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Development of Wastewater Treatment System for Coconut-Based Food Production

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ABSTRACT

Coconut-based food production, particularly coconut jelly processing, is a key industry among SMEs in Samut Songkhram province. However, a manufacturing process generates a large volume of wastewater per day that released into the surface water causing water pollution and foul odors. This study aims to develop and implement an appropriate wastewater treatment system for coconut jelly and white coconut meat processing industries, with the goal of establishing practical design specifications for SME applications. The design of the developed wastewater treatment system depends on the volume of wastewater generated from the production process. The treatment system consists of an anaerobic pond (serving as a combined equalization and grease trap pond), an aeration pond, and a sedimentation pond. In 2024, the pilot plant wastewater treatment system for coconut jelly production was installed at SME entrepreneurs in Samut Songkhram province. The pilot plant wastewater system has been designed for the influent 5 m^3/day. The designed consist of (1) 25 m^3 anaerobic pond with retention time 5 day, (2) the 6 m3 aeration pond with oxygen transfer rate 5.3 Kg.O_2/day, retention time 1.2 day and (3) 1.8 m3 sedimentation pond with retention time of 0.4 day.

The results indicate that, when compared with the Notification of the ministry of natural resources and environment on the establishment of wastewater discharge standards from small enterprises producing goods or providing specific services, B.E. 2564 (Group 2). The results of the implementation of this system demonstrate that the effluent pH of 6.1 – 6.4, within the standard range (5.5 – 9.0). BOD ranged from 5 – 58 mg/L, meeting the standard (≤60 mg/L) with 96.77 – 98.27% removal. TSS ranged 6 – 20 mg/L, within the standard (≤ 50 mg/L), with 87.26 – 97.62% removal. Oil and grease were undetectable, achieving 100% removal (≤ 20 mg/L).

The developed wastewater treatment system effectively reduced organic pollutants and improved effluent quality, providing a sustainable and practical model for wastewater management in coconut-processing SMEs.

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Introduction

Coconut is an important economic crop in Thailand. Coconut-processing businesses, including coconut collection centers (longs), community enterprises, and household-scale operations, are growing rapidly and expanding most extensively in Samut Songkhram Province. This expansion has caused environmental impacts, as the coconut production process generates a large volume of wastewater each day. Wastewater from soaking, washing coconut meat, and producing coconut jelly is discharged into public canals, resulting in water pollution and unpleasant odors, as widely reported in newspapers and various media outlets. In 2017, the Governor of Samut Songkhram Province ordered an inspection and the

closure of illegal coconut-processing establishments (longs) that lacked wastewater treatment systems or operated with substandard treatment facilities. This incident raised significant concern among local communities regarding environmental quality in the province. Recognizing the environmental impacts caused by these operations, authorities took action to address the issue. Office of Samut Songkhram provincial farmers council coordinated with the Department of Science Service (DSS) to find ways to develop and improve wastewater treatment systems for coconut processing. During a preliminary field survey and wastewater sampling conducted by DSS on 6–7 February 2018, it was found that coconut-processing operators generated approximately 500 – 7,000 liters of wastewater per day from activities such as soaking white coconut, washing, producing coconut jelly, cold-pressed coconut oil, or processing other coconut-based products. Some establishments discharged untreated wastewater directly into canals within orchards connected to public waterways. Several operators had constructed wastewater settling ponds, grease traps, and treatment ponds; however, these systems were still insufficiently effective.

Coconut-based food production, particularly coconut jelly processing, is a key industry among SMEs in Samut Songkhram province. However, a manufacturing process generates a large volume of wastewater per day [1,2]. Since there was no appropriate technology applied for wastewater treatment, thus the effluent which over Thailand national discharge standard released to the environment caused water pollution (Figure 1) and complaint

by the community nearby [3,4]. Furthermore, the intermediate products from coconut processing entrepreneurs without wastewater management system cannot delivers to factory which usually certified by ISO14001 for final production.

Department of Science Service (DSS), recognizing the importance of addressing this issue, conducted research and developed wastewater treatment technology for the coconut-processing industry by integrating physical and biological methods. This approach aims to make coconut processing an environmentally friendly process, thereby promoting and supporting a stable and sustainable green economy. Furthermore, once the research and development process has been completed, resulting in a wastewater treatment system, treatment methods, and optimal operating conditions, the researchers must implement a plan and management strategy to ensure the practical application of the developed technology. This involves transferring the technology and installing the developed wastewater treatment systems for coconut-processing operators in Samut Songkhram Province, in order to achieve tangible and highly effective results. Moreover, the wastewater treatment system for coconut processing can serve as a model for other districts within Samut Songkhram Province, as well as for other provinces with a large number of coconut-processing operators, such as Ratchaburi, Prachuap Khiri Khan, and Chumphon. This aims to promote proper and sustainable wastewater management at the local level.

