

VALUE ADDITION AND PROFITABILITY OF *Parkia biglobosa* PROCESSING AMONG MARKET ACTORS IN BENIN CITY, EDO STATE, NIGERIA

OSADOLOR, N.¹ AND *KOLEDIOYE, G.F.²

¹Department of Forestry and Wildlife Management, Faculty of Agriculture, University of Benin, Nigeria

²Department of Agricultural Extension and Rural Development, Faculty of Agriculture, University of Benin, Nigeria

Corresponding author: gbenga.koledoye@uniben.edu

Abstract

This study assessed value addition and profitability of Parkia biglobosa processing among market actors in Benin City, Edo State, Nigeria. Specifically, it identified the major value-added products, estimated processing and marketing costs, compared the profitability of raw and processed products, and examined the principal constraints affecting the enterprise. A cross-sectional survey design was adopted. Multistage sampling involving purposive and random techniques was used to select 120 processors, suppliers and traders from eight markets in Oredo and Egor Local Government Areas. Primary data were collected using a structured questionnaire and analysed with frequencies, percentages, means, standard deviations, weighted mean scores, gross margin and cost-and-return analyses. Results showed that fermented locust bean, locally known as iru/ogiri, was the dominant value-added product, accounting for 80.8% of products traded, compared with powdered locust bean (7.5%), dried dawadawa (6.7%) and raw seeds (5.0%). The total cost of handling raw seeds was US\$0.64 /kg, while processed products required US\$2.03/kg. Nevertheless, processed products generated total revenue of US\$4.25/kg, gross margin of US\$2.34/kg and net return of US\$2.23/kg, compared with US\$1.22, US\$0.59. and US\$0.58./kg, respectively, for raw seeds. The return on investment was 1.10 for processed products and 0.91 for raw seeds, while profit margins were 52.3% and 47.7%, respectively. Major constraints were high market levies (mean = 3.51), limited awareness of value-added products (3.41), inadequate transportation (3.22), lack of storage facilities (3.20), processing and marketing risks (3.14), and poor access to ready markets (3.11). The study concluded that processing substantially increased profitability and recommended improved training, packaging, storage, cooperative marketing and streamlined market levies.

Keywords: *Parkia biglobosa*, Value addition, Profitability, Market actors, Locust bean Benin City

Introduction

Non-timber forest products play an important role in Nigeria's rural and urban economies by providing food, medicine, raw materials, employment and income for households. One of the most valuable indigenous non-timber forest products is *Parkia biglobosa*, commonly known as the African locust bean tree. The species is widely utilised in Nigeria because its seeds, pulp, leaves, bark and roots have nutritional, medicinal and commercial uses. The seeds are particularly important because they are processed into fermented condiments commonly known as iru, dawadawa, ogiri or okpeyi, depending on the locality. These condiments are widely consumed in Nigerian households because of their distinctive flavour, cultural acceptability and nutritional value (Adejumo *et al.*, 2013; Sodimu *et al.*, 2020).

In their raw form, locust bean seeds are hard, bitter and unsuitable for direct consumption. They therefore require processing through sorting, boiling, dehulling, washing, fermentation, drying and packaging before they become acceptable to consumers. These activities improve the taste, digestibility, shelf life, convenience and market value of the product. Value addition therefore occurs when the raw seeds are transformed into fermented, dried, powdered or packaged forms that attract higher demand and better prices. Ijigbade *et al.* (2021) observed that processing and other value-adding activities increased the economic worth of locust bean products in Ondo State, Nigeria. The processing and marketing of *Parkia biglobosa* constitute an important livelihood activity among small-scale market actors in Nigeria. The enterprise is predominantly undertaken by women who participate in boiling,

dehulling, fermentation, packaging and retailing. Income obtained from the enterprise contributes to household feeding, children's education, healthcare and other welfare needs. Studies conducted in different parts of Nigeria have shown that locust bean processing supports women's livelihoods and contributes to poverty reduction (Ifeanyieze *et al.*, 2016; Aderounmu *et al.*, 2019; Alao *et al.*, 2020).

Despite its importance, processing remains largely traditional, labour-intensive and time-consuming. Repeated boiling, manual dehulling and natural fermentation require substantial labour, water, fuel and time. Akande *et al.* (2010) identified depulping, dehulling and other processing operations as major challenges confronting the locust bean industry, while Akinoso and Adedayo (2012) reported that the processing operation requires considerable energy. These costs may reduce the net returns obtained by processors, particularly where modern equipment is unavailable. Traditional processing methods may also produce inconsistent quality because fermentation conditions, boiling time, hygiene and storage practices vary among processors. Although improved technologies can reduce drudgery and increase processing efficiency, their adoption remains low because of inadequate finance, limited technical knowledge and poor access to equipment (Kolapo *et al.*, 2020). Food safety is also a concern because processing is often carried out in environments with inadequate access to clean water, hygienic surfaces and appropriate storage facilities. Poor handling and storage may expose the product to contamination and rapid deterioration, thereby reducing consumer

confidence and profitability (Omoare *et al.*, 2022).

