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Community Empowerment at Air Telang Protected Forest Area on Green Production of Nata de coco and Swamp Water Filtration

M Verawaty[1*], B Lakitan[2,3] and S Herlinda[4,5,6]
[1]Biology Department, Faculty of Mathematics and Natural Sciences, Sriwijaya University, South Sumatera, Indonesia
[2]Faculty of Agriculture, Sriwijaya University, South Sumatera, Indonesia
[3]Ministry for Research & Technology (RISTEK), Republic of Indonesia, Jakarta, Indonesia
[4]Plant Pest and Disease Department, Faculty of Agriculture, Sriwijaya University, Indonesia
[5] Crop Science Program, Graduate School, Sriwijaya University, Indonesia
[6]Center for Sub-optimal Lands (PUR-PLSO), Sriwijaya University, Palembang, Indonesia
[*]Corresponding author: marieskaverawaty@yahoo.com

Abstract. Banyuasin Regency, one of the regencies in South Sumatera Province, has abundant natural resources such as coconut plantations that produce wastes. Mostly they are located in Rimau, Muara Telang, Tanjung Lago and Banyuasin II sub-districts. Sri Tiga Village is one of 10 villages in the Sumber Marga Telang which is a division of the Muara Telang sub-district. Currently, the potentially produced wastes are still unmanaged properly. Besides, there are also raising problems in this area, some of the coconut plantations are located in protected forest areas, there are great pressures for occupation from the community around the protected areas for cultivating crops to meet their needs, and this made deforestation and forest degradation unavoidable. One of the solutions can be offered for solving those problems is to increase the income of the forest communities, especially by utilizing the available natural resource in the area such as coconut water waste for producing nata de coco. The abundance of coconut and copra products has not been utilized, with technical assistance in the production of nata de coco, it can increase the income of the people around the forest, and therefore the pressure on the forest occupation can be decreased. Besides the waste, clean water also a problem in this area, in this program the community was also introduced a simple and reliable technology for swamp water filtration.

1. Introduction

Banyuasin Regency is one of the regencies in South Sumatra Province. Based on data from the Central Statistics Agency of Banyuasin Regency in 2017, its area covered around 11,832.99 Km^2 which is located between 1.3000 '- 4000' South Latitude and 1040 40 '- 1050 15' East Longitude. It consists of 19 sub-districts covering 288 villages. The widest sub-district is Banyuasin II with an area of 3,632.40 Km^2 or around 30.70% of the total area of Banyuasin Regency. Sumber Marga Telang is the smallest sub-district with an area of 174.89 Km^2 or about 1.48% of the total area of the Regency [1].

Banyuasin, apart from its geographic position, its location is also strategic; it is located on the inter-provincial traffic route. Besides, its natural resources are abundant, it is also known as the rice granary in South Sumatra. Its plantation commodities are the leading sector of this regency. According to the Central Bureau of Statistics for Banyuasin Regency in 2017, rubber, palm oil, and coconut are the biggest commodities compared to other plantation commodities. Production of coconut commodities in a row from years 2015, 2016 and 2017 reached 44,269 tons, 44,058 tons and 44,248 tons respectively [1].

Residential communities' coconut plantations can be found in almost the entire Banyuasin Regency, whereas there are four sub-districts that have a large amount of coconut production, which are located in Rimau, Muara Telang, Tanjung Lago and Banyuasin II sub-districts. Based on this condition, the Banyuasin Regional Government has determined the four sub-districts to become the Production Centre for coconut fruit and its derivatives. Therefore, due to the wide potential of coconut trees and its products such as copra, this community empowerment program was conducted in these two sub-districts (Sumber Marga Telang and Banyuasin II); these two sub-districts production in 2017 were reported as follows; its plant area covered of 5,444 Ha and 9,177 Ha respectively; The total production is 4,742 tons and 9,900 tons respectively [1].

Beside those potentially wasted resources, there also problems raised in this area, such as some of the community coconut plantations are located in protected forest areas, even sometimes the pressure for occupation from the community around the protected forest is high, and their basic needs for living conditions is the biggest triggering factor. The community tends to extend their crops cultivation to the protected forest and caused deforestation and forest degradation.

