

Fish powder: Assessing profitability and affordability in Timor-Leste

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Nutritious fish powder made by the Beacou women's group in Timor-Leste. © Kate Bevitt 2019

Background

Processed fish-based products – such as dried fish, smoked fish and powdered fish – can offer significant nutritional, economic and social benefits for both producers and consumers, particularly for women and children. These products, just like fresh fish, are rich in essential micronutrients such as iron, zinc and calcium, and have a nutritional profile well suited to the needs of women, and infants during the first 1000 days of life, as well as school-aged children (Bogard et al. 2015; Byrd et al. 2022). Some fish-based products are shelf-stable and easy to transport, making them particularly valuable in areas lacking reliable cold-chain infrastructure (Bonis-Profumo et al. 2024a). Fish processing contributes to income generation and provides employment opportunities, particularly for women, who account for the majority of post-harvest fish workers and processors in the small-scale fisheries sector globally (Weeratunge et al. 2010, Basurto et al. 2025).

Women's engagement in fish processing provides opportunities for their economic participation and empowerment, as well as enhancing nutrition (Harper et al. 2013). The sale of fish-based products can generate important income, particularly in rural areas where barriers to engaging in economic activities can be even higher for women than in urban areas (Adam et al. 2024). Notably, women also tend to be responsible for feeding children and managing food preparation in both their homes and public institutions. This means that engaging

women in fish processing can also provide opportunities to promote improved nutrition for women, children and other consumers. However, a key challenge lies in keeping fish-based products affordable for nutritionally vulnerable consumers while ensuring that small-scale producers earn a decent income (Bonis-Profumo et al. 2024a).

In Timor-Leste, the national government is seeking to increase and diversify production from its fisheries sector, in line with its objective to strengthen the blue economy (Government of Timor-Leste 2023). Small-scale fish processing is perceived as one such mechanism to promote economic activity and enhance livelihoods in coastal regions, particularly for women. The Ministry of Agriculture, Livestock, Fisheries and Forestry, through its General Directorate of Fisheries, Aquaculture and Aquatic Resource Management (DG-PAGRA), as well as partner organisations, have promoted various fish-based products for diversifying livelihoods through training workshops in coastal communities, including dried fish, fish jerky, fish balls, fish floss and fish powder (Monteiro et al. in prep). Fish powder, in particular, has also generated considerable interest from development agencies due to its potential as a nutritious and shelf-stable supplement in the nation's school meals programme (Bonis-Profumo et al. 2023).

Fish powder has an excellent nutritional profile, providing essential fatty acids, protein, vitamins and minerals to diets, and has been shown to improve nutritional outcomes for vulnerable populations in low- and middle-income countries (Byrd et al. 2022; Mamun et al. 2022, Bogard et al. under review). Fish powder in Timor-Leste was first introduced to a women's group in Beacou in Bobonaro municipality by Japanese aid agency Pacific Asia Resource Centre Interpeoples' Cooperation (PARCIC). From 2018 to 2020, WorldFish supported some of these women to establish a fish powder microenterprise, which produced 12.7 kg over seven months, most of which was sold at retail outlets in the capital Dili with a use-by date of three months (Hunnam et al. 2021). Producing the larger quantities required for use in public institutions, such as schools, can theoretically be achieved through both centralised and decentralised approaches. For instance, in 2019 PARCIC established a dedicated production facility in Biqueli on the island of Atauro operated by a women's group, which was able to supply approximately two tonnes of fish powder to CARE International to support school meals in 2023 (Bonis-Profumo et al. 2023). Alternatively, a decentralised or localised 'mosaic of approaches' could see individual schools sourcing fish powder from individual small-scale producers,

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using marine or farmed fish (Bonis-Profumo et al. in prep). However, for this to be feasible, fish powder needs to provide a decent income for the producer, while still being affordable for schools.

This study investigates the financial profitability of small-scale, home-based fish powder production in Timor-Leste, by estimating the costs and potential profits of producing one kilogram of product using one particular recipe. It also estimates affordability for schools, based on existing allocated school meal budgets. By providing insights into these aspects, this study seeks to identify research gaps and inform decision-making and investment that can achieve both nutrition and livelihood objectives in rural and coastal Timor-Leste.

Methodology

Raw ingredients and quantities to produce fish powder were based on the recipe from the Beacou women's group, published in Duarte et al. (2022), and verification measurements made by the research team while practising production. Since the recipe produces 420 g of fish powder, quantities of raw ingredients were adjusted to result in 1 kg of final product. Raw ingredient price data were collected through direct market assessments carried out from September 2023 to June 2024, predominantly in Dili and Baucau municipalities, with additional pricing from Liquiçá, Viqueque, Lautém and Manatuto municipalities. For each ingredient, prices were standardised to a per-kilogram unit, outliers were removed, and the average price was calculated for use in subsequent analyses. Fish price was based on the average landing price recorded in Timor-Leste's national catch monitoring system in 2023 and 2024 (<https://timor.peskas.org/>, accessed 3 June 2024). All prices are in United States dollars (USD), the official currency of Timor-Leste.