Packaging is another critical aspect of value addition. Fermented locust beans are commonly sold in nylon bags, leaves, bowls or simple plastic containers. Although these materials are cheap and readily available, they may not provide sufficient protection against moisture, contamination and spoilage. Inadequate packaging also limits branding, labelling and access to higher-value outlets such as supermarkets, restaurants and formal retail shops. Improved packaging could increase product appeal, extend shelf life and enable market actors to obtain premium prices. Profitability determines whether market actors will continue to participate in locust bean processing and marketing. The enterprise is financially viable only when revenue from sales exceeds the costs of raw seeds, labour, transportation, fuel, water, packaging, storage and market levies. Studies have generally shown that locust bean processing and marketing are profitable. Olapade-Ogunwole *et al.* (2011) reported positive returns among processors and marketers in Osun State, while Farayola *et al.* (2012) established that the enterprise was profitable in Kwara State. More recent studies have similarly confirmed that processing locust beans into value-added products generates positive income for market actors (Abdu-Raheem *et al.*, 2023; Abdulhamid *et al.*, 2024).

However, profitability varies across locations because of differences in access to raw materials, processing practices, transportation costs, product forms, market demand and prevailing prices. In Benin City, market actors operate within a large urban food market where locust bean products are consumed by people from diverse cultural backgrounds. A

substantial proportion of the products traded in the city is sourced from local and interregional markets, thereby exposing actors to transportation charges, market levies, spoilage and fluctuations in supply. These conditions make it necessary to determine whether the additional value created through processing adequately compensates for the costs incurred. Although *Parkia biglobosa* processing and marketing provide important livelihood opportunities, the enterprise in many parts of Nigeria, including Edo State remains largely informal and dependent on traditional methods. Market actors incur costs for raw materials, labour, fuel, transportation, storage, packaging and market levies, yet the extent to which these costs influence profitability is not sufficiently documented. Without reliable information on costs and returns, processors and traders may be unable to determine the most profitable product forms or identify the stages at which value is created or lost.

Although, existing and available studies have established that locust bean processing can be profitable, but most were conducted in major production areas Osun, Kwara, Ondo, Ekiti, Oyo and northern Nigeria (Olapade-Ogunwole *et al.*, 2011; Farayola *et al.*, 2012; Ijigbade *et al.*, 2021; Abdu-Raheem *et al.*, 2023). Thus, their findings may not fully reflect the conditions of an urban consumption and distribution centre like Benin City, where raw materials are often sourced from distant markets and where transport costs, spoilage and urban market charges may substantially alter the cost structure. This represents clear geographical and economic gaps in the literature this study intends to fill. This study therefore fills these gaps by assessing value addition and profitability of *Parkia biglobosa*

processing among market actors in Benin metropolis. Specifically, the study identified the major value-added products traded in Benin City, estimated the costs associated with processing, packaging and transportation, compared the profitability of raw and processed products, and determined the principal constraints affecting market actors. The findings are expected to provide evidence for improving processing efficiency, reducing losses, strengthening market linkages and increasing the income of processors and traders engaged in the *Parkia biglobosa* enterprise.

Methodology

Study Area

The study was conducted in Benin City, the capital of Edo State, Nigeria. Benin City is located in the South-South geopolitical zone of the country and lies approximately between latitude 6°20'N and longitude 5°37'E. The city has a humid tropical climate characterised by a wet season extending approximately from April to October and a dry season from November to March. Annual rainfall ranges from about 2,000 mm to 2,500 mm, while the average temperature ranges between 24°C and 34°C. Benin City is a major commercial and administrative centre with strong linkages to surrounding rural communities that supply agricultural and non-timber forest products to urban markets. Agricultural commodities and forest-based products such as cassava, oil palm products, vegetables, medicinal plants and locust bean products are commonly traded within the city. The large population, diverse food culture and presence of numerous traditional markets make the city an important consumption and distribution centre for processed *Parkia biglobosa* products.

Administratively, Benin City extends across Oredo, Egor, Ikpoba-Okha and parts of Ovia North-East Local Government Areas. However, the study concentrated on Oredo and Egor Local Government Areas because of their high concentration of markets and market actors involved in the processing and trading of *Parkia biglobosa* products.

Study Design

The study adopted a cross-sectional survey design. The design was considered appropriate because data were collected from processors, suppliers and traders of *Parkia biglobosa* products at a particular period to determine their value-addition practices, marketing activities, costs, returns and constraints. Both quantitative and qualitative information were obtained from the respondents. The population of the study consisted of market actors involved in the *Parkia biglobosa* value chain in Benin City. These included processors, suppliers, traders and individuals engaged in the handling, packaging, transportation and marketing of raw and processed locust bean products. The respondents represented actors who added value to the product through activities such as boiling, dehulling, fermentation, drying, packaging, transportation and retailing.

