From Local Agricultural Market Disposals to Environmentally Friendly Products

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Abstract
Taradd Thai Market is one of the biggest agricultural markets in Thailand located in a suburban area of Pathumthani province, in Thailand. Four local tropical fruits, Durian, Mango, Mangosteen, and Marian Plum were selected from the market to study in this research. Two environmentally friendly products, lactic acids and biochars, from agricultural market disposals were focused. The percentage of volatile materials was measured and recorded. For the first product, the tropical juice extracts from the four fruits were separately prepared. The percentages of reducing sugar per 100g were analyzed and the results revealed that the percentage of reducing sugar in Durian juice was the highest with 58.7% w/w. Whereas, in Marian Plum juice, the percentage of reducing sugar was 43.5 % w/w while, in Mango juice, 50.9% w/w of reducing sugar were measured and the percentage of reducing sugar of Mangosteen juice was 35.3 % w/w. *Lactobacillus plantarum* was used to produce the lactic acids with the variation of times. The results displayed that the optimum time to generate the highest amounts of lactic acids was at 50 hrs. For the second environmental friendly product, it was to transform the agricultural market disposals to biochars. Durian and Mangosteen were chosen to prepare the biochars due to their hard skins. Moreover, both physical and chemical properties of these biochars were also characterized. Metal determinations were analyzed via ICP-OES. Heat of combustion was also recorded via bomb calorimeter.

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Introduction

Thailand is one of the prestigious countries in the world for food producers. Not only were rice, tapioca and para rubber produced, but also variety of fruits were planted. However, the market prices of those fruits were unconstanted, mostly quite low. Therefore, those unsold fruits would be wasted. In Pathumthani province, Taradd Thai, one of the biggest and important agricultural markets in Thailand, was also met the problem from fresh fruit waste disposals in this area that could be consider as environmental significant concerns. Therefore, the management solutions to solve those wastes were to transform them to valuable materials such as lactic acid or biochar. Lactic acid was prepared from the fermentation of microorganisms such as *Lactobacilus plantarum* over juices and it could also be used as a biodegradable starting material such as biodegradable suture, prostheses or microcapsule for drug delivery system. In the case of biochar preparation, Durian pell and mongosteen skin were chosen as starting materials due to their hard skin and high carbon content. The properties of biochar productions from those two fruits were varied from both choices of feedstock and process conditions. The biomass transformation to long-lived soil carbon species yields in a long term of carbon sink.

The aim of this research was the preliminary investigation of the production of lactic acid derived from the four thai tropical fruits. The local fruits were Durian, Mango, Mangosteen, and Marian Plum. Physical and chemical properties, including turbidity were under examined. The productions of lactic acid were monitored. In addition, the reducing sugar was analysed via UV-Visible spectrophotrometry at 540 nm by the reaction between the fermented solution and 3,5-dinitrosalicylic acid. In addition, some physical and chemical properties of biochars derived from Durian peel and Mangosteen rind were also characterized. Heavy metal determinations of those biochars were analyzed via ICP-OES. Heat of combustion was also recorded via bomb calorimeter.

Experimental

Lactic Acid Preparation

Four extracted juices of each unsold local tropical fruits, Durian, Mango, Mangosteen, and Marian Plum, from Taradd Thai were collected. The microorganism food was prepared using MRS formula. The microorganism, *Lactobacillus plantarum*, was chosen for the fruit juice fermentations to generate the lactic acid.

- Reducing sugar determination

The reducing sugar was determinated by the reaction of the production of lactic acid. The solutions of dinitrosalicylic and potassium tatrate were prepared and transfered into the sample solution. The standard calibration curve between glucose and absorbance were developped.

- Turbidity determination

The *Lactobacillus plantarum* was selected to ferment unsold juice extracts for the growth of the microorganism for the turbidity determination. The turbidity of each solutions was then characterized at 600 mn using UV-Visible spectrophotometer.

- pH
The pH determination was detected by a pH meter and the meter was then calibrated with the standard solution pH with the two-point calibration at pH=4 and pH=7. The pH of the fermented solutions were then measured. Furthermore, another method for pH determination was the titration of the fermented solution with standard sodium hydroxide (0.01 N). The conversion of lactic acid was calculated.

- Monitoring of Lactic Acid
The progress of fermented juice fruits were monitored by FTIR spectrophotometry focusing on the gaining of C=O peak every 12 hours.

