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Performance of Indonesian Candlenut Oil in the International Markets of the United States, Singapore, and India

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ABSTRACT

Candlenut oil is one of Indonesia's potential export commodities in the global market, but its competitiveness in various main destination countries remains untapped. The purpose of this study is to measure and analyze the competitiveness of Indonesian candlenut oil exports in three major market countries, which are the United States, Singapore, and India, using a quantitative and comparative approach. The data used in this study are from 2016 to 2023. The time series data analysis methods used are Revealed Comparative Advantage (RCA), Revealed Symmetric Comparative Advantage (RSCA), and Trade Balance Index (TBI). Based on the RCA index calculation, the average RCA value of Indonesian candlenut oil is greater than 1, indicating a comparative advantage in the United States, Singaporean, and Indian markets. The average RSCA index calculation shows that Indonesian candlenut oil has strong comparative advantage (RSCA>0) in the Singaporean and Indian markets. Meanwhile, in the United States market, Indonesian candlenut oil does not have a comparative advantage. The average TBI calculation indicates that Indonesian candlenut oil is a strong net-export position in the United States and Singapore markets, while in India it is at the export specialization growth stage. Potential markets such as India, Singapore, and the United States deserve further development to optimize export profits. Dissemination of technology to improve the quality of candlenut oil to higher grades is also necessary to compete with competing countries, thereby increasing candlenut oil exports.

INTRODUCTION

Indonesia has a significant opportunity to maximize the export potential of non-timber forest products, particularly candlenut (*Aleurites moluccanus*) (Jumiyati et al., 2024), which is widely cultivated in eastern Indonesia (Shaah et al., 2021). Candlenut (*Aleurites moluccanus*) is a non-timber forest product with both

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economic and ecological potential (Dako et al., 2024).

Candlenut oil is a candlenut derivative product that has high economic value in the export market. It has a high oil content ranging from 30-60% (Shaah et al., 2021). Candlenut oil is composed of high levels of unsaturated fatty acids and contains small amounts of aromatic oils, such as essential oils (Cabral et al., 2016; Subroto et al., 2017). Therefore, candlenut oil has the potential to be processed as a raw material for vegetable oils, such as candlenut oil and as a wax substitute (Dako et al., 2024).

In addition to its high economic value, candlenut oil contributes to a sustainable agroforestry system that provides ecological and social value (Ningsih & Baharuddin, 2021). The global market is currently well-positioned to meet the growing demand for bio-based products (Virgin et al., 2022) and the shift in global consumer preferences toward sustainable, environmentally friendly, and healthy goods. Due to its high concentrations of linoleic acid, oleic acid, and vitamin E, candlenut oil is highly valued in the pharmaceutical, cosmetic, and hair care industries, in addition to being used as a raw material in the food industry (Shintawati et al., 2022).

The US, Singapore, and India are three key export markets considered crucial for increasing the competitiveness of Indonesian candlenut oil (BPS, 2024). These three countries were selected for analysis because the United States is one of the world's major markets for the beauty and personal care industry (Statista, 2025); Singapore's largely urban-dwelling upper-middle class, which serves as a global product tester, and India's growing middle-class market (Fernandes, 2023) segment all contribute to the potential for Indonesian candlenut oil exports.

However, despite the wide open market opportunities, the competitiveness of Indonesian candlenut oil exports remains suboptimal compared to competing countries such as the Philippines and several African countries, both in terms of export volume, added value, and market penetration (UN Comtrade Database, 2024). This gap is partly attributable to Indonesia’s continued reliance on the exports of raw materials (candlenut kernels) rather than high-value processed products like candlenut oil. A significant challenge lies in the post-harvest stage, where suboptimal processing technology and a lack of standardization are major obstacles to increasing product value (Sutejo et al., 2023). More seriously, Indonesia's existing standardization process is not fully aligned with international standards in terms of legal framework and technical competence, as identified by Kristiningrum et al. (2022). This lack of consistent quality standards poses contaminant risks, similar to the problems faced by palm oil (Andarwulan et al., 2022), which can hinder compliance with global food safety and cosmetic standards. As a result, Indonesian candlenut oil products struggle to penetrate premium markets such as the US and Singapore, limiting economic opportunities for local producers (Sukananda, 2019).