The cost of ingredients was calculated by multiplying the average price per kilogram by the weight required to produce 1 kg of fish powder. Given high variability in shrimp price, three recipe variations were costed: with in-season shrimp, with out-of-season shrimp, and fish only (no shrimp, substituted with extra fish). Other production costs – including transport, firewood, electricity, phone credit and equipment depreciation – were estimated based on a single production batch size of 3 kg, which is considered feasible with home-based equipment and production time, and standardised to a per-kilogram unit. To assess profitability and affordability, three potential price points (low, mid and high) were based on the retail prices of fish powder used by the Beacou group and the PARCIC-Atauro group, and the midpoint between the two. Note the PARCIC-Atauro product pricing is only referred to as an example of a potential acceptable retail price; related costings for the PARCIC-Atauro recipe are beyond the scope of this study. Gross profit was calculated for each recipe variation and price point by subtracting total costs from revenue. Gross profit margins were subsequently expressed as a percentage of revenue.

Raw ingredient supply and pricing

Raw ingredients needed to produce fish powder based on the Beacou recipe can be obtained from a mix of domestic and imported goods. Fish, shrimp, moringa, and chili are primarily sourced domestically, while cooking oil and sugar are imported. Both domestic and imported sources can supply ingredients such as garlic, onion, sesame and salt. Imported ingredients are typically acquired through supermarkets and local retail shops, while domestically produced items are obtained from fresh produce markets or street vendors. Due to the importance of freshness and quality, fish and shrimp should be sourced locally, with the freshest and cheapest supply available direct from fishers.

Table 1. Raw ingredients required to produce 1 kg of fish powder based on the Beacou recipe, and average price per kilogram in Timor-Leste..

Raw ingredients	Quantity for 1 kg fish powder (kg)	# of sample prices	Average price per kg (USD)	Ingredient cost for 1 kg fish powder (USD)
Fresh fish	1.667 (if include shrimp) 2.697 (if exclude shrimp)	NA	3.20	5.34 (if include shrimp) 8.64 (if exclude shrimp)
Fresh shrimp	1.286	3	4.11 (in-season) 15.33 (out-of-season)	5.28 (in-season) 19.71 (out-of-season)
Dried moringa	0.119	5	4.63	0.55
Sesame seed	0.238	5	6.58	1.57
Red onion	0.086	9	3.00	0.26
Garlic	0.024	8	3.02	0.07
Chili	0.024	4	6.01	0.14
Sugar	0.012	7	1.32	0.02
Salt	0.012	5	0.60	0.01
Cooking oil	0.071	19	1.28	0.09

Notes: Shrimp price was discussed with three vendors in two locations who all provided the same high and low season price structure. Fish price is the average landing price per kilogram recorded in 2023 and 2024 in Timor-Leste's catch monitoring system, Peskas. All other ingredient prices are averages from market surveys.



The price of raw ingredients varies between shops and market retailers, even for imported items of similar weight. Fish and shrimp comprise the largest component of total ingredient cost (Table 1). The shrimp price is highly dependent on seasonality. Fish price also varies by season, species and location, but for simplicity of calculations, only the national average has been used in this study.

Cost of producing fish powder using the Beacou recipe

The cost of ingredients comprises the largest proportion of production costs (Table 2). Costs were estimated for three recipe variations due to high variability in the price of shrimp. When shrimp is obtained in season, the cost of ingredients to produce 1 kg of powder is around USD 13, while out of season the cost doubles to nearly USD 28. Excluding shrimp from the ingredient list makes the cost of ingredients cheaper since fish can be sourced at a lower price per kilogram than shrimp.

Is making fish powder using the Beacou recipe financially viable for home-based producers?

Current retail pricing for fish powder in Timor-Leste varies widely, from USD 1 for 30 g (approximately USD 33 per kilogram) to

USD 12 for 850 g (approximately USD 14 per kilogram). These prices, and a mid-point, were used to assess profitability.

Gross profit margins across price points and recipe variations ranged from 55% indicating strong profitability, to -123% indicating a substantial loss (Table 3). Both the high- and mid-price points generated a gross profit, but only for the in-season shrimp and fish-only variations. Both these recipe variations had strong profitability at the high price point (49–55% gross profit margin) and acceptable profitability at the mid price point (30–38%). The variation using out-of-season shrimp yielded only a minimal profit, with a gross profit margin of 5% at the high price point. The low price point incurred a loss across all recipe variations, suggesting it is too low for fish powder made by small-scale home producers using the Beacou recipe.