Sampling Design

A multistage sampling procedure involving purposive and random sampling techniques was used to select the respondents. In the first stage, two Local Government Areas, namely Oredo and Egor, were purposively selected from the Local Government Areas covering Benin City. The selection was based on the concentration of major markets and the large number of actors involved in the sale and distribution of *Parkia biglobosa* products. In the second stage, eight major

markets were purposively selected from the two Local Government Areas. The selected markets were Ekiosa, Oba, Agbado and New Benin markets in Oredo Local Government Area, and Uwelu, Uselu, Oliha and Ogida markets in Egor Local Government Area. These markets were selected because of the visible presence of traders, suppliers and processors of locust bean products. In the third stage, respondents were selected from the identified market actors through random sampling where lists or clusters of traders were available, while purposive selection was used to identify actors with direct involvement in the processing or marketing of *Parkia biglobosa*. A total of 120 respondents were selected for the study, with 60 respondents drawn from each of the two Local Government Areas. The sample was considered adequate for describing the activities and economic performance of market actors operating within the selected markets.

Data Collection

Primary and secondary data were used for the study. Primary data were collected through the administration of a structured questionnaire complemented by personal interviews with the respondents. The interviews were particularly useful for respondents who required clarification of the questions or assistance in completing the questionnaire. The questionnaire elicited information on respondents' socioeconomic characteristics, forms of *Parkia biglobosa* products traded, sources of raw materials, processing methods, packaging practices, transportation systems, marketing outlets, costs of value-addition activities, revenue from sales and constraints affecting the enterprise. Secondary information was obtained from relevant journal articles, books, institutional publications and previous

studies on non-timber forest products, African locust bean processing, agricultural value chains and profitability analysis. The secondary information was used to support the conceptual and empirical aspects of the study.

In terms of variables measurement, age and years of experience were measured in years, while sex, education, occupation, location and market were measured as categorical variables. Product forms, processing methods, packaging practices, transportation means and market outlets were measured through frequencies and multiple-choice responses. The forms of value-added *Parkia biglobosa* products were measured by asking respondents to identify the products they processed or sold. These included raw seeds, fermented locust beans, dried locust beans and powdered locust beans. The costs of value addition were measured in naira per kilogram of product. The major cost components included the cost of raw seeds, labour, fuel or energy, water, transportation, storage, packaging materials and market levies. Revenue was measured as the total amount realised from the sale of one kilogram of raw or processed product. Constraints affecting the enterprise were measured on a five-point Likert-type scale of very severe, severe, moderately severe, less severe and not severe, assigned scores of 5, 4, 3, 2 and 1, respectively. The mean score for each constraint was calculated and used to rank the constraints according to their severity.

Data Analysis

Data collected from the respondents were coded and analysed using the Statistical Package for the Social Sciences and Microsoft Excel. Descriptive statistics, including frequency counts, percentages, means and standard

deviations, were used to describe the socioeconomic characteristics of respondents, identify the major value-added products, and summarise processing, packaging, transportation and marketing practices.

The weighted mean score was used to determine the severity of the constraints confronting market actors. The weighted mean was expressed as:

$$\bar{X} = \Sigma fx / N$$

where $\bar{X}$ = mean severity score; f = frequency of responses; x = assigned scale value; and N = total number of respondents.

A decision mean of 3.00 was obtained from the five-point scale. Constraints with mean scores of 3.00 or above were regarded as severe, while those with mean scores below 3.00 were regarded as less severe.

Gross margin and simple cost-and-return analyses were used to estimate and compare the profitability of raw and processed *Parkia biglobosa* products. Gross margin was calculated as:

$$GM = TR - TVC$$

where GM = gross margin; TR = total revenue; and TVC = total variable cost.

Total cost was estimated as:

$$TC = TFC + TVC$$

where TC = total cost; TFC = total fixed cost; and TVC = total variable cost. Net return was calculated as:

$$NR = TR - TC$$

where NR = net return; TR = total revenue; and TC = total cost.

The return on investment was calculated as:

$$ROI = NR / TC$$

The profit margin was calculated as:

$$PM = (NR / TR) \times 100$$

The gross margin, net return, return on investment and profit margin obtained from raw and processed products were

compared to determine the economic advantage associated with processing and other value-addition activities.