Furthermore, reliance on long distribution chains and insufficient international markets promotion further undermines the bargaining position and competitiveness of Indonesian candlenut products.

This is supported by research by Iskandar et al. (2016), which shows that farmers have a relatively weak bargaining position in the marketing of candlenut products. Most previous studies, such as those by Sutejo et al. (2023) and Iskandar et al. (2016), have focused more on production aspects, supply chains, and issues at the farmer level, and have not specifically measured export competitiveness quantitatively in the international markets. Based on these issues and gaps, this study aims to specifically analyze the export competitiveness of Indonesian candlenut oil in three major markets—the United States, Singapore, and India—with varying demand characteristics.

This research will provide novelty by not only analyzing competitiveness based on existing RCA indicators but also integrating value chain analysis and non-price competitiveness factors such as product standards, certification, logistics performance, weather, and branding product. This integrative approach has not been widely explored in the context of Indonesian candlenut oil. Detailed analysis in each market will provide a more in-depth understanding than general studies.

The results of this analysis are expected to provide a solid foundation for formulating detailed export policy recommendations and concrete business strategy recommendations for stakeholders. For the government, these recommendations could include incentive policies for downstream processing, product standardization, and integrated promotion. For businesses, the research findings can serve as a guide for improving supply chain efficiency, diversifying products, and building a strong brand image in the global market.

METHODS

The primary method employed in this research is descriptive analysis by collecting the data to be studied, followed by processing, analyzing, and interpreting the data in hypothesis testing (Putri et al., 2019). This study uses secondary data in the form of time series data obtained from recording documents or reports from related agencies. Some of the secondary data used in this study comes from the Central Bureau of Statistics, ITC Trade Map, UN Comtrade Database, and other supporting resources. The approach used in this study is a quantitative approach where the research results are presented in the form of mathematical calculations.

The data used in this study are from 2016 to 2023 for the United States, Singapore, and India. The United States, Singapore, and India were chosen because Indonesia exports the most candlenut oil products to these three countries. The time frame is based on the latest 8 years of data, because data for India is available from 2016 and 2024 data is

not available for the three countries from data sources, namely UN Comtrade and the International Trade Center. The search HS code used was 151590 (with the product description: "Other vegetable oils and their fractions, whether refined or unrefined, but not chemically modified"). Candlenut oil is included in HS code 151590 because it is a vegetable oil extracted from candlenut kernels, has not undergone significant chemical modification, and is used for cosmetic and pharmaceutical purposes. The use of this code poses a risk of aggregation bias because the reported data may include other vegetable oils. This means that the actual value of candlenut oil exports may be overstated, so the competitiveness findings should be interpreted with the recognition that they reflect the competitiveness of a broader product category. This study adds interpretive constraints by focusing the analysis on export destination countries known to consistently import candlenut oil from Indonesia. This approach helps ensure that calculated indicators, such as RCA and competitiveness, continue to reflect the specific performance of candlenut oil and are not distorted by other products in the same HS group. Thus, the analysis results are expected to remain relevant, representative, and not significantly biased towards other commodities in the HS 1515.90 category.

Data processing in this study used Microsoft Excel software. The time-series data analysis methods used were Revealed Comparative Advantage (RCA), Revealed Symmetric Comparative Advantage (RSCA), and the Trade Balance Index (TBI). The Revealed Comparative Advantage (RCA) method is used to measure the comparative advantage of commodities within a region and is an accepted method for trade analysis. Essentially, the RCA method calculate the share of a commodity's export value in a country's total exports, compared to the share of that commodity's value in world trade (Stellian & Danna-Buitrago, 2022). The RCA method can also be used to examine a region's export specialization patterns (Purwono et al., 2022). However, RCA often produces asymmetric values, leading to unbalanced weighting for the applied regression. This is because the range of values obtained ranges from 0 to infinity (Tandra et al., 2022). In this study, we employ a destination-specific (bilateral) RCA to measure Indonesia's export competitiveness for candlenut oil in each importing market. This is done by focusing on trade performance between a specific exporter and destination rather than global trade, following the approaches of Laursen (2015) and Vollrath (1991). The bilateral RCA is formulated as follows:

$$RCA_{ij} = \frac{(X_{ij} / X_{it})}{(M_j / M_t)}$$

Where:

X_{ij} : Indonesia's export value of product *i* (candlenut oil) to country *j* (US$)

X_{in} : Indonesia's total exports to country *j* (US$)

M_j : The total world exports of product *i* to country *j* (US$)

M_t : the total world exports to country *j* (US$)

The RCA index value ranges from zero to infinity. If the RCA index is between 1 and infinity, it indicates a country has a comparative advantage in candlenut oil, reflecting export competitiveness. Meanwhile, if the value is between zero and 1, the country has a comparative disadvantage. The RCA index is a useful tool for constructing descriptive trade data and interpreting results at the industry or country level (Tandra et al., 2022).

Due to several limitations of RCA, Laursen (2015) refined it by proposing the Revealed Symmetric Comparative Advantage (RSCA). RSCA provides a more realistic and accurate index value for a country or region's comparative advantage in trade. The RSCA can be calculated using the following formula:

The trade balance index (TBI) is used to identify whether a country specializes in exports as a net exporter or net importer (Lafay, 1992). The contribution of a particular commodity or good to the national surplus or trade deficit with trading partners can be determined through this index. The TBI can be calculated using the following formula:

$$TBI_{ij} = \frac{(x_{ij} - m_{ij})}{(x_{ij} + m_{ij})}$$

TBI_{ij} = country i's trade balance index for product j
x_{ij} = country i's exports of product j
m_{ij} = country i's imports of product j.

The TBI value ranges from -1 to 1. If a country only imports (a net importer), the TBI value is -1. Conversely, if the TBI value is 1, the country only exports (a net exporter) a good or commodity (Purwono et al., 2022).

To complement the RSCA and TBI index analysis, products are mapped and classified into four groups: A, B, C, and D (Figure 1) (Widodo in İzgi & Kavacık, 2024).

RESULTS AND DISCUSSION

Analysis of the Comparative Advantage of Indonesian Candlenut Oil in the United States, Singapore, and India

Analysis of the competitiveness of Indonesian candlenut oil in the United States (US), Singapore, and India markets using the Revealed

	TBI<0	TBI>0
RSCA>0	**Group B** Comparative advantage Net-importer (RSCA>0 and TBI<0)	**Group A** Comparative advantage Net-exporter (RSCA>0 i TBI>0)
RSCA<0	**Group D** Comparative disadvantage Net-importer (RSCA<0 and TBI<0)	**Group C** Comparative disadvantage Net-exporter (RSCA<0 and TBI>0)

Figure 1. Product Mapping based on RSCA and TBI values
Source : (Widodo in Izgi & Kavacık, 2024)

Comparative Advantage (RCA) and Revealed Symmetric Comparative Advantage (RSCA) indices shows a varied picture.

Indonesia generally has a significant comparative advantage in the candlenut oil trade (average RCA above 1), reflecting great potential to gain profits in the global market (Makkarennu et al., 2021). This competitiveness is most pronounced in India (average RCA 5.21), where it is supported by increasing awareness of natural beauty products (Moharir, 2025), and in Singapore (average RSCA 0.58), which offers logistical advantages as a trading hub (Sauvé et al., 2024). However, competitiveness in the United States market proved weak (mean RSCA negative –0.05). Sharp fluctuations in RCA values in the US and Singapore indicate that Indonesia's competitiveness is vulnerable to non-price factors. These include competition from countries offering higher quality and purity (Yusri & Sutanto, 2021), as well as the lack of international certification among many Indonesian manufacturers (Khasanah et al., 2024). This fluctuation is also influenced by the increase in Indonesian exports compared to world exports (Vanzza Aji et al., 2019). These challenges are exacerbated by supply chain constraints from extreme weather and cyclical harvest patterns (Dahivale, 2025; Oriekhoe et al., 2024), unfavorable consumer perception of the product (Du et al., 2023), and market domination by palm oil, which has a more established supply chain and economies of scale (López et al., 2016; Matondang & Budiman, 2019). Thus, future success depends on improving product quality and standardization as well as managing supply chain risks. Based on Table 1, a simple diagram can be made showing the fluctuations in RCA, and RSCA in the USA, Singapore, and India from 2016-2023 as follows.