Solutions can be offered to increase their income, and it is preferred to be based on the available natural resource in the area; these include the clean and green technology for nata de coco production and swamp water filtration that utilize the coconut's water waste and charcoal. This program is actually in line with the Palembang Banyuasin protected forest management unit (KPHL) Long-Term Forest Management Plan (RPHJP); in this case, the KPHL UPTD Unit III Palembang-Banyuasin plans to conduct community empowerment activities in their working areas, especially for the community whom live and grow crops in and surround the protected forest. Through this Community Partnership Program (PKM), it is believed that cooperation between the university and the community will be established; and also the community service framework is also parts of the Tri Dharma Perguaruan Tinggi.

Nata de coco currently is marketed as coconut gel; it is produced by coconut water fermentation. The gels are microbial cellulose that is produced by *Acetobacter xylinum*. Nata de coco is originated from the Philippines, the gels are famously mixed with ice cream, puddings and fruit cocktails [2]. Its name comes from the Spanish and means "cream of coconut" or "coconut milk-skin" [3]. Nata de coco is a natural cellulose resources, it only consists of glucose as the monomer with unique characteristic [4, 5] its unique characteristic includes its cellulose physiochemical properties that differ from plant cellulose [5]. Nata de coco is also low-calorie food that suitable for diet and diabetics [6]. Another benefit of nata has been studied such as its potential possibility for preventing colon cancer [7]. Compare to the cellulose derived from wood pulp material, cellulose produced by *Acetobacter* strain is pure (contamination free from other polysaccharides); besides, it is also environmentally friendly compared to the wood pulping that potentially cause deforestation [8, 9].

2. Methods

This community empowerment program consisted of three main activities which are clean water production (swamp water filtration), nata de coco production and its wastes treatment (nata de coco clean production).

2.1. Clean water production (Swamp water filtration)

Swamp water filtration was installed by adopting the aerator pump filter and stirrer model that known as the TP2AS Model with some modifications [10]. It consisted of three main stages:

neutralization, coagulation, and filtration. The neutralization of acidic peat swamp water was performed by adding and mixing it with alkaline (limestone). Coagulation, a process of deposition and separation of dissolved solid particles from the water through particles binding followed by large particle settling prior to a separation step, this process used alum ($AL_2(SO_4)_3$) as coagulants; in case the alum unavailable, *Moringa Oleifera* seeds and clay can be used as a replacement. The filtration was the filtering step of coagulation product to produce cleaner water. Illustration of this technology is presented in figure 1.

