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Identification of Potential Processed Products from Coconut Water for MSME Development in Indonesia

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ABSTRACT: Coconut products, especially coconut water, have the potential to be carried out on a household or MSME scale. The purpose of this study is to identify processed products from coconut water that have the potential to be developed on an MSME scale in Indonesia. The study is conducted in 2 stages. The first stage is the identification of processed products from coconut water. The second stage is selecting potential products. The selection of potential products is done by applying the Bayes method through interviews with nine experts. The selection criteria were market potential, business capital, technology, human resources, and availability of raw materials. The results show that the top 3 products were nata de coco, coconut vinegar, and packaged coconut water. This study is expected to be useful to related stakeholders, such as MSMEs, local governments, and universities, in developing downstream coconut water products.

Keywords: Coconut Water, MSMEs, Bayes Method

ABSTRAK: *Pengolahan produk kelapa khususnya air kelapa berpotensi dilakukan pada skala rumah tangga atau UMKM. Tujuan dari penelitian ini adalah mengidentifikasi produk olahan dari air kelapa yang potensial dikembangkan pada skala UMKM di Indonesia. Penelitian dilakukan melalui 2 tahap. Tahap pertama yaitu identifikasi produk olahan dari air kelapa. Tahap kedua yaitu pemilihan produk potensial. Pemilihan produk potensial dilakukan dengan penerapan metode Bayes melalui wawancara dengan 9 pakar. Kriteria pemilihan adalah potensi pasar, modal, teknologi, sumber daya manusia, dan ketersediaan bahan baku. Hasil penelitian menunjukkan bahwa produk pada 3 rangking teratas berturut-turut adalah nata de coco, cuka kelapa dan air kelapa dalam kemasan. Hasil penelitian diharapkan dapat bermanfaat bagi stakeholder terkait seperti UMKM, pemerintah daerah, perguruan tinggi untuk mengembangkan produk-produk hilir air kelapa.*

Kata Kunci: *Air Kelapa, UMKM, Metode Bayes*

INTRODUCTION

Indonesia ranks second in the world after the Philippines in terms of coconut cultivation area, with an area of 3.41 million (Novarianto, 2021). Compared to almost the same planted area in the Philippines, the diversification of coconut products produced by Indonesia is still far behind. Of its total production, the Philippines can export 51% in the form of *Crude Coconut Oil* and the rest in the form of other derivative products. Meanwhile, Indonesia is very dominant in exporting Crude Coconut Oil (78%), even though the value of this product is relatively small (Mela et al., 2015).

According to data from the Ministry of Agriculture of the Republic of Indonesia (2023), over the past ten years, the area of coconut plantations in Indonesia has declined from 3.50 million hectares in 2014 to 3.23 million hectares in 2023. A similar trend is observed for hybrid coconut plantations, which decreased from 104.47 thousand hectares in 2014 to 87.35 thousand hectares in 2023. During the period 2019–2023, coconut production centres in Indonesia were distributed across several provinces, including Riau, North Sulawesi, East Java, North Maluku, Central Sulawesi, and Central Java. Riau Province contributed the largest share of tall coconut production in Indonesia at 11.39%, followed by North Sulawesi (9.14%), East Java (8.15%), North Maluku (7.22%), Central Sulawesi (6.70%), and Central Java (5.85%). The remaining 51.55% of production came from other provinces.

In general, coconut plantations in Indonesia are predominantly composed of tall coconut varieties, accounting for 97.24% of the total plantation area, while hybrid coconuts cover only 2.76%. Coconut cultivation in Indonesia is managed by smallholder plantations, state-owned large plantations, and privately owned large plantations. Between 2014 and 2023, smallholder plantations dominated coconut cultivation, managing approximately 99.04% of the total coconut plantation area. In comparison, state-owned large plantations accounted for only 0.11%, while privately owned large plantations covered around 0.85%. These figures highlight that coconut remains a highly significant commodity for the Indonesian people, especially for small-scale farmers who rely on it as a primary source of livelihood.