Table 2 shows that Indonesia's average Trade Balance Index (TBI) for candlenut oil from 2016 to 2023 was positive, confirming Indonesia's position as a net exporter specializing

Table 1. RCA and RSCA Index of Indonesian Candlenut Oil in the United States, Singapore, and India, 2016-2023

Year	RCA			RSCA		
	United States	Singapore	India	United States	Singapore	India
2016	0.79	3.24	-	- 0.11	0.53	-
2017	1.13	4.88	3.32	0.06	0.66	0.54
2018	1.53	3.39	1.25	0.21	0.54	0.11
2019	0.64	2.49	2.15	- 0.22	0.43	0.37
2020	0.30	3.33	2.62	- 0.54	0.54	0.45
2021	0.60	4.62	5.19	- 0.25	0.64	0.68
2022	1.52	4.66	8.96	0.21	0.65	0.80
2023	1.58	4.23	12.97	0.23	0.62	0.86
Mean	1.01	3.85	5.21	-0.05	0.58	0.54

Source : UN Comtrade, 2025 (processed)

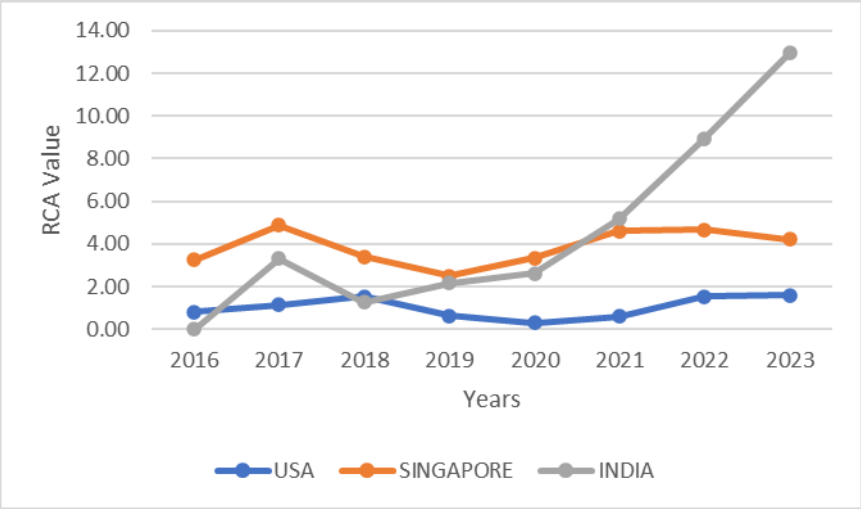

Figure 2. Revealed Comparative Advantage of Indonesia Candlenut Oil in Global Market
Source : Secondary Data Processed (2025)

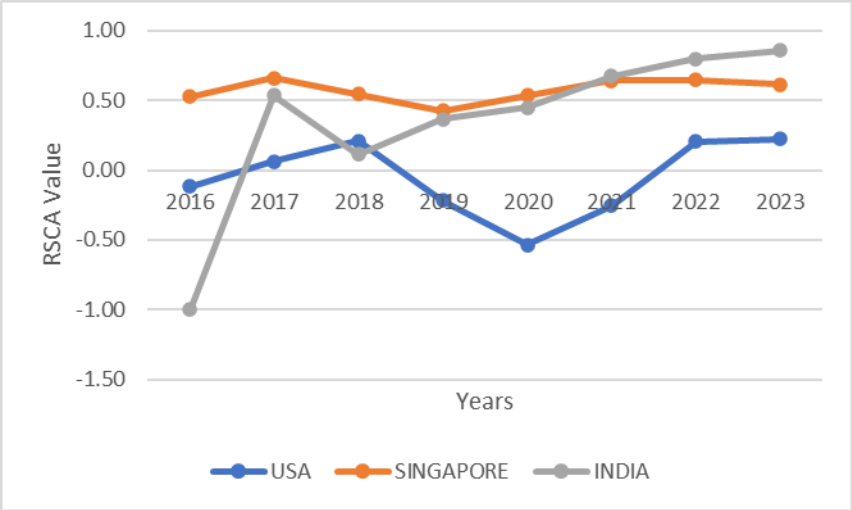

Figure 3. Revealed Symmetry Comparative Advantage of Indonesia Candlenut Oil in Global Market
Source : Secondary Data Processed (2025)