Results and Discussion

Major Value-Added *Parkia biglobosa*

Products Traded

Results in Table 1 shows that fermented locust bean, locally known as *iru* or *ogiri*, was the dominant product processed and traded by market actors, accounting for 80.8% of the respondents. Powdered locust bean constituted 7.5%, while dried locust bean, commonly referred to as *dawadawa*, accounted for 6.7%. Only 5.0% of the respondents were mainly involved in the sale of raw locust bean seeds. The predominance of fermented locust bean indicates that fermentation constitutes the most important form of value addition to *Parkia biglobosa* among market actors in Benin City. Raw locust bean seeds are hard, bitter and unsuitable for direct consumption; hence, they must undergo boiling, dehulling, washing and fermentation before they become acceptable as food condiments. Through fermentation, the seeds acquire the characteristic taste, aroma, texture and digestibility preferred by consumers. The process therefore transforms a relatively low-value raw material into a more useful and marketable product.

The high proportion of respondents dealing in fermented locust bean may also be associated with its widespread acceptance as a traditional seasoning in Nigerian dishes. Fermented locust bean is used in the preparation of soups, stews and sauces by households from different ethnic and cultural backgrounds. Benin City is a large urban market with consumers originating from various parts of Nigeria; consequently, the demand for

fermented locust bean is likely to be more stable than the demand for raw seeds or less familiar product forms. This demand provides an incentive for processors and traders to concentrate on *iru* and *ogiri*. The result aligns with Adejumo et al. (2013) findings that reported that the seeds of *Parkia biglobosa* are mainly valued because of their transformation into fermented condiments used as flavouring ingredients in West African foods. It is also consistent with Sodimu et al. (2020), who observed that fermented locust bean products remain culturally acceptable and economically important indigenous condiments in Nigeria. The dominance of fermented products therefore demonstrates that consumer acceptance and culinary traditions strongly influence the form in which *Parkia biglobosa* is processed and marketed.

The low proportion of respondents selling raw seeds suggests that limited value is obtained when the product is marketed without processing. Raw seeds require additional labour, time, fuel and knowledge before they can be consumed. Urban consumers may therefore prefer already fermented products because they reduce the inconvenience associated with household processing. The preference for processed products supports the observation of Ijigbade et al. (2021) that processing activities increase the utility, demand and economic value of locust bean products. Powdered locust bean accounted for only 7.5% of the products traded. Although powdered locust bean is convenient to use, easy to measure and

potentially suitable for modern packaging and formal retail outlets, its limited presence indicates that this product form has not been fully developed among market actors in the study area. Producing powdered locust bean requires additional drying, milling, hygienic handling and moisture-resistant packaging. These requirements may increase production costs and discourage small-scale processors who lack appropriate equipment and capital. Similarly, dried locust bean constituted only 6.7% of the products traded. Drying can extend shelf life and reduce deterioration, but its limited adoption may be connected with inadequate drying facilities, weather dependence, insufficient technical knowledge and consumers' preference for fresh fermented products. The low proportions of powdered and dried products reveal that opportunities for product diversification, shelf-life improvement and entry into higher-value markets remain largely underexploited. The findings further indicate that value addition within the *Parkia biglobosa* enterprise in Benin City is concentrated mainly at the traditional fermentation stage. More advanced forms of value addition, such as drying, milling, branding, labelling and improved packaging, were relatively uncommon. This pattern may limit access to supermarkets, restaurants, institutional buyers and distant markets where hygienic, standardised and conveniently packaged products are preferred.

Table 1: Major *Parkia biglobosa* products processed and traded

Product form	Freq.	%
Raw locust bean seeds	6	5
Fermented locust bean (<i>iru/ogiri</i>)	97	80.8
Powdered locust bean	9	7.5
Dried locust bean (<i>dawadawa</i>)	8	6.7

Costs of Value-Addition Activities and Profit Margins

Results in Table 2 shows that the total cost of handling one kilogram of raw *Parkia biglobosa* seeds was ₦863.85 (US\$0.64), while the total cost of producing and marketing one kilogram of processed locust bean was ₦2,736.82 (US\$2.03). The higher cost associated with the processed product reflects the additional activities required to convert raw seeds into fermented and market-ready forms. These activities included boiling, dehulling, washing, fermentation, drying, packaging, storage and transportation. The cost of raw seed purchase was ₦185.48 (US\$0.14) per kilogram for both product categories because raw seeds represented the basic input used by processors and traders. Transportation cost amounted to ₦251.85 (US\$0.19) per kilogram for both raw and processed products. This indicates that transportation constituted a substantial component of the cost incurred by market actors, particularly because much of the product traded in Benin City was sourced from local and interregional markets.

