



IMPLEMENTATION OF CLEAN PRODUCTION SYSTEMS IN THE PINEAPPLE FRUIT PROCESSING BUSINESS TO INCREASE EFFICIENCY

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ABSTRACT

Only a small portion of pineapple fruit produced by farmers is processed modernly, and the rest is processed by home industries that process pineapple fruit into jam, lunkhead, chips, fruit juice, and fruit flour in the traditional way using simple equipment. In the management of pineapple fruit, most of them only use the fruit flesh,

while the skin, cob, and crown of the fruit still contain nutritional value that has not been utilized optimally. The basic problem for small industries in waste management is the lack of knowledge from business actors and the lack of awareness of waste management. With the implementation of clean production management, the management of processed pineapple fruit waste is expected to increase the efficiency of the production process and support environmental balance. Pineapple processed waste management can be carried out with the 3R principle, namely reduce, reuse, and recycle, by business actors, local communities, and farmers because it does not require large capital but can provide tangible results that can be utilized directly, has high economic value, creates jobs, and maintains the balance of the environment. A waste management model like this can be used as a model for other fruit-processing businesses that produce organic waste.

KEYWORDS: Clean production, efficiency, pineapple skin, waste.

INTRODUCTION

Many types of fruit are mainly produced in Indonesia and have the potential to be developed into processed products such as canned fruit, fruit juice, candied fruit, jam, and other

processed fruit products. Types of fruit that are usually processed are mangoes, oranges, pineapples, passion fruit, and others. The demand for organic tropical fruit (green product, eco production) is increasing both for domestic and foreign consumption due to public awareness of food safety and environmental sustainability.

Pineapple is a type of tropical fruit with a sweet and sour taste that is in great demand and is grown by the people of Indonesia. According to the Central Statistics Agency (BPS) in 2021 pineapple production will reach 2.89 million tons and grow 17.95% compared to 2020. The largest production is contributed by the province of Lampung.^[1] Exports of processed pineapple products are increasing year by year, one of which has been achieved by a pineapple processing company in Lampung, namely PT Great Giant Pineapple Co (GGPC), which reported that processed pineapple exports in 2020 reached IDR 87 billion and in 2021 increased to IDR 151 billion.^[2] This will be a great opportunity for other processed fruits. The pineapple processing business, which is mostly done on a small scale, is increasing year over year. Only a small portion of pineapple fruit produced by farmers is processed modernly, and the rest is processed by traditional home industries using simple equipment. Home industries usually process pineapples into jam, lunkhead, chips, fruit juice, and fruit flour.^[3] In pineapple-producing areas, it is necessary to develop an integrated agro-industry so that it can increase the added value of fruit business actors, farmers, and the surrounding community so that circular economic growth occurs.^[4] In general, in the management of pineapple fruit by small businesses, they only use the fruit flesh, while the skin, tubers, and crowns of the fruit, which still contain nutritional value, have not been utilized optimally. Waste from pineapple fruit processing activities is organic waste, and if it is not handled seriously, it will have an adverse impact on the environment. Therefore, waste management must be carried out from upstream to downstream so that it does not pose a threat of pollution, which is fatal to the environment.^[5]

Waste is a very serious problem, so there is a need for environmentally friendly industry regulations.^[6] The fundamental problem for small industries in waste management is the lack of knowledge among farmers and businessmen and the lack of awareness of waste management. Organic waste contains organic components that are easily decomposed and destroyed by the activities of microorganisms and, if not controlled, can have a very harmful impact on the environmental ecosystem. Waste, if managed properly, can provide benefits to

all parties with an interest in waste, such as the surrounding community, businessmen, farmers, and local governments.^[7]

The purpose of this article is to explore alternative applications of clean production systems for pineapple processing businesses to improve production efficiency through waste management and support environmental balance. The benefits of this article include increasing knowledge for pineapple processing businesses, local communities, and pineapple farmers to utilize waste from pineapple processing to create economically valuable products.

RESEARCH METHOD

The exploration of data regarding solid waste management in pineapple processing businesses in Kediri is conducted using qualitative methods. This includes direct observation of the entire process, from raw material procurement to product distribution, waste disposal, and other related activities. Interviews are also conducted with pineapple processing workers, pineapple farmers, and local communities to identify important factors in solid waste management, such as pineapple skin, core, crown, and pulp. The data is then analyzed, taking into account the interests of all parties involved, including pineapple processing businesses, local communities, and pineapple farmers, to ensure that everyone benefits.

RESULTS

The byproduct of pineapple fruit processing

According to the Ministry of Environment and Forestry, in 2022, the amount of waste in the final disposal site (TPA) will reach 19.45 million, with 60% being organic waste.^[8] Improper management of this waste can lead to uncontrolled fermentation, resulting in unpleasant odors and the production of methane (CH₄) and carbon dioxide (CO₂) gases that contribute to greenhouse effects and global warming. Currently, the government and the world are making efforts to minimize global warming caused by human activities. However, waste management remains a significant issue, which can have negative impacts on both local and global environments.

According to BPS data in 2021, pineapple production in Indonesia reached 2.89 million tons and is expected to increase in the coming years. Pineapple waste, which includes the skin, crown, core, and fruit residue, accounts for 27% of the total production.^[9] As a result, in 2021, pineapple production can generate approximately 0.78 million tons of solid waste,

which is organic and easily decomposable, causing unpleasant odours. Most of the waste ends up in landfills, and only a small portion is processed into more useful products.