in candlenut oil exports during that period. A high TBI (above 0.8) indicates a country's tendency to Export rather than import (Zuhdi et al., 2021). Specifically, the average TBI in the United States and Singapore markets is 0.86, indicating that Indonesian candlenut oil has become a strong and specialized export commodity in both countries. Meanwhile, in the Indian market, the TBI is less than 0.8. This indicates that although Indonesian candlenut oil has been exported to India, the sector is still in the growth stage because export value has not yet significantly exceeded import value. The implication of this lower TBI is the need for future strategic focus, not only on increasing export volume, but also on increasing India's

domestic market share in India and reducing India's dependence on imports from competing countries. Additionally, this growth stage offers optimal opportunities for investment in marketing and quality improvement to maximize the potential for increasing demand in India (Moharir, 2025).

Based on Table 2, a simple diagram can be made showing the fluctuations TBI in the USA, Singapore, and India from 2016-2023 as follows.

Based on the RSCA and TBI index calculations, Indonesian candlenut oil exports can be categorized, as shown in Figure 5.

According to Figure 5, Indonesian candlenut oil exported to Singapore and India falls into group A because it has an RSCA value > 0 and a TBI value > 0, indicating a comparative as an

Table 2. Trade Balance Index (TBI) Values for Indonesian Candlenut Oil in the United States, Singapore, and India, 2016-2023

Year	TBI		
	United States	Singapore	India
2016	0.81	0.60	- 1.00
2017	0.87	0.92	- 0.13
2018	0.90	0.84	0.73
2019	0.73	0.86	0.06
2020	0.79	0.87	0.39
2021	0.87	0.88	0.61
2022	0.99	0.94	0.93
2023	0.94	0.94	0.79
Mean	0.86	0.86	0.20

Source: UN Comtrade, 2025 (processed)

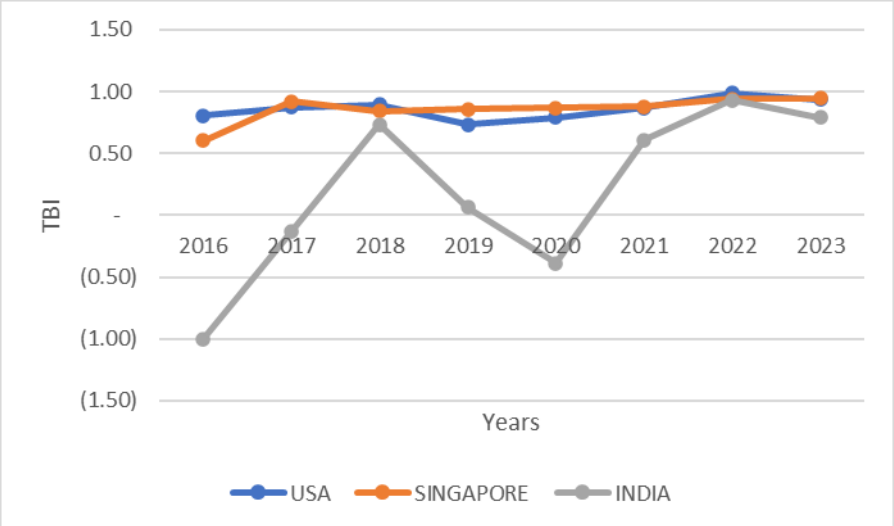

Figure 4. Trade Balance Index of Indonesia Candlenut Oil in Global Market
Source : Secondary Data Processed (2025)

