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Viability Analysis of Value-Added *Engraulicypris sardella* Obtained Using Parboiling and Sun-Drying Processing Methods in Nkhotakota District, Malawi

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Abstract: This research aimed to assess the added value of sun-dried and parboiled *Engraulicypris sardella* (usipa) products as a basis for determining their viability in terms of business. To this end, a survey was conducted in Nkhotakota District at 12 sites (beaches), where fresh usipa commonly lands and is processed as sun-dried and parboiled fish. A proportional stratified method was used to determine the number of respondents, followed by a simple random sampling technique to select 57 *E. sardella* processors. An interview with a structured questionnaire was conducted to collect data from these *E. sardella* processors. The Hayami method was used to analyze the added value of Usipa products, and the viability of the sun-dried and parboiled processing method was determined on the basis of the revenue/cost ratio. The results of the study show that both sun-dried and parboiled usipa products generate positive added value, being greater for the latter than the former. Thus, sun-dried and parboiled usipa are profitable, with the highest revenue/cost ratio of the two being for parboiled usipa. We conclude that while sun-dried and parboiled usipa are both viable products, the viability of the business is more greatly enhanced when fish is parboiled rather than sun-dried.

Keywords: value-added products; processing methods; small-scale fisheries; business viability; *Engraulicypris sardella*; Malawi

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1. Introduction

Fishing and fish businesses are a source of livelihood for millions of people around the world. Fishing plays an important role in the economy of Malawi, where 4% of the gross national product is supported by the fisheries sector [1]. One of the most abundant and traded fish species in Malawi is *Engraulicypris sardella* (usipa). Its role in lake communities cannot be overemphasized, as it contributes substantially to food security and nutrition [2]. To improve the revenue generated from fish businesses, fishery communities in Malawi add value to the fish in several ways, creating more varieties and forms of fish products that are widely sought-after in the fish market. Apart from imparting a higher economic value, activities that add value to fish reduce postharvest losses by increasing the fish's shelf life. Depending on the requirements of different markets, value can be added to Malawi fish by being frozen, cured, canned, boiled, dried, and smoked [3]. In Nkhotakota district, small fish such as *Engraulicypris sardella* are sun-dried or parboiled [3]. These processing methods not only help to increase the shelf life of the fish but also improve

their organoleptic qualities and attract better prices in the market, ultimately increasing profits [4,5].

Despite the advantages that adding value brings to businesses, the majority of fish business practitioners in Nkhotakota are not aware of how much value they are adding by transforming fresh fish into either sun-dried or parboiled fish. They are also unsure about the viability of these practices. This may mean that business practitioners do not devote additional effort into their business and continue to operate on a small scale for subsistence, thereby experiencing lower profits. In [6–8], the authors argued that the higher the added value that a product has, the higher the profits. Accordingly, performing a value-added analysis for a product is essential for businesses, as it helps owners to better select the most profitable business unit. In addition, a viability study helps organizations to determine the costs and benefits associated with a business [9].

Therefore, this study was conducted to determine the viability of value addition to *Engraulicypris sardella* through parboiling and sun-drying processing methods in Nkhotakota district.

2. Materials and Methods

2.1. Study Location and Sampling Strategy

The research was carried out in Nkhotakota district (Figure 1), which was selected because it is the area in Malawi where most of the *Engraulicypris sardella* (usipa) fish are caught. To sample the population and collect data for this research, Lake Malawi was coded into almost 30 sections, also known as strata, which are numerical points from where fisheries data were collected.