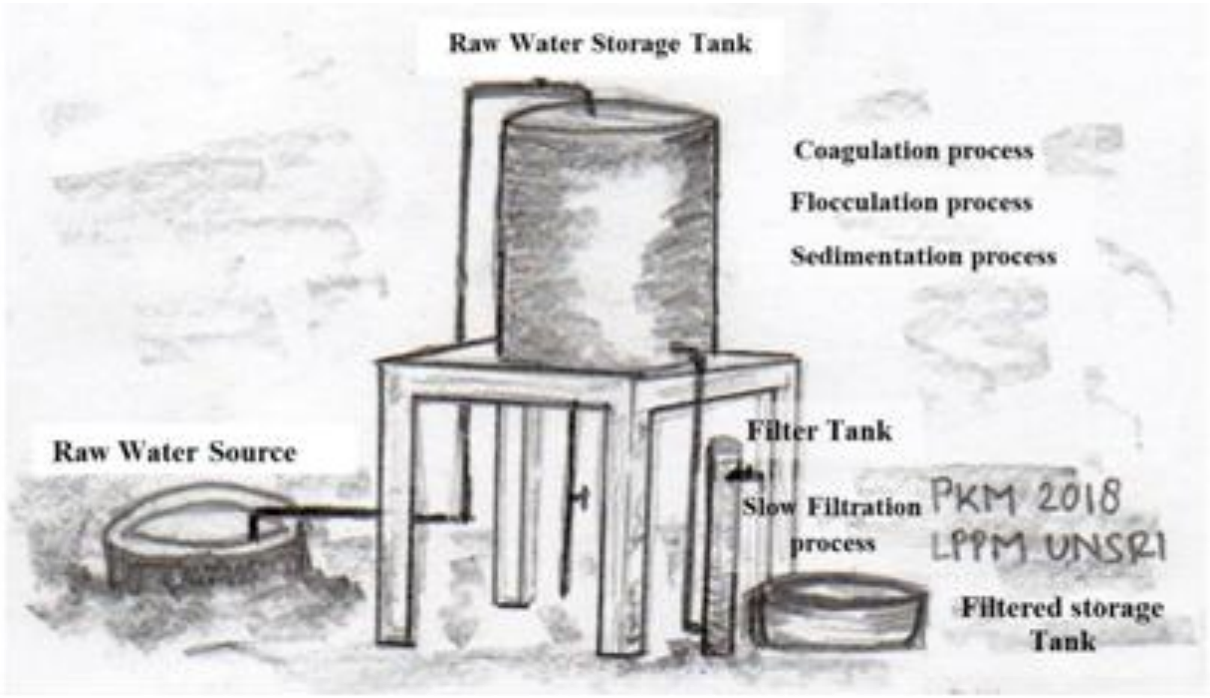

Figure 1. Swamp water purification system by using a modification of TP2AS method by Said, and Wahjono [10]. Image for illustration is modifications has been made during this program.

Types of equipment used for the clean water production are a tank (220 L) that was used as the raw water storage. In the tank, two drain holes were made, first for the disposal of sediment which was placed on the bottom of the tank; the second hole was located on the edge of the tank with a height of 15 cm from the bottom of the tank; it was used to drain clean water from the filtration deposits. The stirring stick was made about 125 cm long; it was made in 2 ways (fast and slow stirring). Filter pipe connected to the tank was made of polyvinyl chloride (PVC) with a height of 110 cm; the inlet hole was on the bottom and the outlet on the top for filter material cleaning. The composition of filter media from top to bottom consisted of 9 layers that are presented in figure 2: layer 1 contains coir or foam (thickness 10 cm), layer 2 was activated charcoal made from coconut shell charcoal (10 cm thick). Layer 3 was zeolite (thickness of 10 cm). Layer 4 was silica (10 cm). Layer 5 was manganese (10 cm). Layer 6 was coarse (10 cm). Layer 7 was fine sand (10 cm). Layer 8 was corn gravel (10 cm) and layer 9 was coir or foam (10 cm). Activated charcoal (coconut shell charcoal) was broken into small pieces of diameter ± 0.5-1 cm was used for odors and chlorine absorption, water purification, produce a better taste. Zeolite is important for increasing oxygen levels and absorbing the added lime, as well as to remove iron or Manganese from the water. Silica is important for removing sludge, soil and small particles in the sediment, while coarse, fine sand and gravel funnel is important to filter fine dirt in the water. Chlorine was used to kill bacteria, viruses, and germs and increase pH.

Water filtration steps are carried out through the following stages; firstly, the raw water was added into the tank. Lime powder (4-6 tablespoons) or around 60-80 grams was dissolved into a small bucket with the raw water and was added back into the water tank while stirring. An aeration hose was inserted into the tank from the bottom and pumped for 50-100 times. Alum powder (4-6 tablespoons) or 60-80 grams were dissolved and added into raw water that has been aerated and stirred quickly through one direction for 1-2 minutes. After that, the stirrer was removed and let the water in the tank rotated until stop and then it was left for 45-60 minutes. The drain faucet was then opened to remove dirt deposits. Finally, the processed water (clean water) was ready for use.

