the absorption of fat-soluble vitamins A, D, E, and K.

2.1.3. Vitamins

Fish is a rich source of various vitamins, including vitamin A, which supports normal vision and bone growth, and vitamin D, essential for calcium absorption and bone metabolism. Riboflavin, niacin, and thiamin (vitamin B1, B2, and B3) found in fish are important for energy metabolism, while vitamin C, albeit in smaller quantities, aids in wound healing and enhances iron and calcium absorption (4).

2.1.4. Minerals

Fish provides essential minerals such as iron, calcium, zinc, iodine (from marine fish), phosphorus, selenium, and fluorine, which are highly bioavailable, ensuring efficient absorption by the body (4). Calcium, crucial for bone strength and muscle function, requires vitamin D for optimal absorption, underscoring the importance of consuming fish rich in both nutrients. Zinc plays a pivotal role in metabolism and immune function, while iodine is essential for thyroid hormone synthesis, critical for metabolism regulation and normal mental development, particularly in children (4).

In summary, fish stands out as a vital component of diets globally, not only for its protein content but also for its rich array of essential fatty acids, vitamins, and minerals. Its nutritional benefits contribute significantly to overall health and are particularly valued in regions where fish constitutes a substantial portion of daily protein intake.

3. Value-Added Fish Products in Sri Lanka

The concept of value addition and product diversification plays a pivotal role in enhancing consumer satisfaction and profitability within the fish processing industry. In recent times, this approach has garnered significant attention, as it allows for the conversion of various fish species into value-added products such as fish sauces, fish sausages, fish balls, fish-filled rolls, and fish curry. These processed fish products are not only convenient and economical but also highly nutritious (3).

Fish sauce stands out as one of the oldest processed products globally, utilizing a variety of fish species. However, a common challenge in fish sauce production is the lengthy fermentation period. Ready-to-consume fish curry packaged in metal cans meets the demands of modern lifestyles, reflecting the high market demand for such processed products. Fish balls, another popular product, are heat-processed in a suitable fluid medium, using several fish varieties that may have lower market value when sold as whole fish (1)

The demand for value-added fish products remains robust among consumers due to the health benefits associated with fish consumption. Health authorities and dieticians recommend fish as a nutritious food choice due to its low-fat content and high levels of omega-3 fatty acids, which are essential for brain development and offer protective effects against cardiac arrhythmias, stroke, and cardiovascular diseases by lowering blood cholesterol and serum triglyceride levels (5). Additionally, fish provides easily digestible proteins with a high biological value and is rich in vitamins such as A and D, along with highly bioavailable minerals including iron, calcium, zinc, iodine, phosphorus, selenium, and fluorine (3).

The development of value-added fish products not only enhances the economic viability of the fish processing industry but also contributes to improving public health through the promotion of nutritious dietary choices.

3.1. Fish Sauce

Fish sauce is a condiment derived from fish that undergo fermentation. It is a water-extracted brown liquid rich in salt and hydrolyzed proteins, characterized by a distinctive odor and flavor obtained from fully fermented small fish or shrimp. This condiment is traditionally produced in most Southeast Asian countries and is used similarly to soy sauce, serving as a condiment for rice, a dip for vegetables, and a flavor enhancer in various dishes (1).

Fish sauce offers a multitude of benefits that enhance culinary experiences worldwide. It provides vibrant contrast in color, aids in digestion, and significantly boosts the nutritional value of dishes by imparting essential minerals and proteins. Additionally, fish sauce enriches the flavor profile of dishes, binds dry ingredients effectively, and improves their overall appearance. Its ability to add moistness to foods makes it indispensable in various cuisines, while also serving elegantly as a garnish, enhancing both the visual appeal and taste of dishes (6).

3.1.1. Physiochemical Characteristic of Commercially Available Fish Sauce

Table 2 Physiochemical characters of commercially available fish sauce in Sri Lanka

Characteristic	Percentage
Crude Protein	5.33
Moisture	67.31
Brix	36.63
pH	5.67

*(7)

The fish sauce exhibits a crude protein content of 5.33%, highlighting its nutritional value, particularly its contribution to dietary protein intake. The moisture content is 67.31%, indicating that the majority of the sauce is water, which is typical for liquid condiments and crucial for maintaining its texture and preventing spoilage. The Brix value of 36.63 reflects a high concentration of soluble solids, including salts, proteins, and sugars, contributing to the sauce's flavor

intensity and preservative qualities. Additionally, the fish sauce has a pH of 5.67, making it slightly acidic. This acidity is important for both flavor and preservation, as it helps inhibit the growth of harmful bacteria and enhances the sauce's tangy taste, making it a versatile seasoning.

Types of Fish Used in Fish Sauce Production Various types of fish, categorized as marine fish, freshwater fish, and shellfish, are utilized to produce fish sauce, as shown in Table 3.