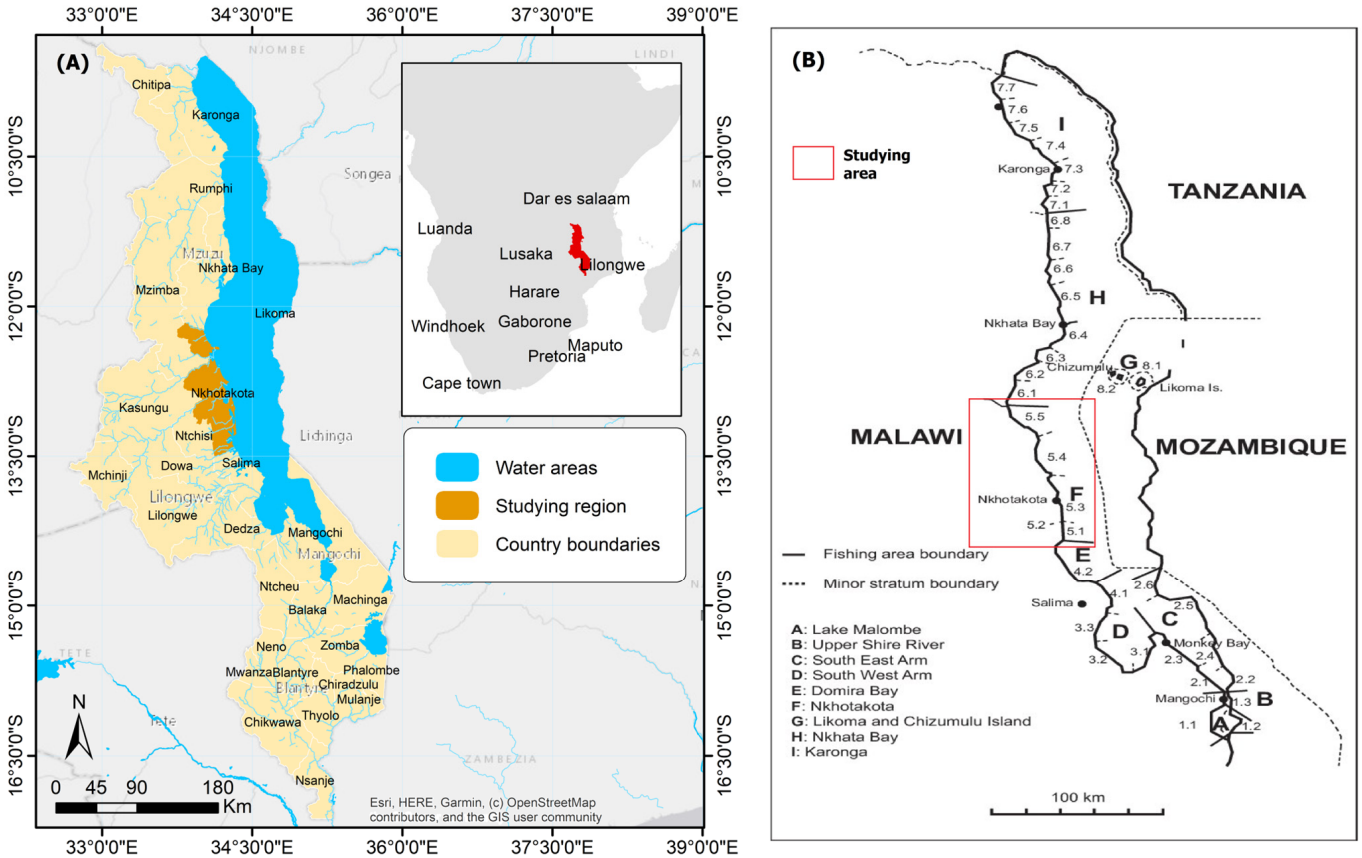

Figure 1. Geographic location of the study region (**A**) and the strata 5.1, 5.2, 5.3, 5.4, and 5.5 (**B**). Adapted from Banda et al. (2005) [10].

Nkhotakota itself has five strata (namely 5.1, 5.2, 5.3, 5.4, and 5.5), within which there are fish landing beaches. However, *E. sardella* usually land on and are processed in four

of these strata (5.1, 5.3, 5.4, and 5.5). Due to resource limitations, time, proximity, and because the other strata were hard to reach, data were only collected from 5.1 and 5.3. This was undertaken in consultation with research officers based at the Fisheries Research Unit in Nkhotakota. The two strata correspond to a total of 12 landing beaches with 269 fish processors. A proportional stratified sampling method was used to determine the number of respondents, followed by a simple random sampling technique, supported by Equation (1), to select 57 *E. sardella* processors.

$$n = (N \times n_0)/(N + n_0), \quad (1)$$

Here, n corresponds to the sample size; N represents the population size; and $n_0 = 1/(E_0)^2$. E_0 is the acceptable margin for random error (5%), corresponding to a confidence interval of 95%.

