

The effect of microwave power variations on phytochemical characteristic of pandan leaves (*Pandanus Amaryllifolius*) using the Microwave-Assisted Extraction (MAE)

N S Djenar¹, E W S Mulyono¹, T R Saputra¹

¹ Department of Chemical Engineering, Politeknik Negeri Bandung, Jalan Gegerkalong Hilir, Bandung, Indonesia

E-mail: nancysd@polban.ac.id

Abstract. Pandan leaves (*Pandanus Amaryllifolius*) are widely used as aroma ingredients, spices, flavouring ingredients, and green givers on dishes or snacks. The extracts of Pandan leaves consist of a number of active compounds in a group of alkaloids, flavonoids, saponins, tannins, polyphenols, and dyes. From several research results, these active compounds can be obtained through Soxhlet extraction, supercritical CO₂ extraction and maceration. However, the type of extraction above requires a relatively longer time with low yield extract. In this research Microwave-Assisted Extraction (MAE) method using water as solvent. Varying microwave power and extraction time were used to extract active compounds from pandan leaves. The results of this research showed that the highest yield of pandan leaves extract obtained was 23.53 percent at 450 Watt microwave power. Based on the phytochemical test, it was found that pandan leaves extract positively contain alkaloids, flavonoids, saponins and tannins. Using spectrophotometry method obtained the highest flavonoid concentration of 0.4130 percent at 450 Watt microwave power.

1. Introduction

One of the plants that produce essential oil and active compounds such as alkaloids, flavonoids, saponins, tannins, polyphenols, is pandan leaves (*Pandanus Amaryllifolius*) [1]. Pandan leaves are widely used as an ingredient of aromas, spices, flavorings, and green color in cooking or snacks. In Indonesia and other Southeast Asian countries pandan leaves are usually used as a food flavoring in traditional foods [2].

To this day the active compounds of pandan leaves can be obtained through maceration, Soxhlet extraction, and supercritical carbon dioxide extraction. From the research results of [3, 4] showed that the extraction of pandan leaves with the above types of extraction requires relatively longer time and with less extraction results and are characterized by high volumes of solvents [5].

Some literatures such as [6-10] explain that extraction using the MAE method has several advantages, namely the extraction time used is relatively shorter so that the solvent and energy used are relatively low, and with more extract produced. Pandan leaves extraction was carried out using the MAE method with varying microwave power and time. From this research, it is expected that it will be in optimum conditions with a lot of extract yield to better study the phytochemical characteristics of pandan leaves (*Pandanus Amaryllifolius*).



2. Methodology

2.1. Materials and chemicals

Dried of pandan leaves were collected from Lembang, Bandung, Indonesia. The leaves then were chopped to a size around 5-10 mm using a commercial grade blender and stored at room temperature until required. Distilled water used in the experimental work was of analytical grade.

2.2. Microwave assisted extraction (MAE)

In employing MAE, was used a domestic microwave oven (Samsung MG23K3505**, maximum delivered power of 800 W) with wave frequency of 2450 MHz. The dimensions of the PTFE-coated cavity of the microwave oven were 48.9 cm x 27.5 cm x 39.2 cm. The microwave oven was modified by drilling a hole at the top. A round bottom flask with a capacity of 1L was placed inside the oven and was connected to the three-way adapter and liebig condenser through the hole. Then, the hole was closed with PTFE to prevent any loss of the heat inside. Seventeen grams of dried pandan leaves and 250 mL of distilled water were placed in the reaction flask and heated by microwave irradiation with 180, 300, 450 and 600 W for 20 minutes. From the microwave power variations above, pandan leaves extract will be obtained and the results will be calculated in % yield. Microwave power with the highest extract % yield will be used for the next process which is to vary the time (minutes), so that the best extraction time is obtained.

2.3. Phytochemical test

Phytochemical testing aims to determine the presence of active compounds such as alkaloids, flavonoids, saponins, and tannins in pandan leaves extract. This test was done by putting the extract into a test tube and then adding reagents such as Mayer reagent, HCl, HCl and hot water and FeCl₃. Positive results will be indicated by physical changes in pandan leaves extract.

2.4. Quantitative analysis of flavonoid

The analysis was performed by measuring the extract concentration using a spectrophotometer at $\lambda_{\max} = 430$ nm, using a standard solution of quercetin. The extraction yield of pandan leaves extract was calculated according to the equation given [8]:

$$\text{Extraction Yield (\%)} = \frac{m_1}{m_2} \times 100 \quad (1)$$

m_1 = mass of extracted material (g)

m_2 = mass of dried Pandan leaves (g)

The research flow chart was shown in the following Figure 1.