Biochar Preparation
One hundred and fifty grams of durian peel were accurately weighed and transferred into a tray. An oven was preheated to 85 ^{o}C. The tray with Durian peel was placed into an oven and left for 60 hours. The dried Durian peel was kept at room temperature. For Mangosteen rind, the drying process of the waste was repeated dried method was repeated as similar to Durian peel. The dried material was transfered into a metal furnace. The furnace was sealed and heated without oxygen. The Heat of Combustion Determination was determined by Bomb Calorimeter.

- Calcium and Magnesium Determination
The accurated weigh of grinded biochar was placed to porcelain. The 15 mL of the distilled water, 5 mL hydrofluoric acid and 10 mL of concentrated HNO_3 were also added. The porcelain was heated and stirred carefully. The solution was left to ambient temperature. The dilutions were prepared and characterized via ICP.

Results and Discussion
The determination of reducing sugar was shown in Table 1. From Table 1, extracted solution from Durian was displayed the highest amount of reducing sugar content. When the time of fermentation was more forty-eighth hour, the reducing sugars of four local tropical fruits from Taradd Thai were reduced less than half. When the fermentation time was 72 hrs, the percentage of reducing sugar was less than 6%.

Table 1 Percentage of reducing sugar of four tropical fruits after fermentation with Lactobacilus plantarum (%w/w)

Fruits	Percentage of Reducing Sugar (%w/w)	Percentage of Reducing Sugar (48 hrs) (%w/w)	Percentage of Reducing Sugar (72 hrs) (%w/w)
Durian	58.7	16.2	5.6
Mangosteen	35.3	9.7	3.1
Marian Plum	43.5	13.8	4.9
Mango	50.9	14.4	5.0

The turbidity of microorganism was related to the amount of lactic acid due to the dead bacteria after the consumption of sugar (Table 2). It was found that the absorbance at 600 nm of the Durian extracted juice was the highest (1.5637) and then

followed by the Mango extracted juice (1.5008), Marian plum extract juice (1.3211) and Mangosteen extract juice (0.6180), repectively.

Table 2 Turbidity of the extracted juices from the local fruits after the fermentation (absorbance at 600 nm)

Fruits	Absrobance at 36 hrs (at 600 nm)
Durian	1.5637
Mangosteen	0.6180
Marian Plum	1.3211
Mango	1.5008

Figure 1 was shown the fermentation progress of *Lactobacilus plantarum* over Marian plum juice. The results showed the increasing of carboxyl peak of carboxylic acid peak at 1,634 cm^{-1} at 12, 24 and 36 hours via FTIR. The top line represented the C=O peak at 12 hrs while the mid line nominated the C=O peak at 24 hrs. The C=O peak at 36 hrs was the bottom line. This indicated that the increasing of C=O peak was related to the reaction time to consumption of reducing sugar. The results found that the optimum time to generate the highest amounts of lactic acids was at 50 hrs.

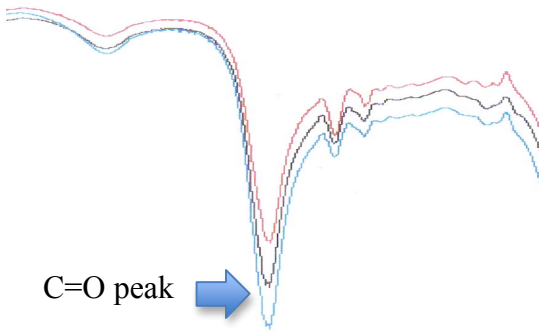

Figure 1 The C=O peak lactic acid production from the fermentation of Marian plum juice using *Lactobacillus plantarum* at varied times (top line) 12 hours (mid line) 24 hours (bottom line) 72 hours

Table 3 displayed that production of biochar from Taradd Thai waste market. The percentage of biochar production from Durian peel was 43.55 while the percentage of biochar from mangosteen rind was 49.33. Moreover, from 1 g of biochars, the combustion heat from Durian peel was 203.619 kJ whereas the combustion heat from mangosteen rind was 157.247 kJ.

Both calcium and magnesium contents were determined using ICP spectrophotometry as shown in Table 3 as well.

Table 3 Percentage of produced biochar, heat of combustion and metal determinations

Materials	% Biochar production(SD)	Average energy	Ca (ppm)	Mg (ppm)
Durian Peel	43.55 (2.44)	48.666 kcal (203.619 kJ)	1.458	99.179
Mangosteen Rind	49.33 (2.89)	37.583 kcal (157.247 kJ)	0.540	2.572

From Table 3, the mangosteen rind biochar was found with lower amount of both cases of Ca (0.540 ppm) and Mg (2.572 ppm) comparing to Durian peel biochar [Ca (1.458 ppm) and Mg (99.179 ppm)].

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