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A Systematic Literature Review of Environmental Impacts of Canned Pineapple Production

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Abstract
A systematic literature review was conducted to assess the current state of knowledge on the environmental impacts of canned pineapple production. The review included studies published in peer-reviewed journals between 2000 and 2022, and focused on the assessment of greenhouse gas emissions, acidification, and eutrophication potential associated with the production of canned pineapple. The results of the review suggest that canned pineapple production has significant environmental impacts, particularly in terms of greenhouse gas emissions, which are mainly associated with energy use and transportation. However, the review also identified several strategies that can be implemented to reduce the environmental impacts of canned pineapple production, such as using renewable energy sources and optimizing transportation routes. The review concludes that further research is needed to fully understand the environmental impacts of canned pineapple production and to develop effective strategies for reducing these impacts.

1. Introduction

A canned pineapple is a product that is made from fresh pineapple (Ananas Comosus) which is canned in a sugar solution, with or without other permitted food additives (SNI-01-4316-1996). Canned pineapple has great potential to be produced as an export product because pineapple is one of the most popular tropical fruits in the world, including Indonesia. According to the Ministry of Agriculture (2017), there was an increase in Indonesian pineapple exports, especially from Lampung Province, reaching 1,810,748 kg in 2017, and 1,347,732 kg in the first quarter of 2017, with export destinations including Japan, Germany, Korea, and Italy. According to BPS (2018), national pineapple production reached 1,795,982 tons with a harvest productivity of 20,785 tons/ha in 2017. In 2021, Indonesia produced 2,886,417 tons of pineapple, making it one of the world's leading pineapple producers (BPS 2021). The highest production is in Lampung Province, in total of 705,883 tons in 2021 (BPS 2021).

According to the GGP Report (2020), 9.1-9.4 million cans of Indonesian pineapple were exported to more than 60 countries, with three marketing regions: America, Europe, Asia Pacific, and the Middle East. The production process of canned pineapple involves various stages, such as cultivation, harvesting, transportation, and processing, which can result in greenhouse gas emissions, acidification, and eutrophication potential (Cerutti, Bruun, Beccaro, &

Bounous, 2011). Therefore, it is essential to understand the environmental impacts of canned pineapple production and develop effective strategies to mitigate them (Cervo, Llido, Barrios, & Panlasigui, 2014).

This systematic literature review aims to provide an overview of the current state of knowledge on the environmental impacts of canned pineapple production. The review focuses on studies published in peer-reviewed journals between 2000 and 2022 and assesses the greenhouse gas emissions, acidification, and eutrophication potential associated with the production of canned pineapple (Usubharatana & Phungrassami, 2017).

The review identifies several strategies that can be implemented to reduce the environmental impacts of canned pineapple production, such as using renewable energy sources and optimizing transportation routes. However, further research is needed to fully understand the environmental impacts of canned pineapple production and develop effective strategies for reducing these impacts (Ingwersen, 2012). Overall, this review provides valuable insights into the environmental impacts of canned pineapple production and highlights the need for sustainable practices in the food industry (Biswas & Nishat, 2019).

2. Materials and Methods

Systematic Literature Review

A systematic literature review (SLR) was employed to analyze and present the current state-of-the-art consideration. The SLR involves several main steps, including defining the research question(s), identifying relevant keywords and search strings, setting constraints such as databases, search period, language, and type of literature, and excluding articles by title, abstract, and full paper. Finally, the analysis of meta-data was conducted. The entire process of the SLR, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

PRISMA Guidelines for Systematic Reviews and Meta-Analyses

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 Statement provides a comprehensive guideline for conducting and reporting systematic reviews. It includes a 27-item checklist that covers the introduction, methods, results, and discussion sections of a systematic literature review (SLR). The SLR carried out in this study adhered to the PRISMA 2020 Statement.

Snowball Approach

The snowballing approach is a useful method for identifying relevant articles within SLRs. It can be categorized into two types: forward and backward snowballing. Both methods use cited references to identify new papers. Forward snowballing identifies papers that reference articles already included in the final sample, while backward snowballing examines the references of papers in the final sample to add more relevant articles.

Final Sample Identification Process

To answer the research questions, this study defined keywords such as LCA, canned-pineapple, global warming potential, acidification, LCA in Indonesia, canned-pineapple LCA in Indonesia, pineapple production, product environmental footprint, eutrofication, and carbon footprint to conduct the SLR. The final sample was identified based on these keywords.

3. Results and Discussions

Canned pineapple is a popular food product that is consumed worldwide. However, the production of canned pineapple has been found to have significant environmental impacts. In recent years, there has been growing interest in assessing the environmental impacts of canned pineapple production using life cycle assessment (LCA). LCA is a widely used methodology that allows for the comprehensive evaluation of environmental impacts associated with the entire life cycle of a product, from raw material extraction to end-of-life disposal (Sukruansuwan & Napathorn, 2018). This review focused on the assessment of greenhouse gas emissions, acidification, and eutrophication potential associated with the production of canned pineapple, as these are commonly used indicators of environmental impacts in LCA studies. The results of the review will help to identify the main sources of environmental impacts in canned pineapple production and highlight potential strategies for reducing these impacts (Banerjee, Ranganathan, Patti, & Arora, 2018).

