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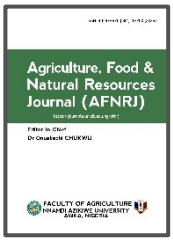

Original Article

Economic analysis of Tomapep production in Nigerian Stored Products Research Institute (NSPRI), Kano State, Nigeria

OPEN ACCESS

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ABSTRACT

This study investigated the economic analysis of Tomapep production at the Nigerian Stored Products Research Institute (NSPRI), Kano. The objective of this study is to conduct an economic analysis of Tomapep paste production at the Incubation Centre of the Nigerian Stored Products Research Institute (NSPRI) in Kano. Specifically, the study evaluates the financial returns and benefit-cost ratio (BCR) of Tomapep production. A hardcopy interview schedule was used to obtain the needed information for this experimental research. An experimental research design was adopted for this study. The data collected were analyzed using cost and returns analysis and benefit-cost ratio (BCR). The entire experiment was conducted within the duration of two days. The results show a BCR of 1.56, indicating that for every ₦1 invested in Tomapep production, a return of 56 kobo is generated. Furthermore, an economic return (profit) of ₦138,103.11 and a unit profit of ₦543.72 were achieved. The findings suggest that Tomapep processing at the Nigerian Stored Products Research Institute (NSPRI) Incubation Centre, Kano, is a profitable venture. It is recommended based on the findings of this study that the Nigerian Stored Products Research Institute (NSPRI) continue to prioritize training for farmers, processors, and other stakeholders in postharvest processing, particularly for tomatoes and bell peppers, since it was discovered from the findings that Tomapep production is profitable.

KEYWORDS: *Bell pepper, Incubation centre, Postharvest loss, Tomato paste*

INTRODUCTION

Globally, tomato (*Lycopersicon esculentum*) is recognized as the most widely cultivated and produced vegetable crop. Despite being a fruit in botanical terms, it is classified and treated as a vegetable within the context of agricultural production and trade statistics (FAO, 2022). According to data from the Food and Agriculture Organization of the United Nations (FAOSTAT, 2022), global tomato production reached approximately 186.1 million metric tonnes in 2022, making it the leading vegetable crop worldwide. The tomato plant is native to the Americas, specifically the Andes Mountains in South America. The Incas first domesticated it in present-day Peru and Chile (Smith, 2014). The tomato plant belongs to the Nightshade family (*Solanaceae*) and the genus *Solanum* (Spooner & Knap, 2013). Tomatoes thrive in well-drained, light-loam soil with a pH range of 5 to 7 (Food and Agriculture Organization [FAO], 2020[b]), and takes 90 to 150 days to

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produce fruit (Behzadian *et al.,* 2015), with 80 to 90 percent of the fruit comprising water (FAO, 2020[a]). In 2018, global tomato production reached 182.26 million tonnes, with China contributing the largest share at 33.81 percent (FAO, 2019). Data from Faostat (Francois-Xavier, 2022), stated the world produces 186.821 million metric tonnes of tomatoes on 5,051,983 hectares in 2020, achieving an average yield of 37.1 metric tonnes/hectare (MT/ha).

Nigeria emerged as the 12th largest producer globally and the second largest in Africa after Egypt, marking a growth trend in fresh tomato production (FAO, 2023). Tomato contains vitamins A, C, E, and K in its structure. It also contains minerals such as potassium and iron (Wang & Seymour, 2017). It has low calories and fat, as well as containing no cholesterol, and plays an important role in a healthy diet, and in the fight against many diseases such as cancer, osteoporosis, and coronary heart disease among others (Palozza *et al.,* 2012). In addition to its positive contributions to human health, tomato, which can be processed in various ways such as canned, paste, puree, ketchup, and pickles, is considered one of the products with high economic value due to its widespread consumption (Adenuga *et al.,* 2013).

As a result of the increasing population in Nigeria and the high demand for tomato products, the Federal Government of Nigeria has implemented a new policy for the tomato sector (Olanite, 2017; Edeh, 2017). The primary objective of this policy reform is to promote the domestic production of tomato products, particularly tomato paste, by attracting investments in the national tomato processing industries. This initiative aims to create more job opportunities and reduce the significant post-harvest losses in the tomato sub-sector, which are estimated to be around 45% in Nigeria (Ashinya *et al.,* 2021). The policy is anticipated to have positive effects in Kano State, one of the leading tomato producers in the country, accounting for approximately 7.5% (44,020 hectares) of Nigeria's total land area dedicated to tomato cultivation (Usman, 2019).

