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# The experimental study to find conditions to process Sago caterpillars for Sago oil and meat

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**Abstract.** Insects have raised their importance as a protein source and their extracted substances such as ready-to-eat products and substances as inputs for cosmetic production. There were many communities in Thailand raising insects and processing them to be their main household income, some communities processed insects using their local wisdoms, therefore unstable amounts of insect products and byproducts were obtained. This work was interested in processing and extracting oil from Sago caterpillars to find stable amount and quality controlled products; processed meat can be cooked as snacks and extracted oil can be used in cosmetic products. By adapting the local wisdoms in frying and squeezing the caterpillars, this work introduced the integrated process between temperature controlled equipment and the optimal time to obtain proper products; the meat and oil. The 300 grams of Sago caterpillars were used in each experiment with the temperature controlled equipment. The investigations were performed according to the local wisdom knowledge with three different temperature ranges: 120 – 130°C, 130 – 140°C and 140 – 150°C, and three different frying periods: 9, 10 and 11 minutes. The optimal temperature range was in the range of 130 – 140°C and optimal time period was 10 minutes; these conditions provided the most amount of extracted oil and meat, the oil was yellow-gold without grease while other temperature ranges and periods provided less amounts of oil, dark yellow color and yellow with grease. The Sago farming community was satisfied with the products and the process could reduce their labor cost and time.

## 1. Introduction

Insects show their market values in many ways; insect meat provides source of protein as one of five main nutrients their extracted substances are inputs in cosmetic products. Insects become popular because of their rich protein property, low farming investment and short harvest. Many communities are interested in insect industry from farming them (from eggs) to processing to get products. Every stage of insects can deliver different main nutrients; caterpillars contain fat and protein while most of pupas contain protein. Insect fat and oil can be used as inputs in soap and supplementary industries. Sago beetle is one of many insects whose caterpillars (Figure 1) are sources of protein and fat, 8.62 % and 20.80 %, respectively [1]. People in Southern part of Thailand eat Sago Caterpillars which are cooked by local wisdoms and cuisines.

Many researches have been working on extracting machines with different extracting and heating methods. Thabthong and Weangkaew [2] introduced their process of oil extraction from



Jatropha curcas seeds using a hydraulic press, they obtained the best oil product of 126 ml. from 1 kg of the seeds. Maoklang [3] designed and investigated performances of a screw type cashew nut shell liquid (CNSL) expeller to extract oil from cashew nuts. He found that, for nut feeding rates in the range of 54 – 95 kg/hr, the screw speeds should be in the range of 7 - 13 rpm while the CNSL expeller prototype provided CNSL rates of 11.93 – 14.90 kg/hr, average percentages of CNSL were in 20.65 – 21.04% and purity percentage of CNSL were in 85.83 – 87.86%. Jidampai [4] experimentally studied the roasting-malt machine to reduce energy consumption cost by replacing power produced by Liquefied Petroleum Gas (LPG) with power produced by an electric-infrared heater prototype. He used germinated paddy rice to test his prototype, he found that his prototype could reduce humidity of the rice from 30 – 33% on a wet basis (wb) to 14% on wb. Pukin [5] introduced his new Jatropha oil hydraulic press which was designed and developed to reduce pressing time and increase extracted oil amount. From experimental results, 2 kilograms of Jatropha seeds were fed to the new press in each experiment, the developed press provided 6 cc of the oil in 4.18 minutes while the former press could produce only 5.6 cc of oil in 7.89 minutes. Techarungpaisan and Pongrat [6] presented their high efficiency prototype sesame roaster, their prototype could roast 1 – 5 kilograms of sesame seeds within 18 – 37 minutes with the average energy cost of the prototype was 1.1 baht per kilogram of sesame seed excluding the labor cost. Sribut [7] introduced a white sesame oil press machine pressed by 2-ton hydraulic power. The average sesame oil products were in a range of 87.90 – 102.09 millimeters per 500 grams of white sesame seeds.