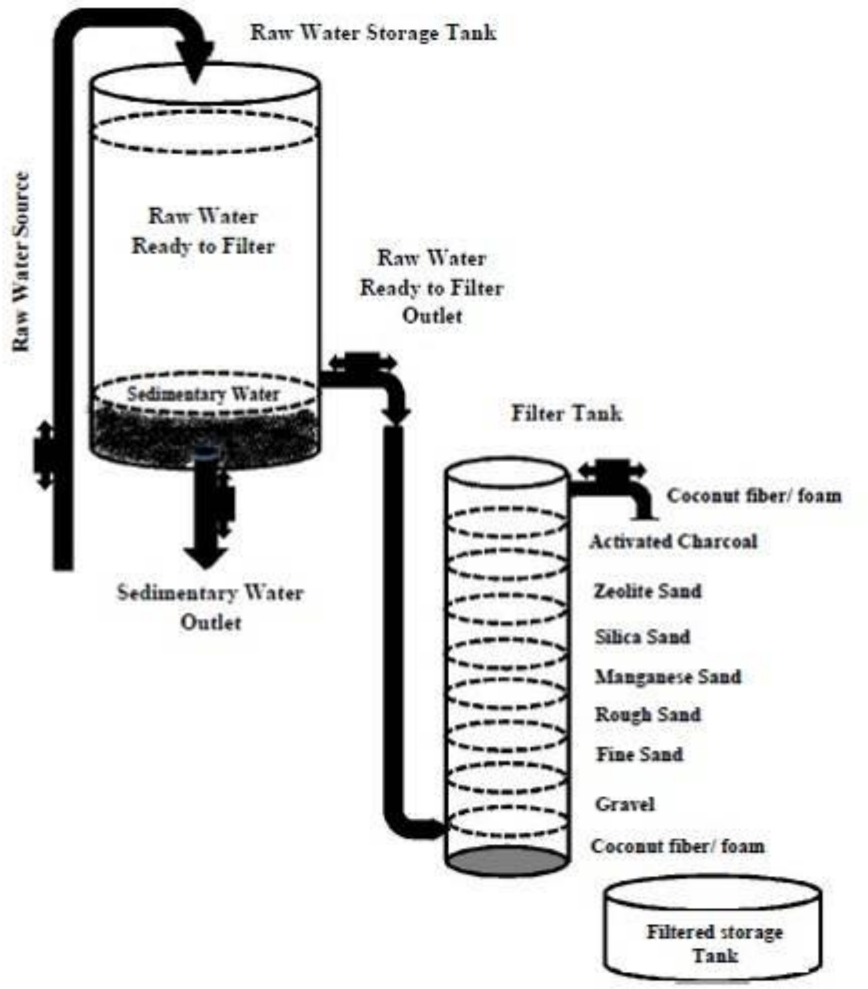

Figure 2. Peat swamp water purification installation, the modification of the TP2AS method by Said, and Wahjono [10].

2.2. Nata de coco production

During this program, the nata de coco production followed methods and procedures had been done by Verawaty [11] and Ria Merlita [12]. There were three steps were done on the nata de coco production: the first step was nata de coco seeds/starter multiplication, nata de coco production and post-harvesting, details of the methods are presented in the following sections:

2.2.1. Seed multiplication

Growth medium for seeds multiplication consisted of coconut water that was pre-fermented for 12 hours before being used for growth medium, and then it was precipitated and filtered. Sugar

(100g) and urea (3g) for 1 liter of coconut water were added, and then boiled and left to achieve room temperature, glacial acetic acid was added, the concentration was 10-20 ml of acetic acid for every 1 liter of coconut water and 10 % (v/v) of ready seed stock (age of three days) was added to the media, after that they were bottled and fermented for 3 days prior to being used as nata de coco seeds for the production.

2.2.2. Nata de coco production
Fresh coconut water was pre-fermented for 12 hours and filtered, and then sugar (100g) and urea (3g) for 1 liter of coconut water were added, and then boiled and left to achieve room temperature, acetic acid was added (10-20 ml/liter) and 10 % (v/v) of ready seed stock was added to the media. Then they were bottled and fermented for 15 days. The volume of 300 ml media for nata production was poured into the fermented bottles and containers for each fermentor. After 15 days the layer of thick nata (1.5 - 2.0 cm) was formed and ready for harvesting process.

2.2.3. Harvesting and post-harvest process
The nata layer was taken from the fermentor and then washed with clean water. The thin layer in the nata was removed with a knife. The nata was soaked in running water and boiled. Nata was cut and washed three times until no acid odor was smelled. The process was repeated for three consecutive days. Sugar and flavor were added for finishing steps and the nata was ready for a drinkable product.

2.3. Nata de coco wastes treatment
The waste treatment process from the Nata de coco production process was done with these following methods based on approached had been performed by Hakimi [13] with some modifications. After nata de coco had been produced, there were solid and liquid wastes that potentially caused environmental pollution that is needed to be treated. Hakimi [13] classified these wastes into waste resulting from filtering coconut water or liquid waste, skin layer, unused waste, remaining pieces of nata, and remaining plastic packaging.

2.3.1. Fertilizer Production
The solid and liquid wastes can be processed to make fertilizer; all the dirt materials were collected from filtering coconut water, nata skin layers, remaining unused pieces and failed nata product were materials to be composted for fertilizer. Before the pre-fermented process, every 100 kg of waste in the form of dirt was mixed with 10 kg of lime. The function of lime was to neutralize the pH [13].

2.3.2. Jelly drink Production
Jelly drink was produced from thin or unsuccessful nata production. Thin nata layer was washed until clean and odorless, and then boiled for 20 minutes until the nata pieces become chewy. Around 100 ml of water was poured to around 250 grams of and then blended until smooth. Sugar and essence flavor were added during the boiling process and left cooled before packaging process [13].

