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Study the Anthocyanin Extraction from the Rind of Mangosteen (*Garcinia Mangostana*) in Vietnam

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Abstract. Mangosteen (Garcinia mangostana) is grown much in Vietnam. Many researches showed that the rind of this fruit has many active components. In Vietnam, till now, the rind of mangosteen is thrown away. That's why the research on anthocyanins extraction from the rind of mangosteen is necessary in Vietnam, it will reduce the waste and raise the value of this fruit. This survey focuses on the condition of anthocyanins extraction from the rind of mangosteen. The optimal condition of anthocyanins extraction was received when ethanol 40^o was used as solvent with HCl 1.5%; the rate of the rind and solvent was 1:10; the extraction temperature was 60 ℃; the extraction time was 40 minutes.

Keywords: Rind of mangosteen, *Garcinia mangostana*, anthocyanins, extraction, food color

1. Introduction

Mangosteen (*Garcinia mangostana* L.) is a tropical fruit. In Vietnam mangosteen is grown in the provinces of the Mekong Delta and the South Eastern area. There are about 5,500 hectares of mangosteen in the Southern region of Vietnam.

In the world, scientists have also done many researches on the powers of nature extracted from the rind of mangosteen on human health (Nakatani, 2002; Vlietinck, 1994). But in Vietnam, mangosteen rind is still a waste and lead to the environment pollution.

Anthocyanins are considered secondary metabolites. Anthocyanin also is a food additive E163. This natural pigment is used quite safely in food; create more attractive colours for food products Among the natural food colours, the anthocyanins is the most popular colour. It is present in almost all higher plants and is found much in some vegetables, flowers, fruits, seeds which has colour from red to purple, such as: grapes, strawberries, cabbage, purple perilla leaves, flowers of hibiscus, black beans, eggplant, black sticky rice, red rice.

That's why, study the anthocyanins extraction from mangosteen peel is not only contributing to the production of food pigments with domestic materials, but also reducing the waste to the environment.

2. Materials and Method

2.1. Materials

The rind of mangosteen (*Garcinia mangostana*) was taken from Lai Thieu village, Thuan An district, Binh Duong province

2.2. Experimental design and analysis

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- Survey the using acid for the anthocyanins extraction: The mangosteen rind was sliced, dried, and ground to a powder, then treated at 37^{o}C, in 45 min, with 1:10 rate of raw material and solvent. The studied solvents were ethanol 50^o and different acid (HCl 2%, acid acetic 2%, acid citric 2%) with 100:10 rate.
- Survey the concentration of ethanol and acid for the anthocyanins extraction: The mangosteen rind was sliced, dried, and ground to a powder, then treated in the suitable acid with different concentration of ethanol (30^o, 40^o, 50^o, 60^o, 70^o) and acid (1%, 1.5%, 2%, 2.5%, 3%) at 37^{o}C, in 45 min, with 1:10 rate of raw material and solvent.
- Survey the rate of raw material and solvent for the anthocyanins extraction: The mangosteen rind was sliced, dried, and ground to a powder, then treated in the suitable concentration of extracted solvent at 37^{o}C, in 45 min, with different rate of raw material and solvent (1:5, 1:10, 1:15, 1:20).
- Survey the suitable temperature processing time for the anthocyanins extraction: The mangosteen rind was sliced, dried, and ground to a powder, then treated in the suitable concentration of extracted solvent with suitable rate of raw material and solvent at different temperature (40^{o}C, 50^{o}C, 60^{o}C, 70^{o}C), in different extraction time (20, 40, 60, 80 min.)
- The quantity of anthocyanins was analyzed as following formula (Huynh Thi Kim Cuc et al, 2004; Fuleki, Francis, 1968; Zarena, Sankar, 2012)

$$a = \frac{A.M.K.V}{\varepsilon.l}; g$$

Where: $A = (A_{\lambda max \cdot pH=1} - A_{700nm \cdot pH=1}) - (A_{\lambda max \cdot pH= 4,5} - A_{700nm \cdot pH= 4,5})$

$A\lambda_{max}$; A_{420}: is the absorbance value of the anthocyanins sample at max and 700 nm

a: the content of anthocyanins, g; M = 449.2: molecular weight of anthocyanins

l: curvet size, cm; K: diluted standard; V: volume of extraction solution, L

The final product was sent to QUATEST 3 for analysis of anthocyanins parameters.