The bell pepper is a fruit from plants in the grossum group of the species Capsicum annuum. It is one of the most commonly grown vegetable crops globally (Hossein et al., 2024). This warm-season crop, notable for its glossy exterior in various colors, thrives in temperate regions. Since 2000, the global production and consumption of bell peppers have steadily increased. Asia produces over 70% of the world's supply, with China leading the production, followed by Mexico and Indonesia.

In Nigeria, bell pepper cultivation has surged as women increasingly take on economic responsibilities to meet their goals (Ogundele & Adeyemo, 2014). Many women entrepreneurs have transformed their innovative ideas into successful bell pepper production ventures, achieving self-sufficiency, job creation, and improved living standards. This improvement in living standards reflects their socio-economic priorities and the dedication and resilience they bring to bell pepper farming. Dhingra & Tenreyro (2020) note that diverse motivational factors have driven these women to effectively allocate, mobilize, and utilize resources to meet the demands of a changing environment.

This research aims to conduct a comprehensive cost analysis of tomato paste (Tomapep) production, specifically focusing on utilizing fresh tomatoes and fresh bell peppers in the production process.

Tomapep is a value-added tomato product produced from the processing of tomatoes and bell peppers in a ratio of 175kg and 75kg in a hygienic food processing center, contributing to the product's taste, color, and nutritional profile. According to Smith *et al.* (2019), tomatoes are a primary source of lycopene, an antioxidant associated with numerous health benefits. Similarly, bell peppers are rich in vitamins A and C, providing flavor and essential nutrients.

The broad objective of this study is to analyze the cost of Tomapep production in the incubation center of the Nigerian Stored Products Research Institute (NSPRI), Kano. To achieve the main objective, the study specifically seeks to: assess the raw material costs associated with Tomapep production; identify opportunities for cost optimization at NSPRI, Kano; analyze the production expenses involved in Tomapep production; and to determine the economic returns and benefit cost ratio of produced Tomapep. Empirical data formed the foundation for deriving the economic indicators used in estimating the profitability and economic feasibility of Tomapep production.

MATERIALS AND METHODS

Production of Tomapep

Three (3) baskets (192kg) of fresh tomatoes of UTC variety and three (3) bags (91kg) of fresh bell peppers were purchased from Yan Kaba Market, Kano. UTC tomato variety was used for this study because it has been found to outperform other varieties in terms of yield, disease resistance, quality, and its wide adaptability to different locations. Fresh tomatoes and bell peppers were sorted to eliminate damaged, diseased or unripe ones, ensuring that only those meeting quality standards for ripeness, colour and absence of defects were retained for processing.

Data collected were on the cost of fixed and variable inputs used in the production as well as an estimate of the product output in kilogram, price per unit output of processed Tomapep and the total revenue from the sales of Tomapep. Data on production costs used were estimates of rent, transportation, labour, water, detergent, charcoal, gas, stickers, petrol and bottles. Data on economic returns and benefit cost ratio were equally collected on the output of produced Tomapep. A hardcopy interviewed schedule was used to obtained the needed data in the cause of this experimental research.

The steps in the production of Tomapep carried out at Nigerian Stored Products Research Institute's Incubation Center

(NSPRI-IC), Kano, Kano State is given in the production flowchart below in figure 1. In the first day, fresh tomato and bell pepper were purchased after which it was sorted, washed (figure 1) and stored in an off-grid solar cooling system. All the other activities, as depicted on the flow-chart (figure 1) were carried out on the second day. That is, this experimental design was carried out within a period of two days.