2.3.3. Liquid waste treatment by filtration
Wastewater filtration was introduced during this program to clean the wastewater from the nata de coco production. Residual nata water from the washing process as well as from the skin layer and also waste water from other processes was treated by filtering the wastewater through a similar procedure as described in the swamp water filtration as previously described at point 2.1 with some modification because the filtered water will not be used for daily consumption [13].

3. Result and discussion

3.1. Information about Partner Location for Community Partnership Program

Partner villages in this Community Partnership Program are administratively located in Teluk Payo Village, Banyuasin II Sub-district and Sri Tiga Village, Sumber Marga Telang sub-district, Banyuasin Regency, these locations are ± 60 Km and ± 65 Km from Palembang City and ± 90 Km and ± 95 Km from Unsri-Indralaya Campus respectively. Map of Activity Partner Locations can be seen in the figures 3A and 3B. The location of the partners is in forest area management of the Telang and Muara Musi Protected Forest Resort Areas, UPTD KPH Unit III Palembang-Banyuasin South Sumatra Province Forestry Service. Map of the working area of the Telang and Muara Musi Protected Forest Areas, UPTD KPH Unit III Palembang Banyuasin South Sumatra Province Forestry Service can be seen in figure 4.

Overlay results of the partner location map and resort work area map above suggested that part of the partner area is included in the protected forest area, and the land cover is in the form of a coconut plantation owned by the community, this indicates the encroachment of forest areas by the villagers. The communities in this village tend to extend their plant cultivation that caused deforestation and forest degradation.

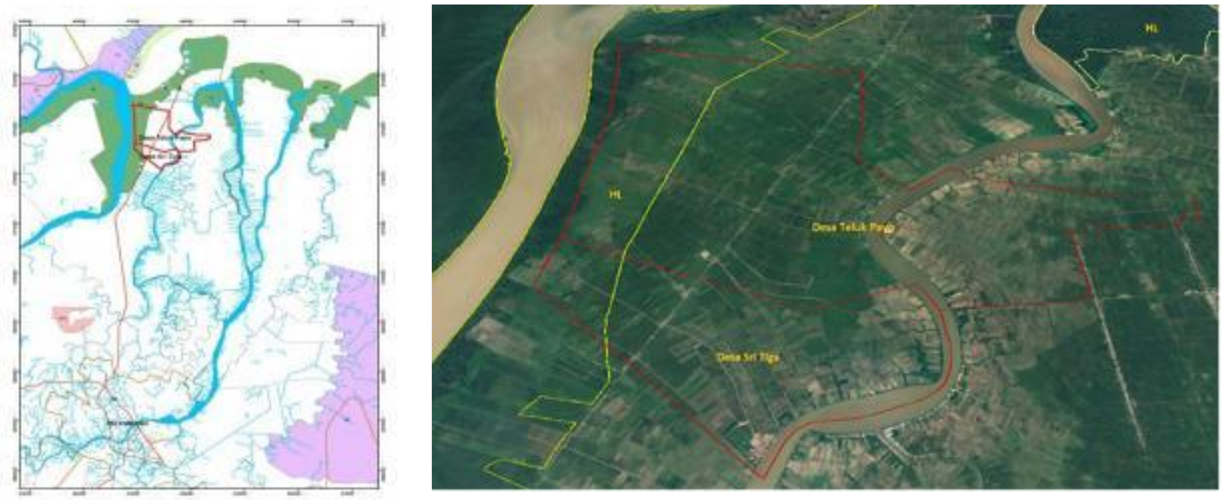

Figure 3. Location of Sri Tiga village, Sumber Marga Telang sub-districts, and Teluk Payo village, Banyuasin II sub-districts, Banyuasin Regency (3A). Location of the Sri Tiga, and Teluk Payo villages, which are included in the Air Telang Protected Forest Area (3B).