2.2. Data Collection and Analysis

Quantitative data were collected during the study. A structured questionnaire was used to collect data from *E. sardella* processors. Information related to the quantity of fish bought and sold after processing, as well as the selling price and the incurred costs, was collected. Furthermore, the revenue generated was calculated.

In [11], it was established that the most common method used for measuring added value is the Hayami method. This method assumes that the sources of added value are the utilization of factors such as labor, capital, human resources, and management. The results obtained from the Hayami value-added analysis are in the form of productivity, output value, added value, labor remuneration, and the benefits obtained from processing activities. Accordingly, in this research, the output, input, price, added value, and value-added ratio for each processing method were analyzed using the Hayami mathematical method (Table 1).

Table 1. Value-added ratio determined using the Hayami method.

Output, Input, Price	Formula	Code
Output (kg/day)		(1)
Input (kg/day)		(2)
Labor (number of employees/day)		(3)
Conversion factor	(1/2)	(4)
Labor coefficient	(3/2)	(5)
Price of output/kg		(6)
Labor wages		(7)
Acceptance and profit		
Raw material price/kg		(8)
Price of another input/kg		(9)
Output value/kg	(4 × 6)	(10)
Added value/kg	(10-8-9)	(11)
Value added ratio	(11/10 × 100)	(12)

The viability study was performed to determine the cost/benefit ratio of sun drying and parboiling *E. sardella*. This was based on the revenue/cost ratio, which represents a comparison between the total revenue the enterprise has accumulated by selling sun-dried versus parboiled *E. sardella* to the total costs that have been incurred. This was calculated using Equation (2), as suggested by [7]. The benefit of processing either sun-dried or parboiled fish was obtained from the difference between total revenue and total cost. The amount of money a company earns through the sale of goods, known as the revenue, is the income that arises in the course of ordinary activities of an entity and is given by Equation (3). Total costs are the sum of fixed costs (FC) and variable costs (VC) (Equation (4)). In this study, total costs are represented by the procurement of fresh fish,

packaging materials, transport, labor, fuel wood, drying racks, and buckets. Data analysis was undertaken using Excel and SPSS version 20, which were also used by [5].

$$R/C = \frac{\text{Total Revenue (TR)}}{\text{Total Costs (TC)}}, \quad (2)$$

An R/C ratio of >1 indicates that a business is profitable; an R/C ratio of <1 indicates that the business is running at a loss; and an R/C ratio of 1 indicates that the business is breaking even.

$$\text{Total Revenue} = \text{Selling Price (P)} \times \text{Quantity(Q)}, \quad (3)$$

$$\text{Total Costs} = \text{Fixed costs (FC)} + \text{Variable costs (VC)}, \quad (4)$$

3. Results and Discussion

3.1. Added Value of Sun-Dried and Parboiled E. sardella

Research shows that the degree of value addition in African fisheries has been relatively low [12], and Malawi is no exception. In the small-scale context, the term value addition is used to characterize adding value to products through some type of processing method; essentially, converting raw fish into a finished or semifinished product that has more value in the marketplace [13].

Usipa fishing in Nkhotakota is mainly small-scale fishing, conducted using small boats or canoes. Usually, there is no value addition performed to fresh fish as the boats/canoes do not have fish preservation facilities, such as cooling systems. Upon landing, fresh fish are immediately sold to processors. The processors are the only actors involved in the value addition of usipa, either by sun drying (Figure 2A) or parboiling (Figure 2B), to avoid fish spoilage.

Figure 2. Fish processing by sun drying (**A**) and by parboiling (**B**).

After that, the fish are sent to the market. Accordingly, value addition to usipa can be seen as a value increase occurring because of incremental activities along the production chain of usipa to improve the overall value of the product, specifically through sun-drying and parboiling processes. The results show that the output, added value, and value-added ratio are higher for parboiled fish than for sun-dried fish (Table 2).

Table 2. Added value of usipa products.