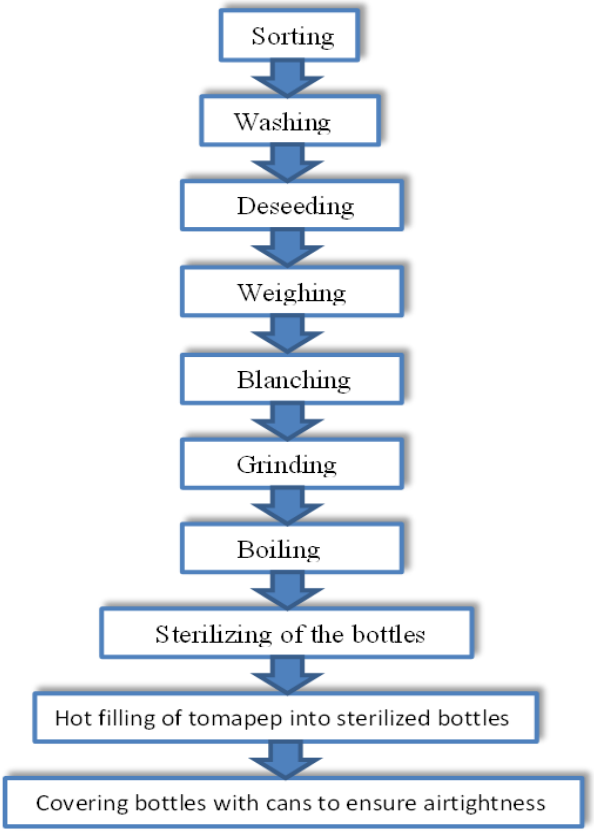

Figure 1: NSPRI Tomapep production flowchart

Sorting

Fresh tomatoes and bell peppers were sorted to eliminate damaged, diseased or unripe ones, ensuring that only those meeting quality standards for ripeness, colour and absence of defects were retained for processing.

Washing

The aim of washing is to eliminate dirt, pesticides and potential pathogens from the surface of the tomatoes and bell peppers. This was done by rinsing the sorted tomatoes and bell peppers under running potable water.

Slicing and deseeding

Slicing was done to prepare the bell peppers for even cooking and removal of bell pepper seeds. This process was carried out by slicing the sorted bell peppers into halves or quarters, depending on their size, to facilitate easy removal of the seeds and faster and more uniform heat penetration during blanching.

Weighing/scaling

The quantity of fresh tomatoes and bell pepper were weighed with the use of scale to ascertain accurate quantity of tomatoes and bell pepper used for the production of Tomapep.

Boiling/blanching

This process helps to soften the tomatoes and bell peppers and to make it easier for grinding and uniformity in the paste. During this stage, the sliced bell peppers and tomatoes are placed in a large pot and allowed to boil for about 30 minutes until the skins became soft for easy grinding or blending.

Cooling

The boiled tomatoes and bell peppers were transferred to a container allowed to cool for easy handling during grinding.

Grinding

This was to create a fine paste from the boiled tomatoes and bell peppers. After the boiled tomatoes and bell peppers were allowed to cool, the grinding was done using food grinder to achieve a smooth paste.

Steaming to reduce moisture

The purpose of steaming was to concentrate the tomato and bell pepper paste by reducing its moisture content. It was done by transferring the paste into a large, open steam pot; heat it for about 40 minutes to 1 hour depending on the initial water content and stirring it constantly to prevent scorching, until it thickens to the desired consistency.

Sterilizing bottles for packaging

To ensure the packaging is free from microorganisms before filling with the paste, the packaging bottles were sterilized in boiling water for about 30 minutes. After sterilization, the bottles were kept inverted on a clean and sanitized surface until they were filled with the paste.

Filling of paste in packing bottles

This was done while the paste was still hot; the sterilized bottles were filled using a funnel. This was done to securely package the concentrated paste in a way that prevents contamination and preserves its quality in 470ml sterilized bottles. The rim of each bottle was wiped to remove any spilled paste to ensure a clean surface for sealing. The bottles were sealed immediately after filling with a screw cap.

Cooling and storage

This was done to allow the filled and sealed bottles of Tomapep to cool down to room temperature gradually, reducing the risk of thermal shock and ensuring the integrity of the seal.

This was carried out by placing the sealed bottles in a cool, well-ventilated area away from direct sunlight. Once cooled, the bottles were labeled with production and expiry dates. The finished products were stored in a cool, dry place until distribution.

Quality control and hygiene

Throughout the production process, high standards of cleanliness and hygiene, to prevent contamination, were maintained. Regularly sanitizing all equipment, utensils and surfaces were done. It was also ensured that all personnel involved in the production process adhere to strict hygiene practices, including wearing of protective clothing, hand gloves, facemask and frequent washing of hands.

Cost and returns analysis

Net Benefit = Gross Revenue-Total Production Cost (1)

Where, Gross revenue = Quantity x Price;

Total Production Cost =Total Fixed Cost + Total Variable Cost

Benefit-cost ratio (BCR)

The Investment Decision Model also utilizes the Benefit-Cost Ratio, which is another indicator of the worthiness of an investment decision. It is given as the ratio of the sum of discounted benefits to the sum of discounted costs. Thus, for a cycle of 15 years duration, the benefit-cost ratio can be represented by the formula:

$$\mathbf{BCR} = \frac{\text{ECONOMIC RETURN}}{\text{TOTAL COST}} \quad (2)$$

Where: Economic Return = discounted revenue (benefits) per annum, Total Cost = discounted total costs per annum.

