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Technology Review of Nutmeg *(Myristica fragrans)* Processing: Jam Production from Nutmeg Flesh

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ABSTRACT

Nutmeg *(Myristica fragrans)* is one of Indonesia's spice commodities with significant development potential derived from its flesh, which contains bioactive compounds, pectin, and organic acids that make it suitable for value-added products such as jam. This review systematically examines the process of converting nutmeg flesh into jam and comparatively analyzes the key factors affecting the final product quality. The synthesis of the findings indicates that the jam-making process involves critical stages, including blanching, smoothing, addition of sugar and additives, and cooking until a gel consistency is achieved. An in-depth analysis confirms that blanching is an essential pre-treatment for enzyme inactivation, color stability, and aroma enhancement. Furthermore, texture and gel stability are critically determined by the optimal balance between pectin, sugar, and acid content (pH), with a pH of 3–4 identified as the crucial point for robust gel formation. Nutmeg flesh jam products thus present significant potential for functional food diversification and economic value enhancement.

INTRODUCTION

Indonesia is an agrarian country with exceptionally high biodiversity, including a wide variety of spices and fruits with significant economic value. One of these prominent commodities is nutmeg *(Myristica fragrans),* which has long been recognized as a major export spice and is native to the Banda Islands in Maluku, historically renowned as the "Spice Islands" (Ha et al., 2020; Rosniyati et al., 2021). Traditionally, the utilization of nutmeg has focused primarily on the seed and mace as culinary spices and raw materials for the food, pharmaceutical, and cosmetic industries. In contrast, the fruit flesh (pericarp), which constitutes the largest portion of the fruit mass (approximately 80–85%), is often considered a low-value by-product and is frequently discarded as agricultural waste, despite its considerable nutritional potential (Rosniyati et al., 2021; Karseno & Setyawati, 2019). Previous studies have reported that nutmeg flesh contains substantial amounts of pectin, carbohydrates, dietary fiber, vitamins, particularly vitamin C, and minerals that are relevant for developing fruit-based processed products (Harlianti et al., 2025; Karseno & Setyawati, 2019). One promising approach to enhance the utilization of nutmeg flesh is the development of jam products.

Jam is defined as a product processed to a specific consistency from whole fruit, fruit pieces, pulp, or purée combined with sweetening agents until it reaches the required soluble solid content and quality characteristics (Codex Alimentarius Commission, 2009). Generally, jam is a gel system with high sugar content (≥65% soluble solids), where interactions between sugar, pectin, and organic acids form a thick or semi-solid texture while simultaneously functioning as a preservative by lowering water activity and inhibiting microbial growth (Winarno, 2008). This principle makes jam an effective method to extend the shelf life of perishable tropical fruits. Processing nutmeg into jam is expected to increase its value addition, extend shelf life, and broaden the diversification of nutmeg-based products in the market, thereby offering consumers more product choices (Bulan, 2017).

Innovation in developing jam from nutmeg flesh also aligns with efforts to promote functional food products. The presence of antioxidants, vitamins such as vitamins A and C, and various bioactive compounds including antibacterial, antifungal, and anti-inflammatory agents offers potential health benefits to consumers (Aulia & Suseno, 2020; Suloi & Suloi, 2021; Harlianti et al., 2025; Karseno & Setyawati, 2019). Therefore, producing nutmeg-flesh jam is not only a means of utilizing abundant agricultural resources and processing agricultural by-products but also represents an innovation that supports food security, empowers farmers, and contributes to local economic development (BPOM, 2019). Based on this background, this article discusses the concepts, processes, and analytical considerations involved in the production of nutmeg jam, with the aim of providing insight into the importance of optimizing and sustainably utilizing local resources.

RESEARCH METHODS

The method utilized in this article is a literature review. The literature search was systematically performed using the Google Scholar database. The keywords employed for the search included "nutmeg processing technology" and "nutmeg flesh processing technology". To ensure the validity and specific relevance of the data, rigorous inclusion and exclusion criteria were applied. Inclusion criteria required articles to specifically discuss the processing and utilization of nutmeg flesh *(Myristica fragrans)* into food products such as jam, to contain data on quality parameters, and to be available in full-text format. Conversely, articles that solely focused on the processing of nutmeg seeds or mace, were available only as abstracts, or were deemed duplicates were excluded from the analysis.

The initial search yielded an estimated 12 articles. Following a rigorous screening process based on the established criteria, a final selection of 7 primary articles was chosen for this review. The data extracted from the selected literature were compiled and analyzed using a descriptive qualitative method to systematically summarize the processing stages and key factors influencing the final quality parameters of nutmeg jam.