Output, Input, Price	Formula	Code	Sun Drying	Parboiling
Output (kg/day)		(1)	181	148
Input (kg/day)		(2)	403	328
Labor (number of employees/day)		(3)	2	2
Conversion factor	1/2	(4)	0.45	0.45
Labor coefficient	3/2	(5)	0.005	0.006
Price of output/kg		(6)	1009.660	1546.250
Labor wages		(7)	6427	5375
Acceptance and profit				
Raw material price/kg		(8)	210	210
Price of another input/kg		(9)	50.602	54.134
Output value/kg (product)	4 × 6	(10)	453.470	697.698
Added value/kg	10-8-9	(11)	192.868	433.565
Value added ratio%	11/10 × 100	(12)	42.532	62.142

The labor coefficient is the quotient between the labor and the input used in the production processes of usipa. The research findings indicate that the overall workforce used to process the fish is around two employees for the sun-drying processing method and two employees for the parboiling processing method. Therefore, the labor coefficient is 0.005 for sun-dried fish and 0.006 for parboiled fish, translating to 5 and 6 days needed to process 1 ton of sun-dried and parboiled usipa, respectively. The labor coefficient indicates that the amount of usipa that can be processed is almost the same for sun drying and for parboiling. This means it is less efficient to utilize labor for the parboiling processing method. The parboiling processing method at Nkhotakota consists of dipping the fish in boiling water for about 5 min, followed by spreading the fish out in a shed for natural sun drying. This first step is omitted for the sun-drying process [3]. Although the sun-drying processing method involves fewer steps, parboiling the fish is a quicker method, as it takes only one day to prepare for market, whereas sun drying alone requires about three days. Therefore, the sun-drying processing method is much more time-consuming and laborious than the parboiling processing method, and the real number of required workers should be considered for each processing method.

The conversion factor is represented by the number of processed fish (output) that can be produced for 1 kg of fresh fish (input). This was determined by dividing the value of the output produced by the raw material (input). The conversion factors for both sun-dried and parboiled fish were the same at 0.45, which means that 450 g of sun-dried or parboiled fish is produced from 1 kg of fresh fish. With this conversion factor, the value of fish produced from 1 kg of fresh fish was estimated as MK 453.470 for sun-dried fish and MK 697.698 for parboiled fish, respectively (where MK stands for Malawian kwacha).

The value added by the processing of sun-dried and parboiled fish was obtained by subtracting the costs of the raw material and other inputs from the output value. Processing usipa generates positive added value. Sun-dried usipa had an added value amounting to 192.868 MK/kg, with a ratio of 42.532%, whilst parboiled usipa generate an additional value of 433.565 MK/kg, with a ratio of 62.142%. The added value of parboiled usipa is greater than that of sun-dried usipa due to the higher output value and higher price of parboiled fish. Customers are willing to pay more for parboiled fish because they tend to prefer the taste. The reason why parboiled fish may taste better than sun-dried fish is because parboiling helps to retain the natural flavor and texture of the fish, while also enhancing it with the added flavor of the cooking liquid. Sun drying, on the other hand, can remove much of the natural moisture and flavor from the fish, resulting in a tougher, less-flavorful product [14]. This finding is also in accordance with [15], who argued that cooking fish leads to improvement of flavor and taste and inactivation of pathogenic microorganisms, improving fish quality. Despite the high added value, parboiled fish is less commonly produced in the study area. This may be because the shelf life of parboiled fish is lower

than that of sun-dried fish. Usually, usipa is processed at the beach and then taken to the main market, which is inland. Given the time from processing to reaching the final consumers, processors prefer to process fish by a method that results in a longer product shelf life. This is in agreement with the conclusions of [16], stating that dried fish is easier to store when considering the long distance from the beach to the markets.

Furthermore, the high price of parboiled *E. sardella* means that it is less commonly consumed than sun-dried fish. The low buying capacity of consumers due to low incomes and the lower price of sun-dried fish as a substitute may be the reasons for this. This is also supported by [17,18], who argued that the actual quantity of a product demanded by a consumer varies inversely with the price. A product that is priced too high may not be affordable to many consumers.

3.2. Viability of Sun-dried and Parboiled E. sardella (usipa)

Results indicated that processing *E. sardella* as a sun-dried product gives a revenue–cost ratio of 1.55 and a benefit of MK 64,872.66, whilst processing *E. sardella* as a parboiled product gives an R/C ratio of 2.35 and a benefit of MK 131,460.36 (Table 3). The financial viability of all processed usipa products is viable to work on because the revenue–cost ratio is above 1. However, the viability of the business is enhanced when fish is parboiled rather than just dried.

Table 3. Viability of processed *E. sardella* (kg/day).