Based on the large area owned by the people, the processing of coconut products has the potential to be carried out on a household or MSME (micro, small and medium enterprises) scale (Sukmaya, 2017) in coconut centre areas (Boekoesoe et al., 2015) due to the ease of obtaining abundant raw materials (Setyawan & Purwanti, 2016). In fact, in some areas, not all farmers turn their coconuts into coconut sugar. They only sell coconut meat. Coconut meat is generally processed into raw materials for making coconut milk, while the water has not been optimally utilised, even though there is 230-300 ml of coconut water in one coconut (Wahyuni, 2018).

Coconut water is a food ingredient that contains good nutrition and can be utilized in various types of products (Mat et al., 2022). According to Barlina (2016) coconut water contains various vitamins, and minerals that are good for health. Coconut water tastes slightly sweet because it contains carbohydrates, electrolytes, and vitamins (Peart et al., 2017), acids, and minerals such as sodium and potassium (Halim et al., 2018). Based on its nutritional content and flavour, coconut water has the potential to be developed into various food or beverages (Wardah, 2018). Coconut water can be developed as a drink to maintain fitness during exercise (Yong et al., 2009), because it can rehydrate the body quickly (Leishman, 2015). According to Coulibaly et al. (2023) most people like to consume coconut water because of it has strengthening, digestive and refreshing properties.

Based on this, coconut center regency has the potential to develop a coconut water processing industry. Research to identify coconut water products that can be developed at the MSME scale needs to be conducted. Product development needs to pay attention to the limitations that are generally owned by MSMEs. These limitations are human resources (Nurani et al., 2022), capital (Achmad et al., 2022), technology (Cunningham et al., 2023), raw materials (Arliman, 2017) and other resources (Yulia et al., 2023).

There has been extensive research on coconut water. In agriculture, its role in seed germination (Karimah et al., 2013) and use in growing media for plants such as *temulawak* (Kristina & Syahid, 2012), patchouli (Surachman, 2011), and mustard greens (Tiwery, 2014) has been documented.

In the food sector, development efforts include making coconut drink powder (Nambiar et al., 2017) while in health, studies address its use in fitness drinks (Alfiyana & Murbawani, 2012), athlete rehydration (Siregar, 2016), and dental care (Rahamat et al., 2019).

However, downstream product development from coconut water—especially products engineered for MSME-scale production—is still rare. Wardah and Baidawi (2020) noted that only about 8% of coconut-derivative research focuses on new product development in agro-industry, with even fewer studies targeting MSME-ready innovations. Moreover, although research has covered products like coconut vinegar and sugar, most are limited to technical feasibility and do not address MSME scalability and commercialization pathways.

Therefore, this study aims to identify and map potential coconut water-based products suitable for MSME development using aggregated data from major coconut-producing regions in Indonesia. While examples from Riau, North Sulawesi, East Java, North Maluku, Central Sulawesi, and Central Java are used to illustrate trends, the analysis focuses on national-level potential rather than region-specific differentiation. The expected outcomes will support MSMEs, local governments, and academic institutions in fostering downstream innovation and commercialization of coconut water products.

METHODS

This research uses two types of data, namely primary and secondary data (Antwi & Hamza, 2015). Primary data were obtained through interviews with nine selected experts, consisting of academics, food technologists, and MSME entrepreneurs involved in coconut-based product development. The selection of nine experts was based on purposive sampling, following the expert elicitation approach suggested by (Hanea et al., 2021), which emphasizes expertise relevance rather than sample size. The number of experts was considered adequate to represent diverse perspectives while maintaining analytical depth and feasibility for qualitative synthesis.

This research was conducted through 2 stages, namely the coconut water processed product identification stage and the potential product determination stage.

(1) Product Identification

Product identification is carried out by listing alternative products that can be made from coconut water using the literature study method by searching literature from books, research reports, proceedings, journals, patents, and trusted websites.