Table 3 Marine fish, fresh water fish and shell fish commonly used in fish sauce production

Type of fish	Scientific name	Common name
Marine fish	<i>Rastrelliger sp.</i>	Mackeret
	<i>Stolephorusindicus</i>	Anchovy
	<i>Engraulis sp.</i>	Anchovy
	<i>Sardinellalongiceps</i>	Herring
Freshwater fish	<i>Opicephalusstriatus</i>	Mudfish
	<i>Trichogaster</i>	Gourami
	<i>Anbustestudinenus</i>	Climbing perch
	<i>Clarias sp.</i>	Catfish
Shell fish	<i>Crthinus</i>	Carp
	<i>Ostrea/ Crassostrea</i>	Oyster
	<i>Atya sp.</i>	Shrimp
	<i>Mytilus</i>	Mussel

*Source: (8)

Various countries have developed their own unique types of fish sauce over the centuries. Examples include Nuoc-Mam from Vietnam, Patis from the Philippines, Budu from Indonesia, and Nampla from Thailand and Burma (9). Each of these sauces reflects the distinct culinary traditions and preferences of their respective regions, contributing to the rich diversity of fish sauce varieties found across Asia.

3.1.2. Steps of fish sauce production

The production process of fish sauce involves several intricate steps to ensure its quality and flavor:

- **Salting:** Salt serves as both a flavor enhancer and preservative. It reduces water activity, thereby limiting microbial growth in meats, fish, and other foods. It also forms a crystalline structure that traps flavor compounds, enhancing taste.
- **Fermenting:** Natural fermentation is typically employed, preserving the salted fish for 2-3 years. Over time, the fish undergoes hydrolysis, breaking down into salty sauce and sediment during fermentation.
- **Maturing:** After separation, the fish is transferred to vats for exposure to air and sunlight, a process known as maturation. During this period, the fish is stirred daily to facilitate flavor development. Over about a month, the fish emits a gradual sweet aroma.
- **Filtering:** Clean liquid is extracted from the vats using long bamboo tubes, although some sediment may remain. The filtered residue can be repurposed as animal feed or fertilizer after soaking.
- **Blending:** Different proportions of crude, middle distillate, and the first distillate are combined to create various grades of fish sauce. The highest grade typically offers superior quality and flavor (10).

3.1.3. Nutrition value of fish sauce

The nutritional value of fish sauces lies in their composition of hydrolyzed proteins such as amino acids, amines, peptides, and minerals like sodium chloride and calcium salts. Despite their high salt content, the amount consumed per meal is typically low. However, in regions such as Vietnam, sauces like "Nuoc-mam" can contribute up to 20% of the daily protein intake. Fish sauces effectively preserve amino acids such as lysine and methionine, which are essential and

often deficient in diets low in meat. Studies indicate that amino acid retention is notably high in sauces like Nagapi and Nuoc-mam (11).

3.1.4. Quality Standard of Fish Sauce

The quality standards for fish sauce are strictly regulated by government agencies to ensure purity and safety. These standards include specific requirements such as the prohibition of artificial sweeteners, except for sugar, and clarity without additional particles beyond those naturally formed during fermentation (not exceeding 0.1 gram per liter). Fish sauce must contain a minimum salt content of 200 grams per liter and total nitrogen content of at least 9 grams per liter, with amino acid nitrogen comprising 40%-60% of the total nitrogen and glutamic acid content between 0.4-0.8. Only caramel color is allowed for artificial coloring, and the sauce must exhibit a distinct fishy odor and taste characteristic of pure fish sauce. The shelf life of fish sauce is three years when unopened; once opened, it should be tightly sealed to maintain its quality (12).

4. Conclusion

Fish sauce production in Sri Lanka presents a promising avenue for both economic growth and culinary enrichment. Despite its long-standing significance in Southeast Asian cuisines, fish sauce has yet to capture widespread popularity among Sri Lankan consumers, primarily due to reliance on imported varieties, resulting in high costs and foreign exchange outflows. However, with its abundant marine and inland fishery resources, Sri Lanka possesses a viable opportunity to establish a robust local fish sauce industry. By harnessing locally sourced raw materials and employing simple, cost-effective production technologies, such as those outlined in this review, Sri Lanka can reduce dependence on imports and capitalize on its underutilized inland fish species. This shift not only promises economic benefits through enhanced value addition and reduced waste but also aligns with global trends promoting sustainable food production and consumption. Moving forward, concerted efforts to meet stringent quality standards, promote consumer awareness, and integrate fish sauce into everyday culinary practices can further bolster its acceptance and contribution to Sri Lanka's economic and nutritional landscapes.

Compliance with ethical standards

Disclosure of conflict of interest

The authors report no declarations of interest.

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