When considering the gross profit that a small-scale producer group could make from a single production batch of 3 kg, both the in-season shrimp and fish-only recipe variations sold at the high price point generate profits likely to be considered worthwhile by groups of up to 4–5 people (>USD 10 each). The same recipe at the mid price point would also generate worthwhile profits but only for smaller groups up to two people (Table 3). This profit per person is equivalent to two days' work at the rate commonly provided to casual labourers in Timor-Leste (USD 5 per day).

Table 2. Estimated cost of producing 1 kg of fish powder based on the Beacou recipe.

Cost	Cost (USD) per kilogram fish powder produced		
	Recipe with in-season shrimp	Recipe with out-of-season shrimp	Recipe with fish only (no shrimp)
Cost of ingredients	13.32	27.75	11.35
Other costs: transport, wood, electricity, communications	2.33	2.33	2.33
Equipment depreciation	1.12	1.12	1.12
TOTAL	16.77	31.20	14.80

Note: Other costs and equipment depreciation are estimated based on a 3 kg production batch, then standardised per kilogram, and assumed home production with no site rental cost, short transport distances for sourcing ingredients and bulk sale of product to a nearby school. Equipment includes a set of scales, blender, container for bulk packaging and label. Labour costs have been excluded since similar small-scale food production in Timor-Leste is generally carried out by a small number of family or group members who divide profits after sale.

Table 3. Revenue and profitability of producing 1 kg of fish powder based on the Beacou recipe.

Price point	Revenue (USD)	Recipe	Total cost (USD)	Gross profit (USD)	Gross profit margin	Gross profit per 3 kg batch (USD)
High	33.00	With in-season shrimp	16.77	16.23	49%	48.69
		With out-of-season shrimp	31.20	1.80	5%	5.40
		Fish only (no shrimp)	14.80	18.20	55%	54.60
Mid	24.00	With in-season shrimp	16.77	7.23	30%	21.69
		With out-of-season shrimp	31.20	-7.20	-30%	-
		Fish only (no shrimp)	14.80	9.20	38%	27.60
Low	14.00	With in-season shrimp	16.77	-2.77	-20%	-
		With out-of-season shrimp	31.20	-17.20	-123%	-
		Fish only (no shrimp)	14.80	-0.80	-6%	-



Women fresh fish traders in Timor-Leste meet fisherfolk at the beach landing site to purchase fish. © Agustinha Duarte

Is buying fish powder (Beacou recipe) from home-based producers affordable for schools?

The Timor-Leste government school meal programme, Programa Merenda Eskolár, provides a budget of 42c per student per meal to all preschools and primary schools in the country to serve their students a nutritious meal each day. It is recommended that students are given animal-source protein foods such as meat, egg or fish, two times per week, and plant-based protein the other days. The recommended serving size is 45 g for preschool students (aged 3–5) and 60 g for primary school students (aged 6–15), with a suggested budget allocation for such foods of 20 c (cents) and 16 c per student per meal, respectively (MoEYS and MSA 2023).

One kilogram of fish powder could provide 100 students with a 10 g serve (equivalent to one tablespoon), which can be added as a topping to rice, the common carbohydrate food served in school meals. For children aged 3–5 years, one 10 g serve of fish powder made using the Beacou recipe (with flying fish and shrimp) is equivalent to 34% of recommended daily protein requirements, 54% for calcium, 26% for iron, and 11% for zinc. In comparison, a 45 g fillet of flying fish is equivalent to 65% of daily protein requirements, 12% of calcium, 7% of iron, and 12% of zinc (Bogard et al. under review). Based on costings above for fish powder made using the Beacou recipe, the price per serve would be 33 c, 24 c and 14 c, if sold at the high, mid and low price points respectively. The high price point would not be affordable for schools, while the low

price point is not profitable for producers if using the Beacou recipe. The mid price point, however, is only slightly above the allocated protein budget. Schools could choose to pay this price on the weekly occasion they serve fish powder, and balance the spent budget (24 c per meal) by procuring cheaper plant-based protein options, such as tempeh (approximately 10 c per meal for 45 g), on other days.

Implications for scaling production and coastal livelihoods

This study demonstrates the challenge of producing a shelf-stable fish-based product in Timor-Leste that is profitable for producers while remaining affordable for nutritionally vulnerable populations such as school children. Based on this analysis and this particular fish powder recipe, only the mid price point (USD 24 per kg) is both profitable for home-based producers and marginally affordable for schools. At this price point, this recipe (fish-only variation) could generate a 38% gross profit margin for producers and a reasonable per batch income for up to two people (USD 10 each) – an attractive value proposition in the context of limited rural employment opportunities, particularly for women. While the cost per 10 g serve (24 c) is slightly above the current allocated budget for school meals (16–20 c), it could be affordable on a weekly basis if schools served cheaper plant-based proteins on other days. Alternatively, the Government of Timor-Leste, or its development partners, could choose to subsidise part of the

fish powder cost, as a food system policy to ensure nutritious affordable meals that contribute to prosperous rural livelihoods. This approach would be aligned with the current requirement of schools to procure 75% of their produce from nationally produced sources (MoEYS and MSA 2023).