- Statistical analysis: All experiments were performed in triplicate. The experiment formulas were design by using Modde 5 program. The experimental results obtained were expressed as means ± SD. Mean values were considered significantly different when $P < 0.05$. Analysis of variance (ANOVA) was performed using the software Statgraphics plus, version 7.0 (Nguyen, 2007; Dang, 1997).

3. Results and Discussion

3.1. Effect of the different solvents on the efficiency of anthocyanins extraction

For the surveying to the effects of the solvent used in extraction, the results of the survey and ANOVA analysis showed that the studied samples have $P = 0.0001596 < 0.05$, so the results between the samples are significantly different. Each sample was repeated three times, the results were analyzed via Tukey.

Table 1: The effect of using solvent on the anthocyanins extraction

Solvent (ml)	Anthocyanins (g)
Ethanol- H_2O	$0.0155^a \pm 0.00100$
Ethanol- HCl	*$0.0213^b \pm 0.00065$*
Ethanol- acid citric	$0.0176^{ac} \pm 0.00010$
Ethanol- acid acetic	$0.0188^c \pm 0.00047$

From the result of table 1, with the solvent of ethanol 50^o and HCl 2% the highest among of anthocyanins was given. It maybe because anthocyanins are the polarized natural organic compound and among the studied solvent, HCl is the most polarized solution, that's why HCl is the best choice for this study.

3.2. Effect of the ethanol concentration and HCl concentration on the efficiency of anthocyanins extraction

From the above experiment, HCl was selected for the other surveys. With different concentration of HCl and ethanol, there was different efficiency of extraction. The results were analyzed via ANOVA with 2 variants. With different concentration of ethanol, P_{value} was 1.547 x 10^{-15}< 0.05; and with different concentration of HCl, P_{value} was 2.2 x 10^{-16}< 0.05, so the results between the samples are significantly different.

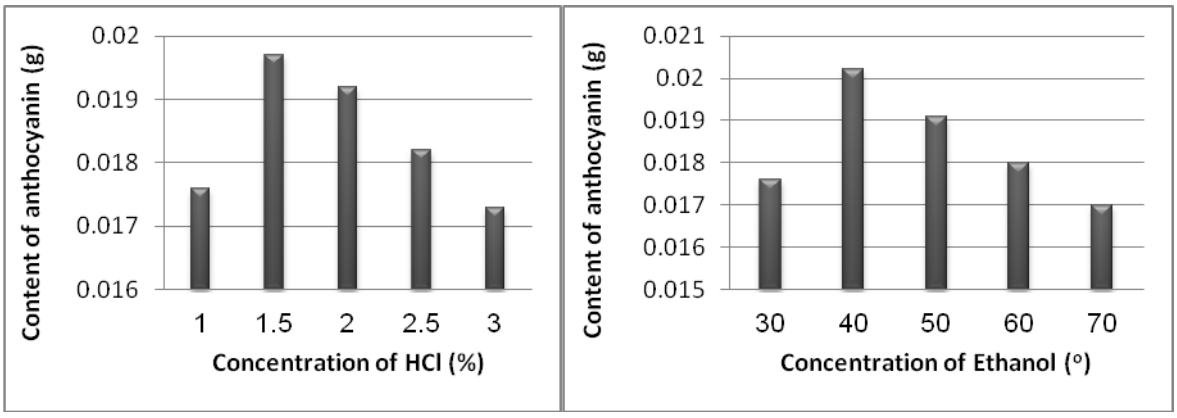

Fig.1: The extraction anthocyanins under the effect of HCl and ethanol

From fig.1 we can see that, with 1.5% of HCl the anthocyanins yield was the highest. With HCl of 1% and 3 %, the received anthocyanins were lowest. The amount of extracted anthocyanins increased quickly when the concentration of HCl increased to 1.5% and got the highest amount at 1.5%. But when the concentration of HCl was higher than 1.5%, and reached to 2-3%, HCl began effect to the quality of anthocyanins. That's why the amount of received anthocyanins reduced rapidly.

This survey also investigated the concentration of ethanol which was used in the extraction solvent. Fig.1 showed that, when not suitable ratio of ethanol was used, the received amount of anthocyanins was not high enough. Among the ratios, the concentration of ethanol was 40^o gave the best result. This result was used for the following surveys

3.3. Survey the necessary amount of using solvent for the anthocyanins extraction

This study used the same solvent which was investigated from the above experiments (ethanol 50^o : HCl 1.5%). Table.2 showed that, when the amount of using solvent was too high, the anthocyanins were being washy. So it was difficult to gather it back, and it effected on both quantity and quality of received anthocyanins. The ratio of raw material and solvent was 1:10 gave the best results.