(2) Determination of Potential Products

The assessment was carried out through interviews with nine experts, consisting of two academics, three entrepreneurs, and four association members. The academic experts held doctoral degrees in food technology and specialized in coconut processing. The association members had been involved in the coconut sector for at least two years and were affiliated with CORINA (Coconut Republik Indonesia), which is managed by the Indonesian Coconut Council and the Indonesian Coconut Sugar Association. The entrepreneurs were experienced coconut business practitioners who had been active in the industry for more than ten years.

Product assessment criteria were developed from the research Abidin et al. (2018); Mela, Fadhillah, et al. (2020) including market potential (based on the number of competitors and market demand), business capital (based on the amount of capital required), technology (based on the need for training in the application of technology and the need for sophisticated tools), human resources (based on the need for special skills in the production process) and and availability of raw materials (based on the ease of obtaining raw materials). The questionnaire was designed with a Likert Scale of 1-5 (Jebb et al., 2021) which was then normalized (Mehmed, 2011; Mela, Wijonarko, et al., 2020).

Table 1. Market Potential Assessment Scale based on the Number of Competitors

Scale	Level	Normalization Value

1	Very many competitors (number of similar companies in one regency is more than 20)	0
2	Many competitors (number of similar companies in one regency 11 to 20)	25
3	Quite a lot of competitors (the number of similar companies in one regency is 6 to 10)	50
4	Few competitors (number of similar companies in one regency is 3 to 5)	75
5	Very few competitors (number of similar companies in one regency 1 to 2)	100

Table 2. Market Potential Assessment Scale based on Market Demand

Scale	Level	Normalization Value
1	Very low market demand (product demand trend in the last 3 years decreased by more than 50%)	0
2	Low market demand (trend of product demand in the last 3 years decreased by 10 to 50%)	25
3	Market demand is sufficient (product demand trend in the last 3 years is relatively stable)	50
4	High market demand (trend of product demand in the last 3 years increased by 10 to 50%)	75
5	Market demand is very high (trend of product demand in the last 3 years increased by more than 50%)	100

Table 3. Business Capital Assessment Scale

Scale	Level	Normalization Value
1	More than one hundred million (≥ 100 million)	0
2	Seventy million to 100 million (70 ≤ x < 100 million)	25
3	Forty million to seventy million (40 ≤ x < 70 million)	50
4	Ten million to forty million (10 ≤ x < 70 million)	75
5	Less than 10 million (< 10 million)	100

Table 4. Technology Assessment Scale based on The Need for Technology Application Training

Scale	Level	Normalization Value
1	Training in the application of technology is urgently needed (training and mentoring by foreign experts is required).	0
2	Training is needed in the application of technology (training and mentoring by Indonesian experts is required)	25
3	Sufficient training is needed in the application of technology (training and mentoring by experts from one regency is needed)	50
4	No training is required in the application of technology (no training is required, but assistance from experts from one regency is still needed)	75

5	Very little training is needed in the application of technology (no training and assistance needed)	100

Table 5. Technology Assessment Scale based on The Need for Sophisticated Tools

Scale	Level	Normalization Value
1	Highly sophisticated tools required (price more than 100 million Rupiahs)	0
2	Advanced equipment required (price more than 75 to 100 million Rupiahs)	25
3	Sophisticated tools are required (price more than 50 to 75 million Rupiahs)	50
4	No sophisticated tools required (price more than 25 to 50 million Rupiahs)	75
5	Absolutely no sophisticated tools required (price below 25 million Rupiahs)	100

Table 6. Human Resource Assessment Scale

Scale	Level	Normalization Value
1	Specialized expertise is required in the implementation of the production process (with more than 3 years of experience are required)	0
2	Specialized expertise in the implementation of the production process is required (with more than 1 to 3 years of experience are required)	25
3	Considerable expertise is required in the implementation of the production process (with more than 6 months to 1 year of experience are required)	50
4	Little specialized expertise is required in the implementation of the production process (with 3 to 6 months of experience are required)	75
5	No special skills are required in the implementation of the production process (no experience are needed)	100