The pineapple skin contains high levels of sugar and carbohydrates, with carbohydrate content at 17.53%, crude fibre at 20.8%, sugar at 13.65%, and protein at 4.41%. Waste analysis of pineapple skin showed cellulose content at 14%, hemicellulose at 20.2%, lignin at 1.5%, ash at 0.6%, and cell soluble matter at 64.8%. The fruit crown contains cellulose at 29.6%, hemicellulose at 23.2%, lignin at 2.3%, ash at 0.2%, and CSM at 61.4%. With simple technology, the waste can be utilized for fruit juice, animal feed, or fertilizer.^[12,13] Dry pineapple skin can be used to produce biodiesel through fermentation process, resulting in bioethanol with a 95.66% ethanol content after 4 days of fermentation.^[14] Meanwhile, pineapple skin waste can be processed into lactic acid through fermentation process. Pineapple skin waste is a potential energy source due to its high carbohydrate content of 71.6% BETN and 9.35% crude fiber. It also contains a high amount of fiber (NDF) at 57.3%, while crude protein is low at 3.5%. Therefore, pineapple skin has great potential as an alternative feed for Rumenia cattle, especially for cows.^[15] The dried waste of pineapple contains 93.79% dry matter, 5.76% protein, 24% crude fiber, 0.93% fat, and 6.08% ash. Fermenting this waste can yield significant results as an additional feed for chicken, with a formulation of 12%-20%.^[16] Pineapple peel can also be utilized to make sweet syrup, as it still contains 13.65% sugar. Students from MAN Brebes Jawa Tengah have already practiced this by adding other ingredients such as starfruit, sugar, ginger, and salt.^[17] Pineapple peel waste can also be turned into multi-functional organic liquid fertilizer through other fermentation technologies.^[18,19,20,21] Additionally, the waste can be used as raw material for making food items such as nata de-pina.^[22]

The utilization of waste from production activities is a crucial consideration that must be considered. It is imperative that every production process implements clean production management by minimizing waste or achieving zero waste to sustain the production process. This can be achieved by starting waste management from the production process, thereby minimizing final waste and improving process efficiency.^[23,24]

The handling of excess materials generated during the manufacturing process

The paradigm of waste management that focuses on the end approach should be replaced with a new paradigm that views waste as a resource with economic value, such as for energy, animal feed, fresh syrup, compost, liquid fertilizer, eco-enzymes, or as raw materials for other

industries. Waste treatment must be done comprehensively from upstream, starting from before a product is produced that potentially generates waste, to downstream, when the product is used and becomes waste that is then safely returned to the environment.

Based on the paradigm, there are several aspects (3R) that must be considered in managing processed pineapple waste, which are as follows: [no further elaboration provided].

Reduce, The principle of waste reduction is fundamental in waste management. All production processes can aim to minimize waste, including liquid, solid, and gas waste. In the case of pineapple processing, minimizing solid waste can be achieved by efficiently using the raw pineapple material, resulting in less waste production. Additional processes, such as blending pineapple skin to produce fruit juice or turning it into pineapple skin flour by drying and grinding it, can also reduce solid waste. These methods can effectively decrease solid waste output from production and increase production efficiency.

The awareness to reach this stage is still very low due to the lack of a mature calculation of the profit and loss from adding those activities. Most still believe that pineapple skin waste is not suitable for further processing, and it is better to use fresh pineapple as a new raw material. Therefore, from field observations, business actors have not yet thought about efforts to increase efficiency in the use of raw materials because they assume that the price of raw materials is cheap and very affordable.

Reuse, which involves the effort to utilize waste or by-products produced from a production process. This utilization can be in the form of further processing or for other activities. In the pineapple processing industry, there are already efforts to utilize the waste from the fruit's skin, although it is still limited to being used as animal feed or directly discarded without processing. Observation shows that the direct use of solid waste from pineapple processing is still very limited and mostly ends up in garbage dumps. Collaboration between the pineapple processing industry, the surrounding community, and farmers must be improved to provide greater opportunities for the utilization and management of waste produced.

Recycling is the final principle in waste management. It involves transforming waste into new products that have economic value. The recycling process requires specific technology and is more expensive than the reduce and reuse processes. Recycling pineapple waste can have significant benefits, such as realizing a circular economy and sustainable development,

increasing community income, creating jobs, and improving resource and energy efficiency.^[25] There are several recycling processes that can be applied to pineapple waste, including fermentation for bioethanol, compost, and liquid fertilizer, as well as eco-enzymes. Pineapple skin flour can be made simply by drying it in the sun and then grinding it into powder.^{[26][27]}

Through observation and direct interviews with pineapple processing business owners, it has been found that there are several issues regarding waste management. To minimize the amount of waste produced and recycle it into high value economic materials with simple technological interventions, an appropriate formulation is necessary. This will have a positive impact on the ecosystem and environment through green production methods. The involvement of relevant local government and academic institutions is expected to provide continuous education on zero waste production to business owners, communities, and farmers, which will ultimately lead to increased production. Success in this matter will raise awareness among all members of the community about the importance of clean production management to create a healthy and green environment. This applies not only to the processed pineapple industry but also to home industries, supporting the global campaign on the importance of zero waste for increased efficiency and productivity.^[22]

CONCLUSION

The identification of waste from pineapple processing in the Kediri region has revealed direct problems with waste management, not only in production processes but also in the potential economic and added value benefits. This highlights the need for ongoing education from relevant local government officials and universities, benefiting business owners, local communities, and farmers, in order to achieve a balanced ecosystem. Pineapple processed waste management can be carried out by business actors, surrounding communities, and farmers because it does not require large capital but can provide real results that can be utilized directly and has high economic value, so a waste management model like this can be used as a model for fruit processing businesses. others that generate organic waste.

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