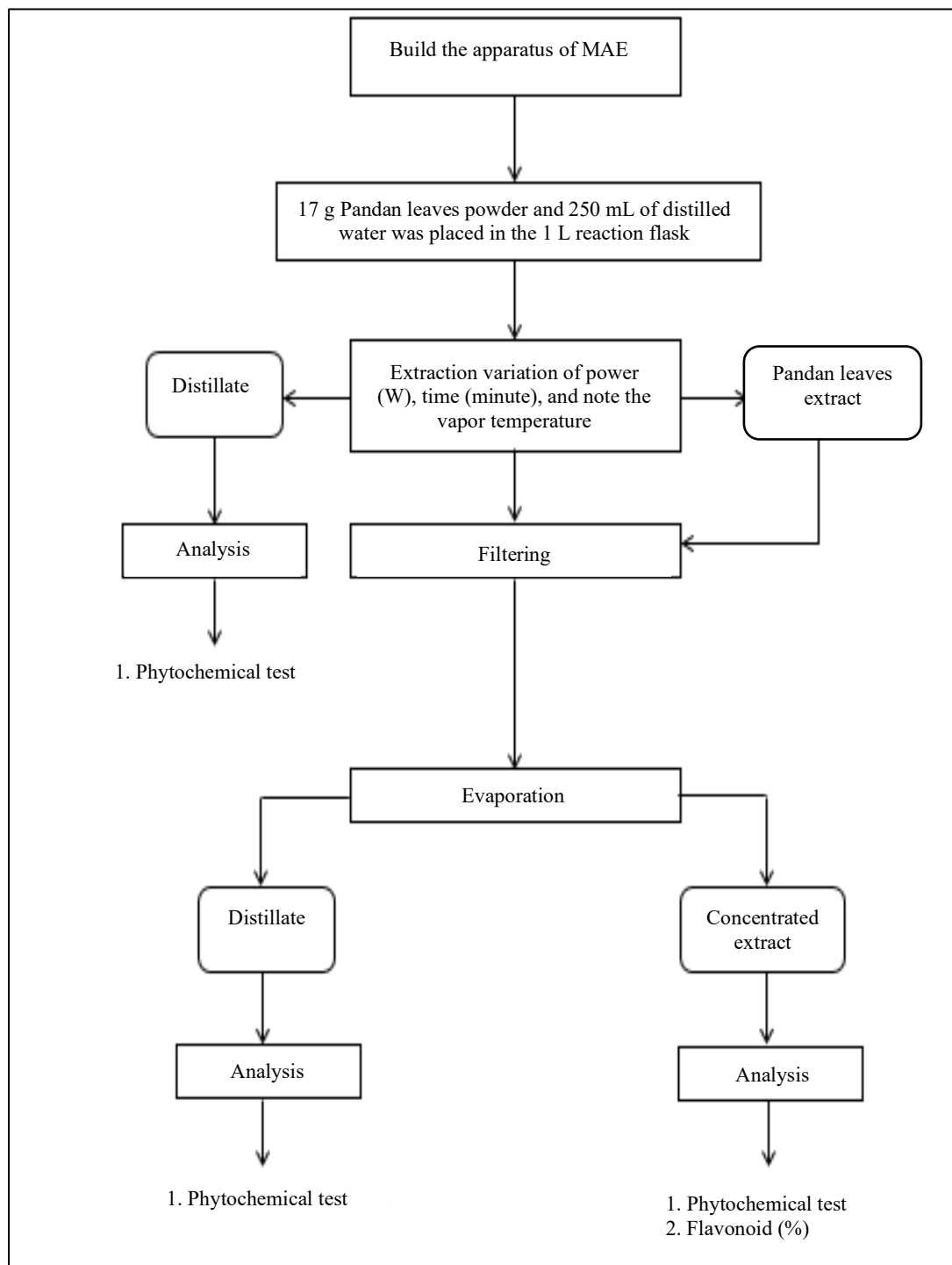


Figure 1. MAE for extraction of pandan leaves.

3. Results and discussion

The selection of solvents in the MAE method is very important – it must be polar. Water solvents have large dipole moments and dielectric constants of 1.85 D and 80.40 at 20°C, respectively. While the ethanol dipole moment is 1.66 D with a dielectric constant of 25 at 20°C. In this study the MAE was equipped with a set of distillation devices to obtain liquid extract of pandan leaves. While the

distillate was the solvent. Furthermore, pandan leaves extract was separated its the residue and concentrated using a rotary evaporator.

3.1. The effect of microwave power on yield of pandan leaves extract

At this stage studied the relationship between microwave power, extraction temperature and extract yield. and the results were shown in Table 1 below.

Table 1. The effect of microwave power of pandan leaves on the extraction parameter.

