

## **NUTMEG SPICE WASTE PROCESSING: TECHNOLOGY AND COST ANALYSIS**

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### **Abstract**

This study investigated the economic feasibility of converting nutmeg waste into chips. The economic evaluation parameters used in our research, such as gross profit margin (GPM), internal rate of return (IRR), payback period (PBP), cumulative net present value (CNPV), break-even capacity (BEC), and return on investment (ROI). The process analysis is the experience of home industries. Economic analysis found GPM is 912.4 USD, ROI is 148%, PBP period is 8.12 months, CNPV is 2,498 USD, and the IRR is 147%. Our analysis concluded that the nutmeg chips business viable and highly profitable. The technical difference between the processing of nutmeg candies or chips proposed in this study lies only in using a dehydrator. Using a dehydrator increases equipment and utility costs but improves product quality. The use of simple technology in processing enabled women to participate in small-scale home industries. The type of technology, low capital investment, business profits, and the nature of the work created opportunities for economic growth, instilling confidence in the potential of this business.

Keywords: Economic evaluation, Home industry, Nutmeg chips, Nutmeg waste, Women empowerment.

### 1. Introduction

Indonesia and India are the leading global producers of nutmeg [1]. The main products derived from nutmeg are nutmeg seeds and nutmeg oil. However, the fruit's flesh, a by-product of nutmeg seed processing, cannot be used as a raw material for nutmeg oil due to differences in the fruit harvesting period needed to achieve optimal yield [2]. Instead, nutmeg rind waste has been utilized to produce candied or nutmeg chips [3, 4]. Utilizing nutmeg seed waste to create chips can help empower women through small home-based businesses and provide opportunities for nutmeg peel workers [3, 5]. Nutmeg chips have the potential to become a local culinary attraction, boosting culinary tourism [6, 7]. Previous research has mainly focused on the technical aspects of producing nutmeg chips [8]. This study delves into the economic feasibility of processing nutmeg waste into chips to empower women [9-13]. We were involved in analysing the gross profit margin (GPM), internal rate of return (IRR), payback period (PBP), cumulative net present value (CNPV), break-even capacity (BEC), and return on investment (ROI) [14, 15]. Previous studies have examined the processing of nutmeg waste [3, 4], but few have evaluated its economic aspects.

### 2. Theoretical Production of Chips from Nutmeg Spice Waste

Figure 1 illustrates the production process of nutmeg chips from nutmeg waste. The process involves 19 simple steps.

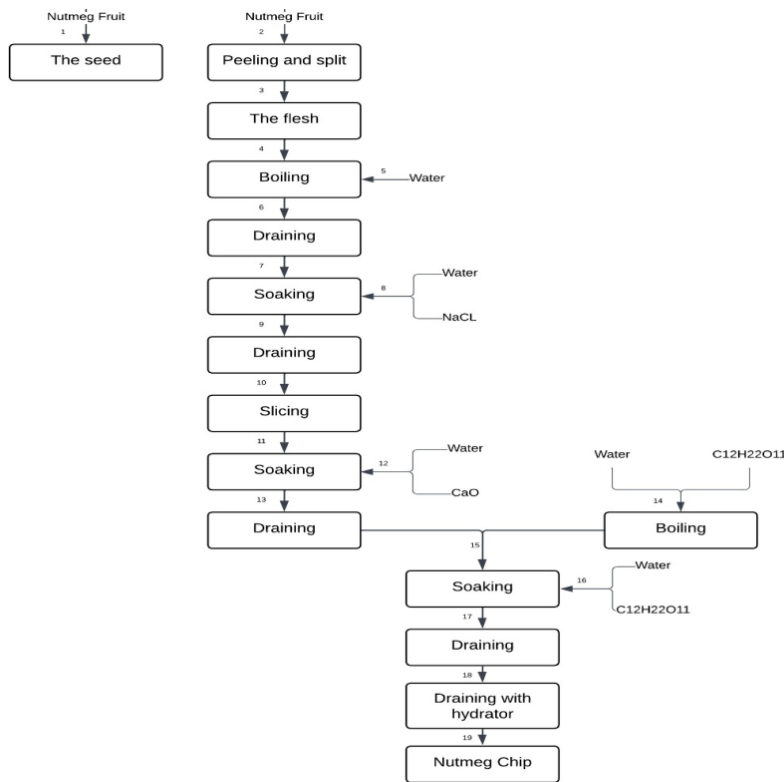


Fig. 1. Nutmeg chips production.