Findings from this study mean that any efforts to scale fish powder production for dual nutrition and livelihood objectives will need to be closely aware of production costs and identify ways to reduce costs where possible. There are several potential factors that could be modified in order to balance the profitability–affordability equation. Applying strategic cost management principles (Shank and Govindarajan 1993) – in particular, effective product design including ingredient selection and suggested serving size, process improvement including waste minimisation, and target costing to work backwards from an affordable serving price – may prove useful in such endeavours, as discussed briefly below.

Fish powders can be made using different ingredients and processing techniques to suit various purposes, which both affect production cost. Some are made from fish only (whole or de-boned) and are typically used to fortify other products such as porridge, noodles or biscuits, while others include additional ingredients for enhanced flavour and texture, and are used as a topping or seasoning (Bonis-Profumo et al. 2024a). Production methods range from drying and grinding whole fish including bones, which improves nutritional content and minimises waste, while others use fish flesh only, or by-products from fish processing (Abbey et al. 2017; Zatta Cassol et al. 2024). The Beacou recipe tested in this study uses fish flesh only, such as flying fish, with shrimp, moringa and sesame seeds added to enhance flavour and nutritional value. However, adjusting ingredient composition and improving processes to minimise waste could improve cost-effectiveness. For example, this study demonstrates the cost savings that can be achieved by omitting shrimp. Furthermore, using whole fish can almost double the quantity of fish powder produced per raw fish weight compared to flesh only (Mamun et al. 2022), although ratios likely vary by species.

Seasonal variations influence supply chains, local economies, and nutritional outcomes (Love et al. 2023). The supply of fish and shrimp in Timor-Leste is seasonal and location-specific, and pricing varies with both availability and species (López-Angarita et al. 2019) as well as supplier's position along the supply chain (Steenbergen et al. 2019). Understanding these pricing dynamics will be critical to ensuring fish powder cost-effectiveness. For instance, there may be opportunities to capitalise on seasonal abundance and procure ingredients at affordable prices, target lower cost fish species and more nutrient-dense species (Bogard et al. 2024), and negotiate supply agreements directly with fishers rather than purchasing from secondary traders. These cost reduction strategies may be sufficient to enable home-based fish powder production to be profitable for producers at a slightly lower price (for instance USD 16–20 per kg), which would achieve the target cost of 16 c to 20 c per serving for school meals.

Identifying market segments is also important for business sustainability. High retail prices could reposition fish powder as a high-end item, but this would limit access for

lower-income consumers and conflict with the objective of improving nutrition. Furthermore, the high-end market is likely to be fairly limited in Timor-Leste, while lower prices would enable access to a much larger market. However, consumer acceptability and preferences are also important (Ragsdale et al. 2024). A recent WorldFish pilot in schools found students thoroughly enjoyed eating filleted tilapia for meals – although this was only possible in schools within 1.5 hours proximity to aquaculture producers to ensure safety and quality, entailed substantial preparation time, and required cost subsidies to be affordable (Bonis-Profumo et al. 2024b). Ready-to-eat, shelf-stable fish-based products, such as fish powder clearly have significant advantages in that they are highly suitable in contexts distant from points of fresh fish supply, are convenient for cooks particularly in large schools, and address concerns about children choking on fish bones. In the context of high malnutrition levels and low animal protein consumption, particularly in rural areas (Ministry of Health 2022), the potential contribution of fish-based products, such as fish powder, cannot be underestimated.

Conclusion

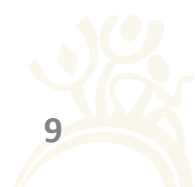
This study provides important insights into the profitability and affordability of home-based fish powder production using a specific recipe. It highlights the critical role of ingredient selection, cost dynamics, and the trade-off between maintaining affordability for consumers and ensuring a viable income for producers. The findings suggest that a mid-range price point can strike a balance – supporting acceptable earnings for home-based producers while allowing institutions such as schools to include fish powder as a cost-effective, protein-rich food within existing budgets. This has significant implications for women involved in fisheries post-harvest activities, who often lead small-scale processing and home-based production. Enhancing the economic viability of fish powder not only promotes women's economic empowerment but also can contribute toward improved household nutrition. However, scaling up decentralised production will require strategic cost management, recipe refinement, and attention to food safety. A simple certification system with clear safety standards may be necessary to support safe and sustainable home-based production models.

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