RESULTS AND DISCUSSION

The production of nutmeg jam using nutmeg flesh, based on the review findings, is carried out in several stages (Figure 1). The first stage is peeling the nutmeg skin, separating the skin, seeds, and nutmeg flesh, then soaking the nutmeg flesh in a salt solution and washing it using clean running water, followed by blanching at 80–90 °C for 15 minutes. After that, the nutmeg flesh is cooled and then blended while adding water in a ratio of 1:2 (w/v) until nutmeg pulp is obtained. The nutmeg pulp is put into a pan, and then sugar, pandan leaves, food coloring, and preservatives are added before cooking. Cooking is carried out with continuous stirring until the mixture develops the thick texture typical of jam. After thickening, the nutmeg flesh jam is ready to be served.

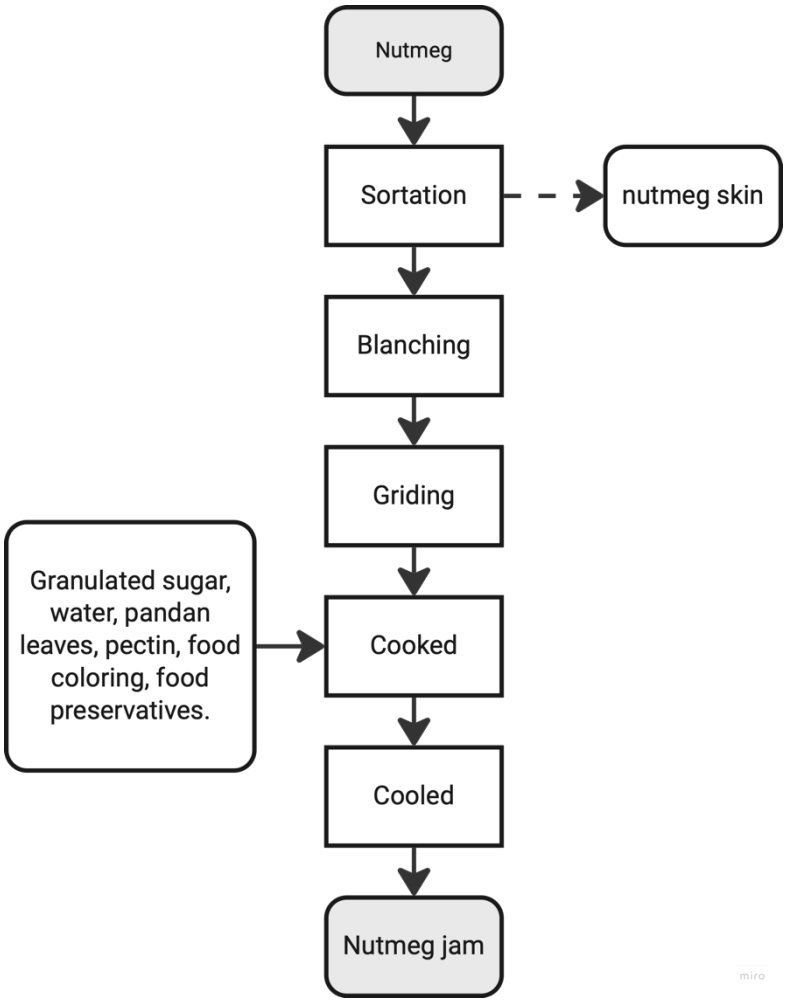

Figure 1. Flowchart of the process of making nutmeg flesh jam (Sembiring et al., 2023)

The processing stages of nutmeg flesh into jam generally include preliminary treatment, the addition of formulated ingredients, and cooking. Nevertheless, the synthesis of results from various studies indicates that there are specific variations in treatment that affect the characteristics of the final product. Table 1 below presents a comprehensive comparison of the main treatments in nutmeg jam processing methods from several selected references.

Table 1. Comparison of Processing Methods

Author/Year	Pre-cooking treatment	Key Additional Materials	Analyzed Quality Parameters	Results
Arief, A. W., et al. (2015)	Soaking in Sodium Bisulfite solution for 20 minutes	Sodium bisulfite, sodium benzoate, agar-agar	Color, aroma, and taste	Average score is 3.3 out of 3 parameters
Karseno, K., & Setyawati, R. (2013)	Blanching for 15 minutes and cooking at 105-110°C	Coconut sugar, pineapple, citric acid 50%	Water content, pectin content, color, aroma, spreadability, preference.	A 25:75 ratio of sugar to coconut sugar results in a spreadable jam with a "like" rating of 3.33. The pineapple masks the bitterness

Author/Year	Pre-cooking treatment	Key Additional Materials	Analyzed Quality Parameters	Results
				and adds a pleasant flavor.
Martati et al. (2023)	Soaking in 0.5% salt for 15 minutes	CMC 0.5%, food coloring	Color, aroma, texture, taste	CMC has an effect on texture.