The required material for this process is nutmeg rind, and the basic solution consists of NaCl, CaO, C<sub>12</sub>H<sub>22</sub>O<sub>11</sub> (sugar), and water. This processing method changes the production methods for candied nutmeg and nutmeg chips. The processes of splitting the fruit, peeling, extracting the seeds, and slicing the fruit flesh are done using simple kitchen knives. The soaking, draining, and boiling processes require essential equipment such as plastic buckets, bamboo strainers, pots, and stoves. The entire process can be carried out using simple home industry technology, with modern technology only used during the draining stage with a dehydrator (step 18), ensuring the accessibility of the process [16].

### **3. Method**

We derived our price data from the average prices of materials on online shopping websites to ensure the accuracy of our cost calculations. The economic evaluation parameters used in our research are CNPV, GPM, PBP, BEC, IRR, and ROI. The process analysis used the experience of home industries rather than technical tests. This approach may lead to efficient and effective processing methods [17]. The analysis of women's empowerment estimates business development opportunities using the technical feasibility of the home business, incurred costs, opportunities for involving female workers, and the results of the economic analysis [18, 19]. Detailed information for the calculation is explained elsewhere [14, 15].

## **4. Results and Discussion**

### **4.1. Economic analysis**

Several assumptions were made to predict possibilities during the processing to ensure economic analysis. The assumptions are: (i) The value of one dollar in IDR, as per the Indonesia Bank rate for July 2024, is 16,000 IDR. (ii) The simulation of nutmeg chip production used 140 kg of nutmeg flesh. Material prices are prices in commercial online shops.

The price of nutmeg is 0.3 USD/kg, C<sub>12</sub>H<sub>22</sub>O<sub>11</sub> is 1.125 USD/kg, NaCl is 0.625 USD/kg, and CaO is 0.625 USD/kg. Water follows the PAMJAYA Jakarta water price for home businesses at 0.466 USD/m<sup>3</sup>, and LPG costs 2 USD/13 kg. (ii) As freelance peelers provide the equipment cost excludes peeling and slicing tools. The electricity cost for optimal dehydration is 7 hours at 70 °C [20]. The gas cost for boiling water is two 13 kg tubes per production cycle. The estimated manufacturing cost did not include land costs. Candied nutmeg producers buy nutmeg fruit from the farmers. (iv) The processing takes three days. A year is assumed to have 300 days (excluding holidays), allowing for 100 yearly production cycles. (v) Workers are divided into ten freelance female neighbours and two permanent workers. The total cost for freelance workers is 8.75 USD per production cycle. (vi) Depreciation was estimated using direct calculation, and the discounted rate is 15% annually [15]. (vii) Suppose a company qualifies as a micro or small individual entrepreneur. In that case, it pays a 0.5% corporate income tax for the first seven years (Government Regulation of the Republic of Indonesia No. 55 of 2022).

Table 1 shows equipment cost and process condition. Table 2 shows the raw material cost for 140 kg of nutmeg rind processing. The estimated shrinkage of nutmeg during peeling using entrepreneurial experience is 20%. The shrinkage of

the fruit due to drying is about 40% [21]. Therefore, the total production in one cycle process is 67 kg. The total production in one year (100 process cycles) is 6,700 kg. The price of nutmeg chips online is 4 USD/kg.

**Table 1. Equipment cost and process condition.**

No	Equipment	Price (USD)	Electricity (W)	Temperature (°C)	Process time (h)
1	Plastic Kimble 120 L	15	0		71.5
2	Pan 150 L	187.5	0		1.5
3	Bamboo strainer three units	5.625	0		4
4	Gas Stove Rinnai R1202S	37.5	0		2
5	WIRASTAR Food Dehydrator 30 tray FDH-20	312.5	1400	70	7
<b>Total Purchase Equipment</b>		<b>558.13</b>			

**Table 2. Raw material cost.**

No	Raw materials	Micro production scale	Unit	Price (USD)	Total
1	Nutmeg fruits	140	kg	0.32	44.8
2	Water	1	m <sup>3</sup>	0.47	0.47
3	LPG	2	3 kg	2	4
4	C <sub>12</sub> H <sub>22</sub> O <sub>11</sub>	70	kg	1	70
5	NaCl	1.4	kg	0.4	0.56
6	CaO	2.1	kg	0.5	1.05
				Price/Cycle	120.88
				Price/Year	1208.8

GPM is 912.4 USD, and ROI is 148%. The ROI value is calculated by dividing the earnings after tax by the fixed capital investment. The PBP period is 8.12 months, and the BEC per kg is 4,535 kg. Considering fixed costs, after-tax income for seven years before the MSME tax increase, and equipment replacement comparing the discounted rate of 15% annually, the CNPV is 2,498 USD, and the IRR is 147%. The lowest NPV only occurs in the first year but is still profitable (first-year net present value minus total capital investment). The nutmeg chips business is considered very profitable.