For raw products, transportation accounted for approximately 29.2% of the total cost, making it the largest identifiable cost component. Labour followed with ₦200.53 (US\$0.15) per kilogram, representing approximately 23.2% of the total cost. Market levies and storage costs amounted to ₦115.84 (US\$0.09) and ₦105.15 (US\$0.08) per kilogram, respectively. The cost structure shows that

even actors who sold raw seeds incurred significant expenses in moving, storing and marketing the product. The total variable cost associated with raw product marketing was ₦858.85 (US\$0.64) per kilogram. After accounting for depreciation of ₦5.00 (US\$0.004) on storage materials, the total cost increased slightly to ₦863.85 (US\$0.64). Total revenue from the sale of one kilogram of raw seeds was ₦1,650.64 (US\$1.22), resulting in a gross margin of ₦791.79 (US\$0.59) and a net return of ₦786.79 (US\$0.58) per kilogram. The positive net return indicates that selling raw locust bean seeds was profitable. The return on investment of 0.91 implies that every ₦1.00 (US\$0.0007) invested in raw seed trading generated approximately ₦0.91 (US\$0.0007) as net return. Similarly, the profit margin of 47.7% shows that almost half of the revenue obtained from raw seed sales remained as profit after the total costs had been deducted.

However, the cost structure of the processed product was considerably higher. Storage represented the largest single cost component at ₦869.58 (US\$0.64) per kilogram, accounting for approximately 31.8% of the total cost. This was followed by labour at ₦617.11 (US\$0.46) per kilogram, representing approximately 22.5% of total cost. The relatively high labour cost reflects the manual and labour-intensive nature of traditional locust bean processing, particularly the repeated boiling, dehulling, washing, fermentation and

drying operations. The processed product also incurred ₦251.77 (US\$0.19) per kilogram for firewood, kerosene or gas. Energy is indispensable in locust bean processing because the hard raw seeds require prolonged boiling before they can be dehulled and fermented. This finding supports Akinoso and Adedayo (2012), who observed that locust bean processing requires considerable energy, particularly during boiling and softening operations.

Packaging materials cost ₦160.48 (US\$0.12) per kilogram of processed product. Although packaging represented a relatively small proportion of the total cost, it was an important value-addition activity because it protected the product from contamination, facilitated handling and improved its presentation to consumers. The expenditure on packaging also distinguished processed products from raw seeds, which were generally sold without specialised packaging. Market levies amounted to ₦250.55 (US\$0.19) per kilogram, while transportation cost ₦251.85 (US\$0.19). These expenditures demonstrate that market actors incurred costs beyond the physical transformation of the seeds. Urban marketing charges, movement of products and access to selling spaces contributed substantially to the final cost of the processed product. The total variable cost of processed *Parkia biglobosa* was ₦2,586.82 (US\$1.92) per kilogram. After the inclusion of depreciation of ₦150.00 (US\$0.11) on processing and storage materials, the total cost amounted to ₦2,736.82 (US\$2.03). Despite this relatively high cost, processed products generated total revenue of ₦5,740.93 (US\$4.25) per kilogram, producing a gross margin of ₦3,154.11 (US\$2.34) and a net return of ₦3,004.11 (US\$2.23).

The return on investment for processed products was 1.10. This means that every ₦1.00 (US\$0.0007) invested in processing and marketing generated approximately ₦1.10 (US\$0.0008) as net return after recovering the investment. The estimated profit margin of 52.3% further indicates that more than half of the revenue obtained from processed locust bean remained as profit after accounting for the relevant costs. The findings demonstrate that value addition increased both the cost and the financial return associated with *Parkia biglobosa*. Although the cost of handling the processed product was approximately three times the cost of marketing raw seeds, its total revenue was more than three times that of the raw product. Consequently, the additional revenue generated through fermentation, packaging and other processing activities adequately compensated for the higher costs incurred. The profitability of the enterprise is consistent with the findings of Olapade-Ogunwale *et al.* (2011), who reported positive returns among locust bean processors and marketers in Osun State. It also agrees with Farayola *et al.* (2012), who established that locust bean processing was economically viable in Kwara State. More recent findings by Abdu-Raheem *et al.* (2023) and Abdulhamid *et al.* (2024) similarly showed that transforming raw locust bean seeds into processed products increased the income realised by market actors.

The substantial contribution of labour to processing costs confirms that the enterprise remains largely traditional and labour-intensive. Manual dehulling and repeated boiling require considerable time and human effort. This agrees with Akande *et al.* (2010), who identified dehulling and related operations as major

constraints in the locust bean processing industry. Access to appropriate processing equipment could therefore reduce labour requirements, shorten processing time and improve the net returns realised by processors. The relatively high storage cost for processed products may be connected with the perishable nature of fermented locust beans. Without adequate drying, ventilation and moisture-resistant packaging, the product may deteriorate rapidly. Market actors may therefore incur storage expenses while attempting to preserve product quality and prevent losses. Improved drying and packaging

technologies could reduce storage periods, minimise spoilage and improve overall profitability. The findings further reveal that transportation and market levies significantly affected both raw and processed product enterprises. Because most respondents obtained their products from markets rather than from their own farms, they depended on transport services to move raw materials and finished products. Rising transportation costs and multiple market charges can reduce the share of revenue retained by processors and traders.