Table 7. Raw Material Availability Assessment Scale

Scale	Level	Normalization Value
1	Very difficult to obtain (main raw materials can only be obtained from abroad)	0
2	Difficult to obtain (main raw materials can only be obtained from outside one regency)	25
3	Available but limited/seasonal (main raw materials can be obtained from one regency but seasonal)	50
4	Abundant at all times (main raw materials can be obtained from one regency throughout the year)	75
5	Very abundant at all times (main raw materials can be obtained from anywhere throughout the year)	100

Data processing was conducted using the Bayes Method (Cui & George, 2008), which involves assigning weights to each criterion based on expert judgment. Each expert's score for an alternative product is multiplied by the corresponding weight to obtain a weighted score (Berger & Deely, 1988). The total score for each product is then calculated by summing the weighted scores across all criteria. This method enables structured and transparent decision-making by combining multiple criteria and expert inputs, even in the presence of uncertainty. It is particularly useful in contexts where decisions must be made with limited quantitative data but strong expert knowledge. The weights used in this study refer to the research (Adiluhung & Ervina, 2020) namely: Product Value = 0.22 Competitors + 0.22 Market Demand + 0.108 Business Capital 0.108 + 0.028 0.028 + 0.028 Advanced Tools + 0.223 Human Resources + 0.173 Raw Material Availability.

RESULTS AND DISCUSSION

The literature study found that 10 products can be developed from coconut water. These products are isotonic drinks (Marapana et al., 2017), bottled coconut water drink (O'Brien et al., 2023), nata de coco (Budhiono et al., 1999), antioxidant drinks (Agbafor et al., 2014), probiotic drinks (Kantachote et al., 2017; Pachori & Kulkarni, 2017), carbonated drinks (Cappelletti et al., 2015; Chauhan et al., 2014), coconut vinegar (Othaman et al., 2014; Trinh et al., 2016; Xu et al., 2022), coconut water blend with fruit (Asante-Donyinah, 2010; Schiassi et al., 2020), coconut powder drinks (Boonnumma et al., 2011; Setiawan et al., 2024) and coconut wine (Prades et al., 2012).

The assessment results from 9 experts can be seen in Table 8. Example of expert 1's calculation for nata de coco products by expert 1: Nata de Coco Product Value from Expert 1 = (0.22 x 0) + (0.22x 75) + (0.108 x 75) + (0.028 x 100) + (0.028 x 25) + (0.223 x 50) + (0.173 x 75) = 52.23.

The "Mean" column in Table 8 represents the average score assigned to each product by the nine experts involved in the assessment. It is obtained by dividing the total score of each product by the number of experts. This mean value provides a general overview of how each product is perceived across multiple expert evaluations. A higher mean score indicates that, on average, the product received more favorable assessments, suggesting it has greater potential for development. The ranking of products is directly based on these mean scores, with higher means corresponding to better ranks. This approach allows for a fair and transparent comparison among the alternative products by summarizing expert judgments into a single representative value.

The results showed that the top three ranked products for development at the MSME scale were nata de coco, coconut vinegar and bottled coconut water. Only the top three products were analyzed in detail because the primary objective of this study was to identify the most promising coconut-based processed products for further development at the MSME (Micro, Small, and Medium Enterprises) level. By focusing on the three highest-ranked alternatives based on expert evaluation, the discussion remains focused, relevant, and actionable for stakeholders who may have limited resources and need clear priorities. These top products also received the highest consensus among experts, indicating strong potential from both technical and market perspectives. While the other products may also have merit, their lower scores suggest they are less feasible or require more extensive development efforts. However, they are not entirely excluded and could be considered in future studies or as secondary options depending on specific local contexts or technological advancements.

Nata de Coco

Nata de coco is a chewy jelly-like material of milky white or clear colour made from coconut water through the fermentation process of Acetobacter xylinum bacteria (Mandey et al., 2024). In Indonesia, nata de coco is usually processed into food or refreshing drinks (Phisalaphong et al., 2016). Nata contains dietary fibre so that it can play a role in the process of food digestion (Gayathry, 2015) and can be utilized as a dietary product (Tallei et al., 2022). In making nata de coco coconut water is utilized as a growth medium for Acetobacter xylinum (Mandey et al., 2024).