While processing methods vary across studies, the success of nutmeg jam formation fundamentally depends on controlling key quality-determining factors. These factors, which include the use of blanching in pre-treatment and the proper balance of sugar, pectin, and acid (pH), are crucial for achieving the desired color, flavor, texture, and spreadability. The synthesized effects of these critical components, derived from the comparative literature review, are summarized in Table 2.

Table 2. Key Quality Factors for Jam

Key Factors	Effect on Jam Quality	Quality Achieved	Key Literature Sources
Blanching	Inactivates the enzymes catalase and peroxidase, reduces the astringency caused by tannins and improves the aroma.	Color is widely preferred. It also affects the aroma, because the aroma increases and the texture becomes softer.	Sembiring, B., et al. (2023) & Kusumawati, R. P. (2008).
Sugar	Produces an easy-to-spread jam and a flavor that helps mask the bitterness of the nutmeg flesh.	The jam has a spreadability score of 2.63–3.33 (easy to spread) due to the use of sugar and coconut sugar, and it also masks the bitter taste of nutmeg.	Karseno K., & Setyawati R. (2013)
Pectin	Affects spreadability and texture	Adding 1%-1.5% pectin produces an ideal jam texture.	Sembiring, B., et al. (2023) & Mutia, A., Khairun & R. Yunus (2016)
pH	Helps release pectin from fruit cells, affecting sourness	The optimal pH for jam formation is 3–4.	Sembiring, B., et al. (2023)

The quality parameters assessed by the researchers Sembiring et al. (2023) were color, aroma, taste, texture, and spreadability. The color parameter of this jam is related to the nutmeg jam production process. During blanching, this heat treatment affects the color because heating causes color degradation. In the process of soaking in hot water, the polyphenolase enzyme is inactivated, which will inhibit the browning reaction (dark brown melanin pigment).

The aroma parameter, the blanching process brings out the distinctive aroma of nutmeg flesh and makes it more pronounced, especially when sugar is added during the cooking process, which enhances the aroma. The higher the sugar concentration in the nutmeg flesh jam, the more pronounced its aroma becomes (Okukpe et al., 2012). The increase in aroma intensity at high sugar concentrations is associated with the Maillard reaction between reducing sugars and amino acids, which produces volatile compounds that enhance the nutmeg aroma. For the taste parameter, temperature during the blanching (boiling) process plays a significant role. At temperatures of 80–90 °C, the sour taste in the jam can decrease. Adding sugar to the jam also enhances the flavor because generally, jam has an optimal sugar content of around 55-65%. Nutmeg fruit flesh contains tannins that give

a bitter taste on the tongue; this sweetener also serves to improve the taste and aroma of the jam. The texture of nutmeg jam will be soft if blanching is carried out. Steaming (blanching) cashew apples before processing them into porridge can produce a softer jam texture compared to processing without blanching (Sembiring and Aditya, 2017). Cashew nut fruit flesh contains approximately 7.36% pectin, 0.76% protein, and 1.8% fat. Cashew nuts contain approximately 2-3% acid.

Pectin is a water-soluble polysaccharide compound that can form a gel in jam products, and acids also contribute to gel formation. According to Arsyad and Abay (2020), the hardness of the gel in jam depends on the concentration of sugar, pectin, and acid content in the fruit pulp. Fajarwati et al. (2017) reported that pectin dissolves in water during blanching by boiling and binds with water, so that the pectin content in the material is reduced. Therefore, when processed into a product by boiling in water, only a small amount evaporates, resulting in a soft product texture. The optimal pectin concentration for jam production is 1-1.5%.

Nutmeg jam is influenced by sugar concentration, thickener, and pH. Spreadability is one of the physical tests to measure consistency, texture, and evenness when spread on bread (Dewi et al., 2010). Good-quality jam has a high consistency and a smooth texture, which is indicated by high spreadability. Texture is related to spreadability. The smoother the texture of the spread, the less spread is needed to evenly coat the surface of the bread. The boiling process also has an effect, although not significantly, due to the weakening of the pectin-rich middle cell wall structure, causing the fruit cells to separate from each other and resulting in a soft texture.

CONCLUSION

The review confirms the strong potential of nutmeg flesh *(Myristica fragrans)* for value-added jam production. Product quality is critically dependent on two key synthesized factors: (1) blanching, which is essential for enzyme inactivation, color stability, and aroma enhancement, and (2) an optimal balance of sugar, pectin, and acid (pH 3–4). Future research should prioritize standardizing these critical formulation parameters for industrial-scale development.

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