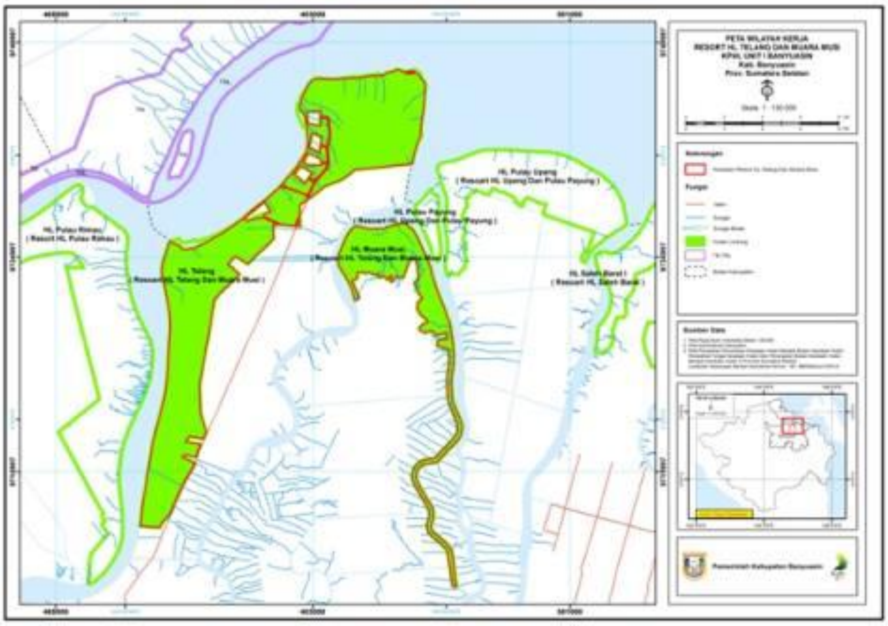

Figure 4. Map of the working area of the Telang and Muara Musi Protected Forest Resort, KPHL Unit III Palembang Banyuasin South Sumatra Province Forestry Service [14]. (Https://kphlbanyuasin.wordpress.com/peta-resort/).

Based on BPS data for 2017, the potential of coconut production in 2016 in the two sub-districts are described as follow, the Banyuasin II Sub-district (3,350 tonnes) and Sumber Marga Telang Sub-district (4,736 tonnes) respectively [1]. Coconut commodities from the community plantations are abundant, that one of the advantages that they have. Currently, coconut water was only wasted. As one of the efforts to utilize the waste, the activity was presented to them was nata de coco production from the coconut water waste.

Figure 5. General images of communities' coconut plantations and their activity on making copra and charcoal

One obstacle was also faced by the community is clean water availability; the villagers of Sri Tiga and Teluk Payo only utilize rainwater that was collected during the rainy season and swamp water for daily life; when long dry season occurred the water become a big problem, they have to buy water for their daily needs. Processing and purification of swamp water are needed by the community, where simple techniques and utilizing the materials available around it such as coconut fiber and coconut shell activated charcoal are suitable technologies for this region. And the second is in the process of nata de coco production; previously they had received training in the manufacture of nata de coco, but the results were not optimal; first, the texture of the produced nata was not good; second, in the preservation process; the durability of the nata was very short; and the third, the nata production still produced untreated waste that potentially pollutes the environment. The activities on the community empowerment program during nata de coco production are presented in figure 6.

Figure 6. Activities during the presentation to introduce nata de coco background and principles for its production, water filtration and wastes treatment, seeds multiplication for nata de coco production, and demonstrations of nata de coco productions to Ibu-Ibu PKK from Sri Tiga and Teluk Payo villages.

3.2. Nata de coco production and its wastes treatment

3.2.1. Nata de coco production

Preparation of *Acetobacter xylinum* seeds is a very important step for the success of nata de coco production, the seeds for this activity were obtained from three nurseries of nata de coco that was located in Prabumulih, Indralaya, and Palembang. During the nata production, there were some problems occurred such as frequent contamination and problem of using ZA fertilizer; most of the community member in the two villages still could not accept using ZA for food production, so in this training the ZA was replaced by using mung bean sprout extract. However, the produced nata was thin, the reason why the results was not optimal needs a further study.

Figure 7. Activities during nata de coco harvesting, cutting, washing, and packaging. Nata de coco being produced had ± 2 - 2,2 cm of thickness and ± 160 g of weight. Ibu-Ibu PKK from Sri Tiga and Teluk Payo enthusiastically participated during the program.