Table 2: The effect of using amount of solvent on the anthocyanins extraction

Rate of raw material and solvent	Anthocyanins (g)
1:5	$0.0162^a \pm 0.00074$
1:10	*$0.0218^b \pm 0.00057$*
1:15	$0.0211^b \pm 0.00074$
1:20	$0.0204^b \pm 0.00061$

3.4. Survey the extraction time and extraction temperature

With different extraction time and extraction temperature, there was different efficiency of extraction. The results were analyzed via ANOVA with 2 variants. With different temperature the P_{value} was 7.995 x 10^{-5}< 0.05, and with different extraction time the Pvalue was 7.665 x 10-12< 0.05, so the results between the samples are significantly different.

The extraction time affected to the ability of anthocyanins drawing out. If the extraction time was short, the amount of anthocyanins was not extracted out totally. But if the extraction time was too long, anthocyanins were oxidized, the quality and quantity of this pigment reduced quickly. Fig.2 showed that, when the sample was extracted in 20 minutes, the amount of anthocyanins was the least. The quantity of anthocyanins increased by the extraction time, and gave the best result at 40 – 60 minutes. When the

extraction time was higher than 60 minutes, the amount of anthocyanins reduced. The fig.2 showed that, the best extracted time was 40 minutes.

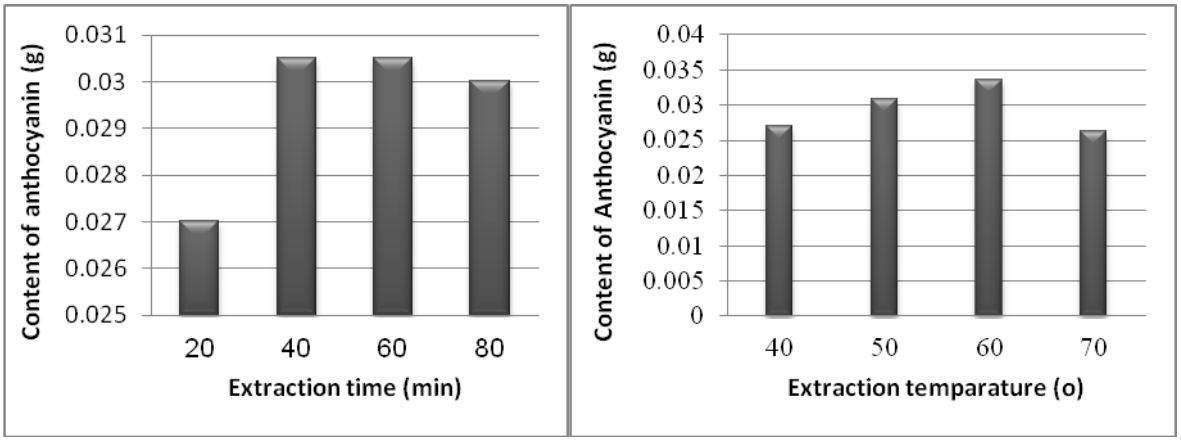

Fig.2. The extraction anthocyanins under the effect of extraction temperature and extraction time

The extraction temperature affects the ability to extract anthocyanins form the samples. When increasing the temperature it will increase the ability of anthocyanins extraction by reducing the viscosity of the solution, while increasing the speed of diffusion of solutes from the material to the solvent. The highest concentration of anthocyanins was reached at the temperature of 60 ℃. It showed the characteristics of anthocyanins that are soluble in warm water. At a temperature of 70 ℃, the quality of anthocyanins reduced, because the anthocyanins were susceptible denaturized by high temperature. In this survey the optimal temperature of 60 ℃ was chosen to extract anthocyanins. (fig.2)

4. Conclusion

The anthocyanins were extracted from skin of mangosteen in the optimal environment, such as: with the optimal solvent (ethanol 40^o and HCl 1.5%); the rate of raw material and solvent was used at 1:10; the extraction time was 40 minutes; the extraction temperature was 60^{o}C. The results showed that the anthocyanins in the skin of *G. mangostana* of the sample were measured by pH-differential spectrophotometer method, reached 0.0335 g.

The continued research should be considered the pectin extraction and the stabilization of the pigment. So the new valuable product can be produced in the future.

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