#### 4.2. Engineering perspective

The technical difference between the processing of nutmeg candies or chips proposed in this study lies only in using a dehydrator. The use of a dehydrator increases equipment costs and utility costs. However, it ensures a more extended production period compared to relying on sun drying and reduces the risk of processing failures due to incomplete drying [21]. Drying using a dehydrator is recommended to enhance process efficiency, maintain fruit quality, and preserve the fruit's flavour [22, 23]. The dehydrator drying can reduce sugar and oil purchase

costs [4, 8]. Operating a dehydrator does not require special skills. Thus, women can operate it in home-based industries [17]. A potential drawback is the ability of women in home-based industries to maintain product hygiene before and after the drying process. The product may be more prone to spoilage and have a shorter shelf life [24]. A dehydrator's lifespan is five years [17]. Economic analysis of nutmeg chip production shows that the equipment cost can be recovered within the first year of operation, indicating that the dehydrator's lifespan does not affect the business's profit projections.

### 4.3. Women's empowerment perspective

The nutmeg chips business is economically profitable. Women can achieve economic empowerment through job opportunities at home and by running micro-home businesses [25, 26]. For women's economic empowerment, it is essential to have a supportive social environment and access to various business opportunities [27]. However, women's labour participation is reduced due to household work burdens [28]. Home-based work is a familiar economic activity for women [25]. The development of female micro-entrepreneurs who employ women has a dual impact on women's empowerment [26].

The nutmeg chip business involves at least one woman as an entrepreneur and ten home-based female workers. One entrepreneur's success encourages other potential entrepreneurs' interest [19]. The business development model into a community enterprise can be implemented through self-help groups that have the potential to grow through business development [29]. Women who have already acquired the skills to process nutmeg chips can teach these skills to other women. Large-scale development requires policy support and promotion from the government to establish nutmeg chips as a local culinary tourism product [30, 31].

### 4.4. Impact on science and technology

The present studies gave impacts two benefits: (i) information on the way to produce nutmeg chips, in which this study has become one of the attractive research recently shown in Fig. 2. Detailed information for getting this data is explained elsewhere [32-34]; and (ii) ideas in the techno-economic evaluation, as reported elsewhere [35, 36].

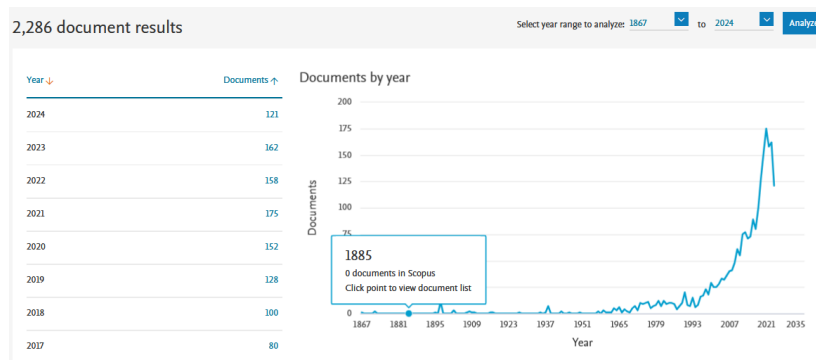


Fig. 2. Previous studies on nutmeg in the Scopus database taken on Sept 2024.

## 5. Conclusion

The nutmeg chips business is economically viable. An analysis of the costs and economic parameters shows positive values. With simple technology, small capital, and waste as the primary raw material, women can run this business profitably in home industries. Female workers, such as nutmeg peelers and slicers, can be involved in their respective homes. The potential profits in the first year can attract other women to start their businesses and create more job opportunities for women. The nutmeg chips business can be proposed as a solution to nutmeg waste management and a means of women's empowerment.

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