According to Rahmayanti et al. (2019), coconut water can encourage bacterial growth because it contains abundant and relatively complete nutrients, making it a natural medium suitable for the growth of microorganisms. Acetobacter xylinum bacteria can form nata if grown in coconut water that has been enriched with Carbon (C) and Nitrogen (N). Through a series of biochemical processes, Acetobacter xylinum will produce extra-cellular enzymes that can arrange sugar substances into thousands of white to transparent fibre or cellulose strands called nata (Cacicedo et al., 2016; Chawla et al., 2009; Diotallevi, 2007).

The materials used for making nata de coco are 100 ml coconut water, 12 ml Acetobacter xylinum starter seeds, 3.5 grams of sugar, 0.6 grams of urea, 4 ml of food vinegar, and 3 grams of yeast extract (Pambayun, 2006). The tools used are pots, trays, stirrers, tablespoons, stoves, newspapers, rubber, and plastic filters. The method of making nata de coco begins with filtering coconut water to remove existing impurity, then coconut water is boiled until boiling, then urea, sugar and vinegar are dissolved in coconut water which is still hot, and then coconut water is placed into a fermentation container and then covered with sterile newspaper. After the solution cools, the seed starter is added and then closed again (Hamad & Kristiono, 2013).

According to Phisalaphong et al. (2016) nata de coco is a suitable product to be developed in small industries or MSMEs. The market potential of nata de coco is still very wide open, because the supply of nata is still below the demand that producers can provide (Wahyuni, 2019). In addition, in terms of capital, nata de coco does not require too much capital. The investment cost required is IDR 57,000,000.00 (Wulandari, 2012).

Coconut Vinegar

The word vinegar comes from the French word vinaigre, which means sour wine (Lim et al., 2019). Vinegar, or acetic acid, is a type of carboxylic acid commonly used in cooking for its sour flavor (Perumpuli & Dilrukshi, 2022). The characteristics of vinegar are in the form of a clear liquid that is colorless and has a very sharp odor (Zhang et al., 2024). Vinegar can be made from fruits such as apples and grapes or other fruits that contain sugar as well as coconut water (Coelho et al., 2017). The complete nutritional content contained in coconut water, which includes simple carbohydrates, proteins in the form of complete amino acids, and various minerals, makes coconut water the right growth medium for microorganisms in the vinegar making process (Xu et al., 2022).

Preparation of coconut vinegar (acetic acid) through alcohol fermentation and acetic acid fermentation (Fatima & Mishra, 2015). Alcohol fermentation occurs under anaerobic conditions through the decomposition of glucose into alcohol and CO_2 with the help of the Saccharomyces cerevisiae yeast (Ishtar Snoek & Yde Steensma, 2007). Furthermore, the fermentation process occurs under aerobic conditions with the decomposition of alcohol into acetic acid with the help of Acetobacter acetii (Sari et al., 2020).

The materials used for making vinegar are old coconut water, fermipan yeast, 10% acetic acid (vinegar starter) 35 liters, sugar, water, NaOH 0.1N, NaCl. The method of making vinegar is that 20 liters of coconut water is added to sugar and dissolved until the sugar dissolves, cooled and yeast is added, then filtered and put into a 20 liter jerry can and allowed to stand for 1 week to undergo anaerobic fermentation. The first 20 liters of fermentation is filtered and then put the alcohol solution into a fermenter that has been prepared with 35 liters of starter vinegar (10% glacial acetic acid). This solution was left to undergo aerobic fermentation. The addition of 20 liters of alcohol was carried out for up to 4 weeks. In week 5, 20 liters of vinegar was harvested and another 20 liters of alcohol was added, and so on (Hasanuddin et al., 2012).