Table 2: Cost and return analysis of raw and processed *Parkia biglobosa* products per kilogram

Cost and return item	Raw product (₦/kg; US\$/kg)	Processed product (₦/kg; US\$/kg)
Raw seed purchase	185.48 (0.14)	185.48 (0.14)
Transportation	251.85 (0.19)	251.85 (0.19)
Storage/rent	105.15 (0.08)	869.58 (0.64)
Labour	200.53 (0.15)	617.11 (0.46)
Firewood/kerosene/gas	–	251.77 (0.19)
Packaging materials	–	160.48 (0.12)
Market levies/tickets	115.84 (0.09)	250.55 (0.19)
Total variable cost	858.85 (0.64)	2,586.82 (1.92)
Depreciation on processing/storage materials	5.00 (0.004)	150.00 (0.11)
Total cost	863.85 (0.64)	2,736.82 (2.03)
Total revenue	1,650.64 (1.22)	5,740.93 (4.25)
Gross margin	791.79 (0.59)	3,154.11 (2.34)
Net return	786.79 (0.58)	3,004.11 (2.23)
Return on investment	0.91	1.1
Profit margin (%)	47.7	52.3

Comparative Profitability of Raw and Processed *Parkia biglobosa* Products

Evidence in Table 3 shows that the processed *Parkia biglobosa* product generated higher revenue and profit than the raw product. The total cost of handling one kilogram of raw seeds was ₦863.85 (US\$0.64), compared with ₦2,736.82

(US\$2.03) for the processed product. This represents an additional cost of ₦1,872.97 (US\$1.39) per kilogram for processing, packaging, storage, energy, labour and other value-adding activities. Although the processed product required a higher investment, it generated total revenue of ₦5,740.93 (US\$4.25) per kilogram,

compared with ₦1,650.64 (US\$1.22) from the raw product. Thus, processing increased revenue by ₦4,090.29 (US\$3.03) per kilogram. The increase in revenue was greater than the additional cost incurred, indicating that the transformation of raw locust bean seeds into fermented and market-ready products created substantial economic value.

The gross margin from the processed product was ₦3,154.11 (US\$2.34) per kilogram, while that of the raw product was ₦791.79 (US\$0.59). The difference of ₦2,362.32 (US\$1.75) shows that processors retained considerably more income after deducting variable costs than actors who sold raw seeds. Similarly, the net return from processed products was ₦3,004.11 (US\$2.23) per kilogram, compared with ₦786.79 (US\$0.58) from raw products. Processing therefore generated an additional net return of ₦2,217.32 (US\$1.64) per kilogram. The net return from processed products was approximately 3.8 times the return obtained from raw seeds. This indicates that the transformation of raw seeds through boiling, dehulling, fermentation, drying and packaging substantially increased the commercial value of the product. The higher net return reflects consumers' willingness to pay more for products that are ready for use, have improved taste and aroma, and require little or no additional household processing. The return on investment for raw seed trading was 0.91, meaning that every ₦1.00 (US\$0.0007) invested generated approximately ₦0.91 (US\$0.0007) as net return. In contrast, the processed product recorded a return on investment of 1.10, implying that every ₦1.00 (US\$0.0007) invested generated about ₦1.10 (US\$0.0008) as net return. Consequently, processed locust bean

provided a higher return per unit of capital invested than raw seeds.

The profit margin of the processed product was 52.3%, compared with 47.7% for the raw product. The difference of 4.6 percentage points further demonstrates the economic advantage of value addition. Although both enterprises were profitable, processed products were more efficient in converting sales revenue into profit. The greater profitability of processed *Parkia biglobosa* can be explained by the utility created during processing. Raw locust bean seeds are hard, bitter and unsuitable for immediate consumption. Processing transforms them into fermented condiments such as *iru*, *ogiri* or *dawadawa*, which are widely used in soups, sauces and stews. This transformation improves palatability, digestibility, convenience and consumer acceptance, thereby increasing demand and market price. The finding agrees with the value-chain principle that product transformation increases utility and market value. Each processing stage adds form, time or place utility to the product. Boiling and dehulling make the seeds edible, fermentation produces the desired flavour and aroma, drying extends shelf life, while packaging improves hygiene, handling and presentation. These improvements enable processors to charge higher prices than actors who sell the seeds in their raw form.