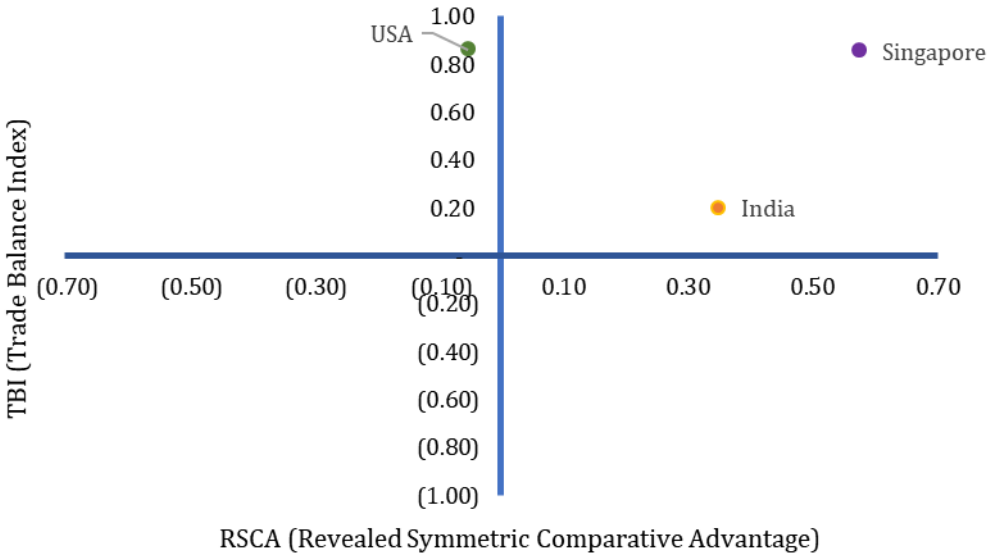

Figure 5. Product Mapping of Indonesian Candlenut Oil by Country
Source: Secondary Data Processed (2025)

exporter to the Singaporean and Indian markets. This means that the Indonesian candlenut market is growing positively and dynamically in both countries, so a strategy is needed to increase exports and competitiveness to these destination countries or other countries by increasing production and meeting the specific required standards (Purba et al., 2021). Conversely, Indonesian candlenut oil exported to the United States falls into group C because its RSCA value is < 0 and its TBI value > 0. This means that Indonesian candlenut oil specializes in exports but lacks a comparative advantage over the US.

This suggests that Indonesian candlenut oil may have a sizable export market share, but its competitiveness in the US market is not as strong as that of other countries. One effective differentiation strategy is through Geographical Indications (GI), which are part of Intellectual Property Rights. A GI is a product name that indicates its geographic origin. The quality, characteristics, and reputation of GI products are directly influenced by natural factors and local traditions (Anggrasari et al., 2021). With GI, commodities such as candlenuts will gain added value due to their enhanced brand image (Batubara et al., 2024), which ultimately can increase selling prices and increase competitiveness in international markets, particularly in key export destination countries.

CONCLUSION AND SUGGESTION

Based on the competitiveness index, Indonesian candlenut oil demonstrates a comparative advantage (average RCA >1) in the US, Singapore, and Indian markets, indicating good export potential and efficiency. This advantage is most evident in India and Singapore (RSCA

>0). However, this analysis critically uncovers structural weaknesses in the United States (US) market, where Indonesian candlenut oil lacks a symmetrical comparative advantage (RSCA <0). Furthermore, sharp fluctuations in the RCA in the US and Singapore confirm that Indonesia's competitiveness is highly vulnerable to non-price factors such as issues of quality, standards, and supply consistency, as well as the dominance of competing products. Although the TBI index shows that candlenut oil is a high-value export commodity in the United States and Singapore markets, and the Indian market is still in the growth stage, the profit optimization is hampered by certification challenges and intense competition, thus requiring strategic intervention.

Based on these findings, recommendations are addressed to the government and business actors. The government (Ministry of Trade and Industry) should provide targeted incentives and subsidies for producers to accelerate the acquisition of international certification and to disseminate high-quality oil processing technology, enabling access to premium markets such as the US. Furthermore, proactive trade diplomacy for registering Geographical Indications (GI) is highly recommended to increase product value and differentiation. Meanwhile, exporting companies should shift their focus to producing value-added products (e.g., virgin cosmetic oils) and build long-term supply chain partnerships that ensure consistent supply to reduce vulnerability to fluctuations. A limitation of this study lies in the use of HS Code 151590 data, which covers other vegetable oils, for which candlenut oil does not have a specific tariff line. Therefore, further research is strongly recommended to conduct a comparative value-added analysis between Indonesian candlenut oil and competing countries (e.g., the Philippines) to assess potential losses from raw product exports, as well as to conduct econometric modelling to measure the quantitative impact of non-price policies (such as certification and subsidies) on the RCA/RSCA index.

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contribution to sustainable development in the agricultural and sugar sectors. Recommendations for sugar factory managerial policies: (1) Sugar factories must strengthen partnerships

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