Figure 1: Water Pollution Cause from Coconut Processing

Methods

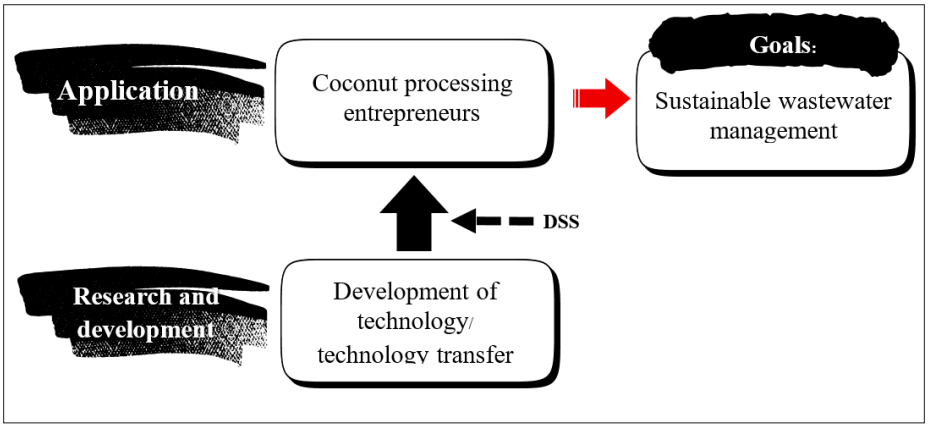

Figure 2: Research Frame Work

Results & Discussion

Operational Test Results of the Wastewater Treatment System

The pilot plant wastewater treatment system for coconut jelly production was installed at SME entrepreneurs in Samut Songkhram Province. This pilot wastewater treatment system was designed to handle an influent volume of 5 m^3/day, as shown in Table 1.

Table 1: The Removal Efficiency of Pilot Scale Wastewater Treatment (Unit: mg/L)

Parameters	1st Sampling (June 28, 2024)			2nd Sampling (September 16, 2024)			Standard[1]	Standard[2]
	Influent	Effluent	Removal efficiency (%)	Influent	Effluent	Removal efficiency (%)		
pH (unitless)	4.6	6.1	-	4.5	6.4	-	5.5 - 9	5.5 - 9
COD	3,810	95	97.51	2,543	133	94.77	≤120	-
BOD	1,796	58	96.77	1,616	28	98.27	≤20	≤60
TKN	607.1	425.1	29.98	512.9	462.7	9.79	≤100	-
TSS	154	17	87.26	840	20	97.62	≤50	≤50

TDS	3,554	3,423	3.68	2,274	3,414	-33.39	≤3,000	-
Oil and grease	4.5	ND	100.00	5.0	ND	100.00	≤5	≤20

Note:"1" = Notification of the ministry of industry on the establishment standards for wastewater discharge from factories, B.E. 2560
"2" = Notification of the ministry of natural resources and environment on the establishment of wastewater discharge standards from small enterprises producing goods or providing specific services, B.E. 2564 (Group 2) "ND" = Not detected

Table 1 The results indicate that, when compared with the Notification of the ministry of natural resources and environment on the establishment of wastewater discharge standards from small enterprises producing goods or providing specific services, B.E. 2564 (Group 2). The results of the implementation of this system demonstrate that the effluent pH of 6.1 – 6.4, within the standard range (5.5 – 9.0). BOD ranged from 5 – 58 mg/L, meeting the standard (≤60 mg/L) with 96.77 – 98.27% removal. TSS ranged 6 – 20 mg/L, within the standard (≤ 50 mg/L), with 87.26 – 97.62% removal. Oil and grease were undetectable, achieving 100% removal (≤ 20 mg/L).

The developed wastewater treatment system effectively reduces organic matter and contaminants in the effluent, resulting in improved water quality and providing a sustainable model for small and medium-sized enterprises (SMEs) in wastewater management. This makes coconut processing an environmentally friendly process, thereby promoting and supporting a stable and sustainable green economy.

Figure 3: Installation and Operation of Pilot Scale Wastewater Treatment System

Conclusion

This research was initiated in response to the needs of coconut-processing operators in Samut Songkhram Province. many operators faced difficulties in supplying coconuts to industrial factories due to inadequate wastewater management. In addition, several establishments received temporary closure orders from the Samut Songkhram provincial authorities for discharging untreated coconut-processing wastewater into natural water bodies. Therefore, the researchers conducted this study and development, even though it involves simple technology or existing technologies. These technologies had not previously been studied, researched, or adapted specifically for coconut-processing establishments, which require a simple yet highly effective wastewater treatment system. This work has thus created new knowledge for coconut-processing operators in the area through the transfer of technology and installation of the developed wastewater treatment systems for operators in Samut Songkhram Province. This aims to make coconut processing an environmentally friendly process, thereby promoting and supporting a stable and sustainable green economy. In addition, entrepreneurs are able to supply their products to large industrial factories and major distributors or retailers, contributing to stable and sustainable economic growth in Amphawa District, where the community members are stakeholders, while continuously creating jobs and livelihood opportunities for the local community.

This approach can support the sustainability of ecotourism in Amphawa District and serve as a model for other areas in Samut Songkhram Province, which is home to nationally renowned floating markets. When the numerous coconut-processing operators in the area manage their environmental impact properly and treat their wastewater before discharging it into natural water bodies, water quality improves and the community's quality of life is enhanced.

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