Type of Calculation	Sun-Dried	Parboiled
Revenue	MK 182,748.46	MK 228,845.00
Total Cost	MK 117,875.8	MK 97,384.64
Benefit	MK 64,872.66	MK 131,460.36
Total Revenue/Total Cost Ratio	1.55	2.35

Where MK stands for Malawian kwacha.

The results presented herein are in accordance with the studies conducted by [5,19], who concluded that subjecting *E. sardella* to different processing methods leads to high profitability. Apart from presenting the products as most admirable, hygienic, and free from pathogens, processing fish makes the product much more attractive to consumers. Usually, fishing activities in Nkhotakota take place away from the consumption areas. Since there are no icing facilities in the study area, processing methods are employed to preserve the fish, thereby influencing the market price and maximizing profits [20]. Furthermore, [21] found that by processing fish, processors are able to pay off their investment, reinvest in the fishing business or consumption, while maintaining a constant flow of fish. In this study, processing fish as parboiled fish enhances profits, particularly since parboiling improves flavor, ultimately attracting consumers and pushing market prices upwards [20].

Nkhotakota is a higher-populated district situated on the shore of Lake Malawi, consisting mostly of rural communities. Like many developing countries, poverty and unemployment are major issues for Nkhotakota's residents. The fishing, processing, and trading of fish are the primary economic activities, making fisheries a crucial source of food, employment, and livelihood for thousands of people in Nkhotakota [22]. Furthermore, the significance of fish has been acknowledged, as it contributes to the nutritional security of impoverished individuals, particularly in developing countries. Direct fish consumption leads to increased micronutrient intake, while the commercialization of fish enhances purchasing power and overall food consumption, as supported by [23]. On one hand, the profitability of *E. sardella* in Nkhotakota can be explained by its status as the cheapest source of animal protein, which according to [24] results in increased demand and consumption, especially among the poorest people. In [25], the authors corroborate this finding, stating that fish is a staple in the diet of the majority of Malawians, and that the demand for fish in Malawi is high, with nearly all fish caught locally being consumed.

Examining processing methods, traders tend to prefer selling dried fish over fresh fish due to the high perishability of the latter, which requires more effort and cost to maintain quality. In Nkhotakota, sun drying and parboiling are the most commonly used processing methods for usipa. However, the parboiling method is mostly used during the rainy season because it accelerates the drying process and makes usipa available for trading within a day [3]. Nonetheless, this method is not as effective for fully drying the fish, reducing therefore its shelf life. As a result, processors tend to process less parboiled fish as they have to transport it to trading points, which are often far from the processing areas. Our study found that less parboiled fish was processed than sun-dried fish. However, the improved flavor of parboiled fish can make it more appealing to consumers, making it more expensive than sun-dried fish. Given the low cost and long shelf life of sun-dried fish, it remains the most popular fish sold in Nkhotakota [26].

The comparison of the viability of processed *E. sardella* at strata 5.1 and strata 5.3 (Table 4) indicates that the business is feasible in both strata, whether they choose to sun dry or parboil, as the revenue cost ratio is above 1. This implies that the *E. sardella* business can sustain itself financially. However, profits are greater when developed in strata 5.3 than in strata 5.1, possibly due to the higher efforts exerted by processors in strata 5.3, resulting in greater benefits.

Table 4. Viability of processed *E. sardella* at Strata 5.1 and strata 5.3.

Type of Calculation	Strata 5.1		Strata 5.3	
	Sun-Dried	**Parboiled**	**Sun-Dried**	**Parboiled**
Revenue	MK 123,515.21	MK 161,900.00	MK 241,981.71	MK 295.790.00
Total cost	MK 96,019.94	MK 70,357.37	MK 139,731.66	MK 124,411.91
Benefit	MK 27,495.27	MK 91,542.63	MK 102,250.05	MK 171,378.09
Total Revenue/Total Cost Ratio	1.29	2.30	1.73	2.38

Where MK corresponds to Malawian kwacha.

4. Conclusions

Engraulicypris sardella (usipa), when subjected to sun-drying and parboiling processing methods in Nkhotakota, has a positive added value. The added value of parboiled *E. sardella* is greater than that of sun-dried *E. sardella*. Processing *E. sardella* as sun-dried and parboiled fish can support businesses in being profitable, with the highest revenue–cost ratio being obtained by the parboiling processing method.

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