The result is consistent with Ijigbade *et al.* (2021), who observed that processing increased the economic value of locust bean products in Ondo State. It also agrees with Olapade-Ogunwole *et al.* (2011) and Farayola *et al.* (2012), who reported positive returns from locust bean processing and marketing in Osun and Kwara States, respectively. The finding further supports the conclusions of Abdu-

Raheem *et al.* (2023) and Abdulhamid *et al.* (2024) that value addition to locust bean products generated favourable returns for processors and marketers. Despite the higher profitability of processed products, their production required substantially more capital than raw seed trading. Market actors had to finance labour, fuel, storage, packaging materials, transportation and market levies before the processed product could be sold. This may restrict the participation of actors with limited working capital, especially women who dominate the enterprise and may have inadequate access to formal credit. The result also suggests that profitability could be further increased if the cost of value addition were

reduced. Labour-saving equipment for dehulling, boiling and milling could lower processing costs and reduce drudgery. Improved drying and storage facilities could minimise spoilage, while collective transportation and bulk purchase of raw materials could reduce logistics and input costs. Modern packaging and branding could also enable processors to access supermarkets, restaurants and other higher-value markets. Therefore, the findings establish that processed products were economically more profitable within the observed sample, but they do not constitute a statistical test of whether the difference was significant at a specified probability level.

Table 3: Comparative profitability of raw and processed *Parkia biglobosa* products per kilogram

Profitability indicator	Raw product	Processed product	Difference
Total cost (US\$/kg)	0.64	2.03	1.39
Total revenue (US\$/kg)	1.22	4.25	3.03
Gross margin (US\$/kg)	0.59	2.34	1.75
Net return (US\$/kg)	0.58	2.23	1.64
Return on investment	0.91	1.1	0.19
Profit margin (%)	47.7	52.3	4.6

Exchange rate: US\$1.00 = ₦1,349.54, based on the official exchange rate as of 19 August 2026.

Constraints Affecting Parkia biglobosa Value Addition and Profitability

Results in Table 4 shows that high market levies and taxes ranked as the most serious constraint, with a mean score of 3.51. This implies that the charges imposed on processors and traders substantially increased the cost of doing business and reduced the share of sales revenue retained as profit. Market actors commonly paid daily tickets, stall charges, loading fees and other informal levies before products could be sold. These charges were particularly burdensome because most actors operated on a small

scale and depended on relatively low volumes of daily sales. The effect of market levies was also reflected in the cost-and-return analysis, where processed products incurred ₦250.55 (US\$0.19) per kilogram as market levies. Such charges can reduce net returns, discourage business expansion and weaken the competitiveness of indigenous food products. The result suggests the need for market authorities to streamline levies and eliminate multiple or duplicative charges imposed on small-scale processors and traders.

Also, limited awareness of value-added products ranked second, with a mean score of 3.41. This indicates that many processors and traders had inadequate knowledge of opportunities beyond the traditional fermented product. Although powdered, dried, branded and ready-to-use locust bean products could attract higher-value consumers, only a small proportion of respondents participated in these product forms. Limited awareness may restrict innovation because market actors are less likely to adopt improved drying, grinding, packaging and branding techniques when they are unaware of their commercial benefits. It may also prevent them from identifying emerging markets such as supermarkets, restaurants, hotels and online retail outlets. Extension education, demonstrations and enterprise training are therefore necessary to expose processors to diversified product forms and improved value-addition practices. Inadequate transportation was another serious constraint, with a mean score of 3.22. Transportation is essential because most respondents obtained raw materials from local and interregional markets and moved finished products to points of sale. Poor transportation systems, high fares and unreliable vehicles can increase product costs and delay delivery.

Furthermore, transportation problems may be more damaging for fermented locust bean because the product is susceptible to deterioration when exposed to heat, moisture and unhygienic handling. The result supports the earlier finding that transportation constituted one of the major cost components in both raw and processed product enterprises. Reducing transport difficulties through cooperative haulage arrangements, improved road infrastructure and better product

containers could lower costs and reduce losses. Lack of storage facilities ranked fourth, with a mean score of 3.20. Fermented locust bean contains moisture and may deteriorate rapidly when stored under unsuitable conditions. Inadequate storage exposes products to mould growth, excessive fermentation, insects, contamination and unpleasant changes in aroma or texture. These losses reduce the quantity available for sale and may force traders to dispose of products at reduced prices.

The seriousness of storage constraints is consistent with the profitability analysis, in which storage represented the largest cost component for processed products. Improved drying, ventilated storage spaces, moisture-resistant containers and refrigeration where feasible could extend shelf life and reduce losses. Collective storage facilities established through market associations or cooperatives could also lower the cost borne by individual actors. High risks in processing and marketing recorded a mean score of 3.14 and was therefore regarded as a serious constraint. The risks faced by market actors include spoilage, inconsistent fermentation, contamination, sudden changes in consumer demand, product rejection and losses during transportation. Since processing remains largely traditional, differences in boiling duration, fermentation conditions and hygiene practices can produce inconsistent product quality. These risks can negatively affect consumer confidence and reduce profitability. Standardised processing procedures, improved hygiene, quality control and appropriate packaging would help reduce product failure and improve the reliability of processed locust bean products.