**Figure 1.** Sago caterpillars.

One community in 3 Southern provinces of Thailand; DNA+ Panya-Namtoon Weloowan Community, Sateng Sub-District, MuangYala District, Yala Province, was the first few communities who have farmed and processed Sago caterpillars, they have carried their local wisdoms in farming and processing Sago caterpillars. Sago processing methods from the local wisdom are as frying Sago caterpillars in pans on stoves to extract Sago oil and smashing the fried Sago caterpillars in mortars to prepare Sago meat. Since the amount and quality of Sago meat and oil relates to individual expertise, the output products from Sago community farming are unpredictable. This research focused on an experimental study to find conditions; heating temperature and period, to process Sago caterpillars for Sago oil and meat. To develop a simple frying, easy maintenance and low-cost mechanism, the heating process was performed on a commercial food fryer available in worldwide markets with acceptable prices, the fryer was connected with an in-house temperature controller to control the temperature during the heating process. According to the local wisdom to process Sago caterpillars; pan temperatures were from 120 to 150 °C and heating periods were from 8 to 12 minutes, three different heating periods; 9, 10 and 11 minutes and three different pan temperature ranges; 120 – 130°C, 130 – 140°C and 140 – 150°C were selected to investigate in the current work. Most of Sago oil was expected to obtain during the heating process according to the local wisdom. Fried Sago caterpillars from the heating process were pressed to take the rest of Sago oil before the fried caterpillars were

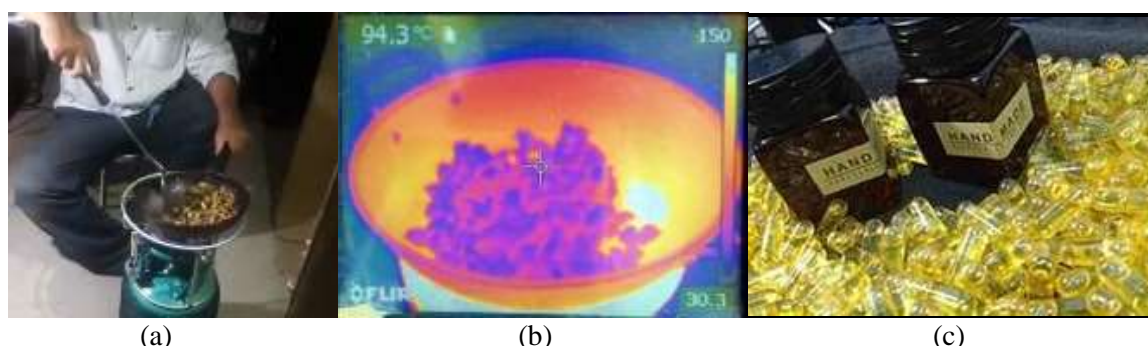
screwed to produce new texture meat. The community could use the new texture meat to produce new Sago snack as their new community product. Since the optimal conditions; the heating temperature and period, could help the community to produce stable quality of Sago products and expected amount of Sago oil for other products, the conditions were the main parameters to be found in this work.

## 2. Materials and Methods

This pilot work related to the local wisdom in Southern Thailand. Sago caterpillars (Figure 1), the raw material used in this work, were raised and prepared by DNA+ Panya-Namtoon Weloowan Community, Sateng Sub-District, Muang District, Yala. Since this research related with the local wisdom, firstly, all procedures to process Sago caterpillars to get Sago oil and meat were demonstrated by an expert from the DNA+ Panya-Namtoon Weloowan Community.

From the local-wisdom procedures, the steps to obtained Sago oil and meat from Sago caterpillars combined of three main parts; 1) caterpillar-heating part, 2) oil-taking part and 3) meat-processing part. In the heating part, Sago caterpillars were placed on a pan heated by a LPG stove (Figure 2a and 2b) and the community member observed color of the released oil. When the community member satisfied with the oil color, the heating part was stopped. The preferred oil color as shown in Figure 2(c) was #FFD700 (HEX Code #RRGGBB) or rgb(255,215,0) (Decimal Code(R,G,B)).