RESULT AND DISCUSSION

Table 1 outlines the quantity of fresh tomatoes and bell peppers utilized in the production of Tomapep. The exercise was carried out with the use of 7 plastic crates (175kg) of fresh tomatoes and 3 plastic crates (75kg) of fresh bell peppers which were realized from the original 3 baskets (192kg) of fresh tomatoes and 3 bags (91kg) of fresh bell peppers, after sorting and washing, as well as deseeding of bell peppers.

The table further shows that 1 plastic crate of fresh tomatoes cost ₦7,000 therefore, the total 7 plastic crates of the fresh tomatoes cost ₦49,000 and 1 crate of bell pepper cost ₦11,475.41 in which the total 3 crates of pepper cost ₦34,426.23. Therefore, a total amount of ₦83,426.23 was used in purchasing both fresh tomatoes and bell pepper for the production of 254 of 470ml bottles of Tomapep.

Table 1: Assessment of Raw Materials for Tomapep Production

S/N	Item	Before	During processing	Value
	TOMATO			
	Variety	UTC	UTC	
1.	Weight of 3 baskets of fresh tomatoes after purchasing	192 kg	Weight of 7 plastic crates of tomatoes after sorting and washing	175kg
2.	Market value of 1 plastic crate of tomato	₦7,000	Market value of 7 plastic crate of tomatoes	₦49,000
	BELL PEPPER			
	Variety	Bell Pepper	Bell Pepper	
3.	3 bags of bell pepper after purchasing	91.5kg	Weight of 3 plastic crate of pepper after sorting and slicing	75kg
4.	Market value of 1 plastic crate of bell pepper	₦11,475.41	The market value of 3 plastic crate of pepper	₦ 34,426.23

Source: Field survey, (2024).

Table 2 shows both the variable and fixed costs incurred in the production of Tomapep. The results in table 2 showed that the respondents incurred the bulk of the expenses on the variable inputs of bottles (₦72,390), fresh tomatoes (₦49,000), bell pepper (₦34,426.23), stickers (₦30,480), labour (₦24,000), gas (₦15,000), charcoal (₦7,500), petrol (₦2,000), water (₦800) and detergent (₦500). Therefore, this amount to a total variable cost of ₦238,096.23 for Tomapep production.

In this study, the only fixed cost component is the cost associated with rent of the incubation centre. Table 2 revealed that the total fixed cost incurred by renting NSPRI incubation centre for the production of Tomapep was ₦4,800. Finally, Table 2 showed the total costs, obtained by adding variable costs and fixed cost, incurred during Tomapep production was ₦242,896.23.

Table 2: Economic analysis of Tomapep Production

S/N	Variables	Items	Price (₦)
1.	Variable Costs (VC)		
		7 plastic crates of tomatoes (175kg)	49,000.00
		3 plastic crates of bell pepper (75kg)	34,426.23
		Labour	24,000.00
		Gas (12kg)	15,000.00
		Transportation	2,000.00
		Charcoal (1/2 bag)	7,500.00
		Petrol	2,000.00
		Bottles (470ml)	72,390.00
		Stickers (148 copies)	30,480.00
		Water	800.00
		Detergent	500.00
	Total Variable Cost (TVC)		238,096.23
2.	Fixed Cost (FC)		
		Rent per production	4,800.00
	Total Fixed Cost (TFC)		₦4,800.00
	Total Cost (TVC + TFC)		₦242,896.23

Source: Field survey, (2024)

Table 3 shows the results for the evaluation of the fresh tomatoes and bell peppers used before and after processing in Tomapep production. The table revealed that before processing, 7 plastic crates (175kg) of fresh tomatoes and 3 plastic crates (75kg) of bell peppers with each plastic crate weighing 25kg for both fresh tomatoes and bell peppers were used for Tomapep production. The table further showed that 254 jars or bottles (470ml/Jar) of Tomapep were gotten after processing fresh tomatoes and bell peppers. To convert 470ml to kg, 0.605kg is gotten per bottle which implies that 153.67kg of Tomapep is gotten from 119,380ml of Tomapep.

Table 3: Quantities of Raw Materials Before and After Tomapep Production

S/N	Before processing	After processing
Tomapep	7 Plastic crates of fresh tomatoes (175Kg) and 3 plastic crates (75kg) of fresh bell pepper.	254 jars (470ml) of Tomapep = 0.605kg 254 jars = 153.67kg.

Source: Field survey, 2024.

Economic and cost benefit returns of Tomapep

Selling price/jar = 1,500 (470ml) = 1,500 X 254 = ₦381,000

Unit production cost/jar = TC/NJ = 242,896.23/254 = ₦956.28.

Profit = (Price – Unit cost) x Quantity

= (1,500 – 956.28) x 254

= 543.72 x 254

=₦138,104.88 (Economic returns).