Coconut vinegar is also a suitable product to be applied to MSMEs because the technology is simple and no large capital is required (Trinh et al., 2016). This has been done by Musnaini et al. (2019) who conducted community service aimed at the household industry in Jambi. Moreover, the production of coconut vinegar is mostly done by people in Southeast Asian countries using homamade static fermentation, which has been long fermentation cycle, low acid production, and different taste, and so it is suitable for household industry (Othaman et al., 2014).

Bottled coconut water

Bottled coconut water is a natural drink made from coconut water that is hygienic and has a high nutritional composition (Jayasundera & Dharmasena, 2014). However, coconut water is perishable so that its storage life is short (Setiawan et al., 2024). Packaged coconut water is a pure coconut water drink that is modified to extend the shelf life of coconut water (Rajashri et al., 2020). This bottled coconut water uses ultrafiltration and ultraviolet processes (Mohan et al., 2020).

In general, ultrafiltration membranes are used to separate microorganisms, large molecules and emulsions in water (Prithviraj et al., 2021). According to Sari Intan et al. (2016), coconut water beverage products resulting from ultrafiltration and ultraviolet processes do not differ much in characteristics from fresh coconut water. The characteristics of the product are that it has a salty taste and aroma that is relatively the same as fresh coconut water and a sweet taste and lower turbidity compared to commercial coconut water drinks . The main ingredient used in making this product is 8-9 month old early maturing coconut water. The method of manufacture, coconut water is filtered then passed through a microfiltration membrane unit, and immediately packaged.

Packaged coconut water products are suitable products to be developed on an MSME scale (Nalla et al., 2024). Based on internet searches in 2023 at on the web: AliBaba.com (2023) the price of ultrafiltration equipment ranges from $ 1200 to $ 1800 is (Rp 18 million to Rp 27 million) in one package. Further research is needed regarding the feasibility of establishing a bottled water industry so that it can actually be applied at the MSME scale.

Table 8. Determination of Potential Products

No.	Product Name	Expert/Expert									Total Score	Mean	Rank
		1	2	3	4	5	6	7	8	9			
1	Nata de Coco	52,23	58,55	65,03	64,40	42,85	52,23	60,33	61,25	54,35	511,20	56,80	1
2	Coconut Vinegar	45,03	58,95	55,33	36,05	25,05	41,23	79,50	72,33	51,65	465,10	51,68	2
3	Bottled Coconut Water Drink	47,95	61,28	49,25	52,00	41,45	37,93	47,15	72,33	41,65	450,98	50,11	3
4	Coconut Wine	41,05	62,60	60,48	36,05	25,75	31,63	41,55	72,33	49,25	420,68	46,74	4
5	Coconut Powder Drink	44,63	66,85	63,43	44,70	25,75	36,43	41,55	61,55	33,35	418,23	46,47	5
6	Coconut Water Blend with Fruit	49,90	61,83	56,15	14,05	20,25	37,83	59,00	52,03	54,75	405,78	45,09	6
7	Probiotic Drinks	49,98	56,40	50,28	26,33	30,45	43,33	47,23	53,65	44,35	401,98	44,66	7
8	Isotonic Drinks	43,78	50,30	42,98	41,65	41,45	40,63	49,85	42,88	47,05	400,55	44,51	8
9	Antioxidant Drinks	34,50	48,43	44,48	34,98	31,85	43,33	45,60	53,65	44,35	381,15	42,35	9
10	Carbonated Drinks	35,43	36,85	46,48	36,05	25,05	43,33	47,23	53,65	33,35	357,40	39,71	10

CONCLUSIONS

There are 10 coconut water processed products that can be developed at the MSME scale in coconut centre regency. The most potential products are nata de coco, coconut vinegar, and bottled coconut water. Therefore, it is recommended that local governments and relevant institutions strengthen policies that support MSME-based coconut water product development. This includes facilitating access to appropriate processing technologies, providing technical training and product standardization assistance, and improving market linkages for coconut water derivative products. Academic institutions can also play a key role through applied research and community service programs that promote technology transfer and commercialization readiness. Such collaborative efforts will accelerate the downstream innovation of coconut water and enhance its contribution to regional economic development.

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