In the oil-taking part, the community member squeezed the fried caterpillars with a spade of the frying pan. In the processing part, the squeezed-fried Sago caterpillars were pounded in mortars to prepare Sago meat; the final meat was mushy. The whole process took 50 minutes to get both products. The research team also observed that the expert needed to stir the Sago in the pan all the frying time. From the demonstration, we found that the Sago oil first came out after the Sago temperature in the pan reached 80 – 90°C and pan temperatures were about 120 – 150°C during the frying period while average frying time periods from different demonstrations were from 9 to 11 minutes. From Figure 2, the temperature of the focus point on the infrared picture showed 94.3°C and the pan temperatures were over 100°C. Panpipat and Chaijan [8] reported that there are several important substances in the Sago oil such as Oleic acid which is in the omega-9 fatty acid group. The omega-9 fatty acid helps to maintain hormone and blood circulation in human body.



**Figure 2.** Sago caterpillars processed by the community expert (a and b) and sago oil product (c).

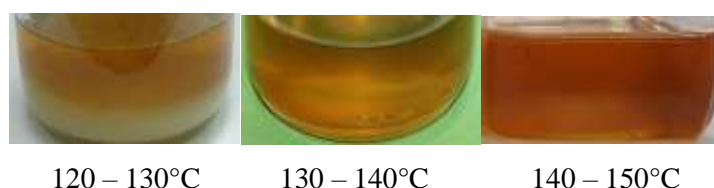
All information and details in the community demonstrations were recorded and analyzed to setup a new system and to specify suitable Sago heating temperatures and periods to obtain the most Sago caterpillar oil and meat. An oil separation and meat processing machine was designed, fabricated and tested; the machine has been in patent pending. The suitable equipment was selected to heat the caterpillars, to squeeze and to process the fried caterpillars. In experimental investigations, the Teflon pan was selected as heating equipment and a stainless agitator was connected to stir Sago caterpillars in the pan to protect any burnt parts to stick on the pan while the oil was released. After the frying process, the fried caterpillars were wrapped with a thin cloth, the thin cloth could collect all caterpillars to stay together and they were pressed to obtain the rest oil. Since the community aimed to

produce a new product with a new texture of the Sago meat part, instead of using a mortar or a blender to mash the squeezed-fried Sago caterpillars, an in-house extruder was designed and fabricated to process the squeezed-fried caterpillars into a special texture called Sago filament.

Because of the limitation on Sago amount in our region, Northeast of Thailand, 300 grams of Sago caterpillars were tested in each experiment; average investigated values were recorded from 5 repeating tests in each experiment. The Sago experiments to find the best product amount and color by using the patent-pending machine consisted of 2 parts; frying Sago caterpillars in three different temperature ranges and frying Sago caterpillars in three different frying periods. The experimental investigations were performed from three different pan temperature ranges; 120 – 130°C, 130 – 140°C and 140 – 150°C, and three different frying periods; 9, 10 and 11 minutes relating to information obtained from the local wisdom processes. Firstly, the pan temperatures were controlled between 120 – 150°C, three different temperature ranges; 120 – 130°C, 130 – 140°C and 140 – 150°C, were chosen by installing a temperature controller to control the heating part to maintain designed temperatures. All oil products from three different temperature ranges were compared by using their colors with the preferred Sago oil color (Figure 2c). The temperature range, providing the preferred color, was carried out to the next experiments to find the optimum amount of Sago oil and meat. The average frying time periods according to the observation were from 9 to 11 minutes, three different frying periods were selected as 9, 10 and 11 minutes to find the best product amount and color.

### 3. Results and Discussion

Firstly, the Sago caterpillars were fried on the Teflon pan in 9 minutes as the expert suggested at the three different pan temperature ranges 120 – 130°C, 130 – 140°C and 140 – 150°C, Sago oil distracted from all three temperature ranges were shown in Figure 3. We found that the Sago oil taken from the 120 – 130°C range contained more grease than that of the oil from two other temperature ranges (Figure 3) and the Sago oil color taken from the 140 – 150°C range was darker than that of oil from two other temperature ranges (Figure 3). We showed all oil to the community expert, the expert confirmed that the oil taken from the 120 – 130°C range was not acceptable because of its grease and the oil taken from the 140 – 150°C range was unacceptable because of its color.