BCR= $\frac{138,104.88}{242,896.23}$ = ₦0.5686.

OR

BCR= $\frac{\text{Total Revenue}}{\text{Total cost}}$

BCR= $\frac{381,000.00}{242,896.23}$ = ₦1.5686.

The result of Tomapep production showed that total revenue accrued from proceeds of sales of 254 bottles or jars of Tomapep was estimated at ₦381,000 and total cost of production was estimated at ₦242,896.23 with a gross profit margin (Economic Returns) estimated at ₦138,104.88 within the period of the study. The total cost of production consists of the costs of fresh tomatoes, bell pepper, water, petrol, bottles, stickers, detergent, rent, gas, transportation, charcoal and labour. The gross profit margin or the economic returns represents the difference between the total revenue (gross returns) and the total cost. The result reveals that Tomapep producers earned an economic return of ₦138,104.88 from 254 bottles of Tomapep, implying that Tomapep production is profitable in Nigerian Stored Products Research Institute (NSPRI) Kano, Kano State. The difference between the total revenue and the total cost is the profit which, was found to be ₦138,104.88; meaning ₦543.72 is gotten as profit per bottle of Tomapep produced, implying that for every ₦1 invested in Tomapep production, ₦0.5686 is realized as a profit.

Discussion

This study has a commonality of findings with the report of a number of works that looked at the economic aspect of tomato marketing. In a study that looked at the market concentration and efficiency's determinants of tomato production in Oyo State, Nigeria by Akinbola *et al*. (2024) reported that the total revenue generated from tomato production amounted to ₦137,675.00, with a return on investment (ROI) of ₦1.71k. In a similar vein, Sanusi and Dada (2016) in their analysis of Tomato marketing reported an average net profit of ₦16,300/basket/month and ₦11,550/basket/month for tomato marketers in Olodo and Kila, respectively. They also discovered that every naira invested in tomato marketing generated returns of 35 kobo and 21 kobo in Olodo and Kila, respectively.

In their work, Olugbire *et al*. (2020) showed that wholesalers, retailers, wholesaler/retailer recorded an average gross margin of ₦38,800, ₦51,000 and ₦40,995.5, respectively. Furthermore, the computed profitability ratio indicates that wholesalers, retailers and wholesalers/retailer gained ₦ 27.50, ₦18.30 and ₦158.00, respectively for every ₦ 100 invested in fresh tomato marketing in Oyo state. In a very recent study that assessed the economic performance of the tomato value chain in Southwest, Nigeria, Agbede *et al*. (2023) reported ROI of 0.54, 0.94, 0.44 and 0.49 for producers, input suppliers, marketers and processors, respectively. In addition, net profit of

₦170,552.00, ₦197,568.00, ₦42,563.00 and ₦1,009,372.00 was recorded for producers, input suppliers, marketers and processors, respectively.

Furthermore, the results of this study resonate with the research of Olapade-Ogunwole *et al*. (2022) and Olugbire *et al*. (2020) who also reported that tomato farming and development of tomato-based products are profitable enterprises with a Benefit-Cost Ratio (BCR) greater than one in their various studies.

CONCLUSION AND RECOMMENDATIONS

The domestic demand and consumption of tomatoes and bell pepper in Nigeria is growing due to population growth, among other factors. In order to feed a teeming population, meet the requirements of the processing industry and address the demand of the export trade, merely increasing the production and productivity of tomato and bell pepper is insufficient. Greater emphasis must be given to postharvest management to maintain quality and help producers deal with seasonal glut. Tomapep paste production offers a highly effective and practical means of preservation to reduce postharvest losses and offset the shortages in supply. Surplus production may be preserved by conversion into paste, which allows for handling, transport and storage of the products for sale outside the community where they are grown or for local usage until the next crop can be grown and harvested.

This study has established that Tomapep paste production in the Incubation Centre of Nigerian Stored Products Research Institute (NSPRI), Kano is a profitable venture. We recommend that NSPRI should continue to give priority to training of farmers and other interested parties in post-harvest processing of fruits and vegetables, particularly tomato and Bell pepper, so as to fully actualize the purpose for which the incubation center was established; curtail the menace of post-harvest loss and improve the welfare of farmers and processors.

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Authors' Contributions

Authors DOS, IMA & DO designed the study, wrote the first draft of the manuscript while MBL, OLB, AAS and NNI managed the literature searches and supervision. DOS, IMA, MK & DO developed the methodology performed the analysis and interpretation. IMA review & edit the final copy. All authors read and approved the final manuscript.

Ethical Statement

Not Applicable

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