Problems of the frequent contamination was often observed during nata de coco production in this activity; some strategies were applied as the solution for this, such as by applying a pre-fermentation of fresh coconut water strategy, the process was conducted for 12 hours prior to being used for media culture for both seeds and nata de coco production, the results showed there was a significant decrease in pH after the pre-fermentation, (it dropped from 6.8 ± 0.7 to around 5,7 ± 0.8). The nata production by applying this technique showed a high success. In relation to this, sometimes, as early as the second day of nata fermentation, contaminated media had been observed; if this the case, the media still can be recovered, it was done by remove or throw the contaminated layer away and collected the remaining media to be prepared for repeating the boiling step for nata production, to do this, a newly sterilized fermentor and new seeds were used. So far, it showed a successful result; by this solution, the potential loss of during nata de coco production can be decreased. Quality parameters of the produced nata de coco such as thickness, weight, texture, and density are presented in table 1.
The thick layer of the formed nata during 15 days of fermentation was also measured (the results are also presented in table 1). The quality of nata de coco produced in this program was fairly good; the final thickness after 15 days of fermentation on average was 183 ± 20 mm. Thickness layer of nata during the 15 days showed an increasing trend with a rate of 7 to 18 mm per day (table 1). The harvested nata has textures of 2.75 ± 0.59 mm/sec, final weights of 153.5 ± 5.6 g and densities of 1.07 ± 0.06 g/cm3. In general, the quality is fairly good. In this regard, theoretically density and texture of nata are interconnected; nata that have heavyweight and proportionate thickness have a thick texture with high density. The high density shows the cellulose (nata) containing more fiber. The chewy texture of the nata illustrates that the cellulose produced is of low porosity that caused by the cellulose bands are densely arranged. In this regard, Hubeis et al., [15] stated that nata with high fiber content is produced by cellulose with low porosity and high density.

Table 1. Quality of produced nata de coco

Day of fermentation	Thickness		Texture (mm/sec)	Weight (g)	Density (g/cm^3)
	Average (mm)	St Dev (mm)			
Initial	0	0	NA	NA	NA
3	24	4			
6	66	7			
9	103	10			
12	133	12			
15	183	20			
Harvested Nata	NA	NA	2,75 ± 0,59	153,5 ± 5,6	1,07 ± 0,06

Figure 8. Activities during the solids and liquids wastes re-cycling and re-using process; thin nata de coco were used to produce jelly drinks, unused nata de coco was used to make fertilizer, and used water from nata washing steps was filtered and re-used for the next nata de coco washing process.

3.2.2. Wastes treatment for green nata de coco production
During the nata de coco productions, there are two type of wastes (liquid and solid wastes); the potential solid wastes were derived from coconut water filtration from media for nata production, failed or contaminated nata de coco, layers of the harvested nata and remaining debris from the washing process, while liquid waste was derived from the washing process. In this program it was introduced wastes recycle and reuse techniques for the wastes treatment processes (these were adopted and modified from methods had been done by Hakimi [13], such as thin nata de coco was blended to produce jelly drinks, used water from nata de coco washing process was reused after filtration processes for the next nata de coco washing process. And also both the liquid and solid wastes that cannot be recycled into derivative products such as jelly drinks or reused as clean water for the next nata de coco washing process were used to make fertilizer. All the steps and procedures are already mentioned in the methods section, and the activities are presented in figure 8.

3.3. Swamp water filtration
Currently, villagers of Sri Tiga and Teluk Payo used rainwater collected during the rainy season and swamp water for their daily life; if long dry season occurred, then they face water problem. They have to buy water, and this is the only option for them; available water for the season (from May to December) is salty and smelly. Therefore technology for water purification is highly in demand to solve their current problem.

Figure 9. Installation of swamp water filtration and the filtered water has been produced.

The water purification process carried out in this program was installed by adopting the TP2AS Model with some modifications [10] as has been described in method section. The treated water has the following characteristics: pH 6.8 and TDS 20 are colorless, there are no deposits, and the typical odor of swamp water has been reduced and does not leave rust as it was before processing.

4. Conclusion

Community Partnership Program had been conducted at Sri Tiga and Teluk Payo villages, Banyuasin Regency, The Province of South Sumatera about technology for green production of nata de coco and swamp water filtration had been successfully conducted; Participants of the activity were very enthusiastic about learning and trying the technique of nata de coco production; at the end of the program, especially women (ibu-ibu PKK) began to try and produce their nata both at the Balai desa and also in their own homes. Nata de coco seeds are still provided to support them who still not successfully produced their nata. The community learned some new technologies that can help to increase their income. The program has successfully change communities' mindsets on how to utilize wastes to produce potential products for their additional income. This activity showed a promising outcome for helping the forest encroachment problem in the location

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