**Figure 3.** Sago caterpillar oil from three different temperature ranges.

To find the proper frying periods, the 130 – 140°C pan temperature range was chosen to investigate at 3 different frying periods; 9, 10, and 11 minutes. We obtained oil from these 3 different frying periods as illustrated in Figure 4. We noticed that the first oil taken at 9 minutes also contained grease and the last oil taken at 11 minutes was dark yellow. The community expert also recommended that these two oils were not preferred. Table 1 presented information obtained from the experiments at 3 different frying periods; 9, 10 and 11 minutes. The average weights of extracted Sago oil from two frying periods were close but the average weights of processed Sago meat were different; the extracted oil was included oil squeezed out from fried caterpillars which were gathered and pressed in the thin cloth. The maximum average weights of Sago oil and meat were 0.042 and 0.178 g, respectively. The processed meat from the 11 minute frying period was crispier than those of two frying periods as shown in Figure 5. The longer frying time the drier meat was caused by its re-frying process; the earlier oil came out of the caterpillars was used to fry themselves when the caterpillars was still left in the pan.





**Figure 4.** Sago caterpillar oil from three different frying periods.



**Figure 5.** Fried Sago caterpillars from three different frying periods.

**Tables1.** Average weights with standard deviation (s.d.) of Sago oil and meat processed from 3 different frying periods; 9, 10 and 11 minutes, at pan temperatures of 130 – 140°C and 5 replications.

Frying period (minutes)	Average weights of extracted Sago oil in kg (s.d.)	Average weights of processed Sago meat in kg (s.d.)
9	0.042 ( $\pm 0.003$ )	0.178 ( $\pm 0.002$ )
10	0.035 ( $\pm 0.002$ )	0.106 ( $\pm 0.002$ )
11	0.041 ( $\pm 0.002$ )	0.091 ( $\pm 0.003$ )

From these two sets of the experiments to find the optimal temperature and frying period to fry the caterpillars, the acceptable quality of oil was the main goal because the fried Sago caterpillars with different frying times and temperatures were similar in texture and smell. However, the fried Sago caterpillars from the 140 – 150°C pan temperature range and 11 minutes were darker color than those of two temperature ranges and four different frying periods. The best conditions to take Sago oil and prepare Sago meat were the 10-minute frying period coupled with the 130-140°C pan temperature because the acceptable oil color, #FFD700 (HEX Code #RRGGBB), was provided and the fried meat could be continuously processed.

The squeezed-fried Sago caterpillars were sent to the in-house extruder to perform the last process; the filament meat as the special texture was delivered as in Figure 6. The community utilised this filament meat to produce a new product, it could be fried or roasted or baked to produce a new Sago snack. Total processing time from heating Sago caterpillars to mashing them into the filament meat was 17 minutes; the new time with new procedures was different from the total of 50 minute process performed continuously by the local wisdom skillful expert. Since the processing time was reduced, the labor cost could be considered to be decreased according by 66% when the labor costs were calculated from the minimum wage multiplied with the old and new processing times.



**Figure 6.** Sago processed meat; the filament meat.

#### 4. Conclusion

Sago caterpillars show their potentials; meat and oil, as promising protein source and promising inputs for the cosmetic industry. To process the Sago caterpillars, heating times and temperatures were realized to be important parameters in this research. The local wisdom procedures to process Sago caterpillars were studied and developed to find new procedures that could reduce processing time and labor costs. The new procedures were presented in this work with the new selected equipment which its heat could be controlled as the heating process in the Teflon pan connected with the agitator to protect overheated parts sticking on the pan, squeezing the fried caterpillars wrapped in the thin cloth and processing the squeezed-fried caterpillars with the in-house extruder. During the heating process, the optimal pan temperature range was 130 – 140°C and the optimal time to fry the caterpillars was 10 minutes. The Sago oil and meat products were preferred by the community with these conditions; the oil was yellow-gold and the maximum fried meat was obtained, the maximum average weights of Sago oil and meat were 0.035 and 0.106kg, respectively. The processing time and labor cost were reduced by 66%. The community, DNA+ Panya-Namtoon Weloowan Community, Sateng Sub-District, Muang Yala District could utilise the new procedures and equipment to obtain the Sago oil and to produce the new Sago snack with stable amounts and quality controlled products.

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