Poor access to ready markets also constituted a serious constraint, with a mean score of 3.11. Most respondents sold their products in traditional local markets, while only a small proportion supplied retail shops and wholesalers. Dependence on local markets can limit sales volumes and expose actors to intense competition and weak bargaining power. Restricted access to formal outlets may be linked to poor packaging, lack of labels, inconsistent product quality and absence of certification. Supermarkets and institutional buyers usually require products that are hygienically processed, properly packaged, standardised and traceable. Improving branding, labelling and quality assurance could therefore help market actors enter higher-value markets and obtain more stable prices. Inadequate processing facilities had a mean score of 2.16 and was classified as not serious. This result may appear inconsistent with the finding that processing was completely traditional. However, the low rating may indicate that respondents had adapted to the manual methods available to them and did not perceive the absence of modern facilities as an immediate obstacle. It may also reflect the fact that most respondents were traders rather than full-time processors.

Unstable product prices recorded a mean score of 1.80 and was similarly regarded as not serious. This suggests that prices may have been relatively predictable during the period of the survey, or that traders were able to adjust their selling prices in response to changes in input costs. Nevertheless, price instability may still become important during periods of scarcity, seasonal fluctuations or rising transport costs.

Insufficient capital or access to credit facilities had a mean score of 1.71. Although financial limitations are commonly reported among small-scale food processors, respondents in this study did not consider them among their most severe constraints. This may be because the enterprise can be operated gradually with small quantities of raw materials and informal working capital. Market actors may also depend on personal savings, rotating savings groups or supplier credit rather than formal loans. The high cost of processing equipment ranked last, with a mean score of 1.29. The low score may be associated with the dominance of manual processing techniques and the limited use of specialised machinery. Because respondents rarely used mechanised equipment, they may not have incurred direct equipment costs or fully appreciated the possible benefits of investing in improved technology.

The findings generally show that the most pressing problems were market- and infrastructure-related rather than strictly production-related. Market levies, limited awareness, transportation difficulties, inadequate storage, business risks and weak market access directly affected the ability of actors to preserve product quality, reduce costs and reach profitable outlets. The results are consistent with the observations in the manuscript that poor packaging, weak storage systems, inadequate transportation and limited technical knowledge reduce the efficiency and profitability of locust bean processing. They also support the view that market actors require more than processing skills; they need stronger market institutions, extension support, infrastructure and product-development knowledge.

Table 4: Constraints affecting *Parkia biglobosa* value addition and profitability

Constraint	Mean	Std. Dev.	Decision
High market levies and taxes	3.51	1.33	Serious
Limited awareness of value-added products	3.41	1.16	Serious
Inadequate transportation	3.22	0.99	Serious
Lack of storage facilities	3.2	0.94	Serious
High risks in processing and marketing	3.14	1.09	Serious
Poor access to ready markets	3.11	1.04	Serious
Inadequate processing facilities	2.16	1.32	Not serious
Unstable product prices	1.8	0.9	Not serious
Insufficient capital or credit facilities	1.71	0.93	Not serious
High cost of processing equipment	1.29	0.46	Not serious

Decision rule: Mean ≥ 3.00 = serious constraint; mean < 3.00 = not serious.

Conclusion

The study concluded that value addition to *Parkia biglobosa* is a profitable livelihood activity among market actors in Benin City, with fermented locust bean (*iru/ogiri*) representing the dominant product form. Although both raw and processed products generated positive returns, processed products were considerably more profitable, recording higher total revenue, gross margin, net return, return on investment and profit margin. Specifically, processed products yielded a net return of ₦3,004.11 (US\$2.23) per kilogram and a profit margin of 52.3%, compared with ₦786.79 (US\$0.58). and 47.7%, respectively, for raw seeds. This confirms that processing activities such as boiling, dehulling, fermentation, drying and packaging substantially increased the economic value of the product. However, the enterprise remained largely traditional and concentrated on fermented products, while potentially higher-value forms such as powdered and dried locust bean were poorly developed. The major constraints were high market levies, limited awareness of value-added products, inadequate transportation, poor storage facilities, processing and marketing risks, and weak access to ready markets.

Based on these findings, extension agencies, research institutions and relevant government bodies should provide practical training and demonstrations on improved processing, drying, hygiene, packaging, branding and product diversification to encourage the production of powdered, dried and ready-to-use locust bean products. Market associations and processors should be encouraged to form or strengthen cooperatives to facilitate collective transportation, bulk purchase of raw materials, shared storage facilities and coordinated marketing, thereby reducing costs and product losses. Local government and market authorities should harmonise and reduce multiple levies imposed on small-scale market actors, while investment should be made in suitable storage structures and improved transport infrastructure. Processors should also adopt moisture-resistant and properly labelled packaging to improve shelf life, product safety and access to supermarkets, restaurants, hotels and other high-value outlets. These measures would improve efficiency, strengthen market linkages and increase the income derived from the *Parkia biglobosa* value chain.

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