Table 1.

Source	Object of research	Scope	Impact	Results and Recommendations
de Ramos & Taboada, (2018)	Fresh and processed pineapple (canned pineapple, juice, dried preparations, etc.)	*Cradle-to-gate* (land preparation to processed production process)	Energy use*non-renewable, global warming* (GWP), carbon footprint analysis, acidification, and ozone formation	Reducing the use of diesel fuel, upgrading canning machines, regulating the use of fertilizers and pesticides, and conducting waste management
(Castillo-González, Giraldi-Díaz, De Medina-Salas, & Velásquez-De la Cruz, 2020)	Fresh and processed pineapple (fresh-packed, dried fruit, and canned)	*Cradle-to-gate* (*agricultural* and*industrial stage*)	*Carbon footprint, water footprint, energy footprint*	Innovating the use of primary energy, selecting suppliers of raw materials
(Usubharatana & Phungrassami, 2017)	Fresh pineapple and canned pineapple	*Cradle-to-farm gate* (fresh pineapple) and*Cradle-to-factory gate* (canned pineapple)	*Carbon footprint*	Using biomass as fuel (using biogas from liquid waste handling), recycling cans, educating farmers to use the right fertilizer
Rizky *et al.*(2021) (Salsabila, Boonraksa, Indriani, Sakina, & Rahardyan, 2021)	PPE from pineapple leaf fiber	*Cradle-to-gate (*taking pineapple leaves to the paper production process)	*Carbon Footprint*	The development of non-woven materials made from pineapple leaf fiber can be continued
(Salsabila et al., 2021)	*Life cycle environmental impacts of fruit consumptions in the UK* (4% fresh and processed pineapple)	*Cradle to grave* (production process on the plantation until it is ready for consumption by consumers)	*Impacts at product level, PED, water footprint, GW, FD, MED, HT, Eutrophication, IR, MD,OD, POF*	Canned packaging has high PED, GWP, and MD. Recommendations for improvement by increasing environmental control on*hotspot*, an appeal to consume local fruit, reduce waste, and decarbonize energy
Karlsoon dan Roos (2021) (Morfeldt et al., 2023)	*Plant-based foods* (including pineapple)	90 products divided into 5 food products (including fruits)	*Climate impact, biodiversity impact, water use, pesticide use*	This research provides a way to use large amounts of data of varying quality, and reduces the complexity of evaluating environmental impacts

Andarani *et al.*(2017)	Canned pineapple	Energy balance and the benefits of implementing a clean canned pineapple production system	Cost savings from the use of biogas and sludge utilization	Disposing of organic waste on a regular basis resulting from the screening process of the biogas production process, benefits in the utilization of sludge and the use of biogas
Agus setiawan (2016)	Canned Pineapple	energy consumption from steam and electricity to produce products*canned pineapple* and*juice concentrate* in each department.	Energy demand development scenario	Savings on the use of steam and electricity will have implications for saving coal fuel, because steam and electricity are generated from the coal heating process that occurs in the department.*coal generator*.
Or*et al.* (2019)	Tamarind herbal product	*Cradle-to-grave* (raw materials to consumers)	*Climate change, eutrophication, Photochemical oxidation*	Utilization of solid waste for organic fertilizer and liquid waste as organic liquid fertilizer, reuse*(re-use)* waste water, and community empowerment
Recanati*et al.*(2018)	*Cupuacu jam*(fruit jam)	*Cradle-to-grave* (handling of raw materials until distributed to retail)	6 dampak (AD, GW, OD, POC, AC, EU)	Reducing the use of fertilizer doses, developing agro-ecosystems
Ahmad *et al.* (2019)	Food production and manufacturing industry	2010-2018 publication review analysis (*Cradle-to-grave dan cradle-to-factory*)	-	Pay attention to endpoint impact*(end-point)* not just the midpoint*(mid-point),*
Chaerul and Allia (2019)	LCA Studies in Indonesia	LCA Research which is published in national journals (2010-2016)	There are 17 journals dfrom bioenergy, plantation, animal husbandry, aquaculture, waste management, water treatment and various kinds of manufactured products	Improvement of research quality

4. Conclusion

Based on the literature review, it can be seen that the results of the life cycle assessment (LCA) analysis on fresh and canned pineapple products have a significant impact on several impact categories. The trend of publications in food production and manufacturing industries in recent years shows that cradle-to-grave and cradle-to-factory gate are the most commonly used scopes of analysis compared to other scopes, where processed fruit-based products tend to be analyzed cradle-to-grave. However, the dominant LCA scope used in canned pineapple production processes is cradle-to-gate. Meanwhile, LCA publications conducted in Indonesia are still relatively limited with research quality that needs to be improved. This provides an opportunity to conduct a cradle-to-gate LCA study on canned pineapple to calculate 3 environmental impact categories (GWP, acidification, and eutrophication).

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