Power (Watt)	Time (minute)	distillate				Temperature (°C)	Extract Yield (%)
		Volume (mL)		Density (g/mL)			
		1	2	1	2		
180	20	5.00	168.00	-	0.9525	82	12.47
300	20	40.00	148.00	0.9531	0.9522	86	21.00
450	20	103.20	70.00	0.9528	0.9522	91	23.53
600	20	152.00	35.50	0.9524	0.9523	92	11.41

Distillate 1 : distillate obtained from extraction

Distillate 2 : distillate obtained from evaporation

The results of experiments using varying microwave power obtained extract yield as shown in Figure 2.

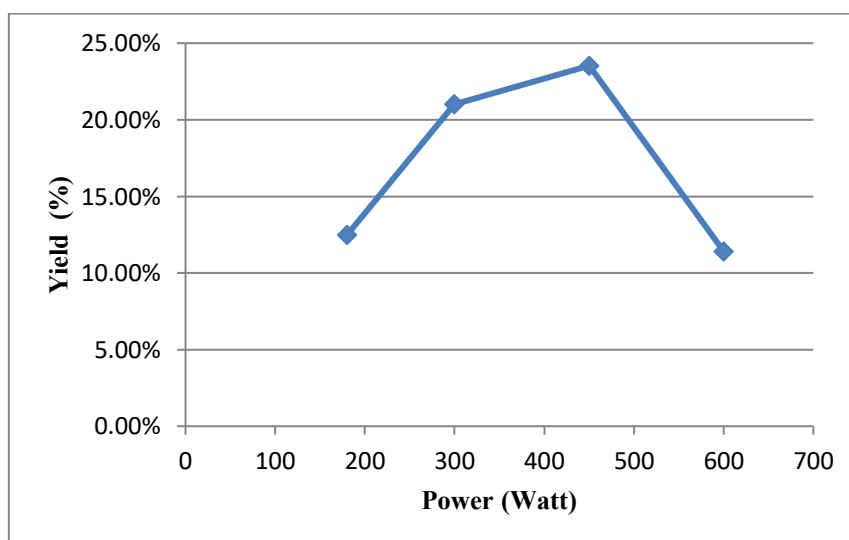


Figure 2. The effect of microwave power on pandan leaves extract yield.

Table 1 and Figure 2 showed that the greater the power, the temperature will increase and the greater the yield obtained. In this condition the water solvent undergoes a superheating, an increase in water's boiling point due to an increase in power, and this resulted an increase in the penetration of solvents on pandan leaves and thus produced more extract yield [7, 11]. However, at 600 and Watt of power, the extract yield has decreased significantly. This was caused by the use of high power resulting in high microwave radiation as well. In this case the heat generated during extraction will decompose and damages the pandan leaves cell tissue.

Table 1 and Figure 2 shown that the highest yield of pandan leaves extract obtained using the MAE method was 23.53% at 450 Watt power. When compared with the results of research by [3, 4] using the maceration, soxhlet extraction and supercritical carbon dioxide extraction methods, the MAE method was proven to be able to increase the yield of pandan leaves extract.

3.2. The effect of extraction time variations on yield of pandan leaves extract

Compared to conventional heating, microwave heating enhances the rate of reaction so that it requires a shorter time [7, 12]. To study this, variations in extraction time were carried out as shown in Table 2 below.

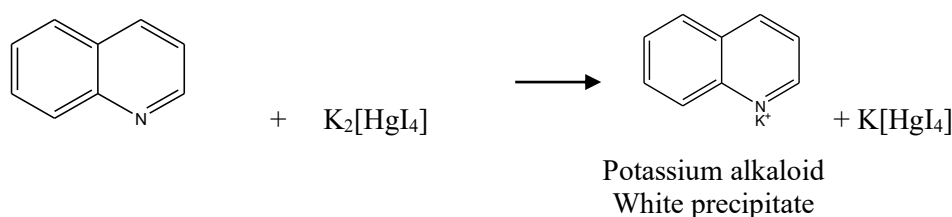
Table 2. The effect of extraction time on yield of pandan leaves extract.

Power (Watt)	Time (minute)	Distillate		Temperature (°C)	Extract Yield (%)
		Volume (mL)			
		1	2		
450	10	34.00	138.00	91	22.30
450	20	103.20	70.00	91	23.53
450	30	142.00	8.50	92	6.94

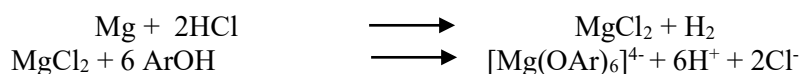
Table 2 shows that extraction times of 10 and 20 minutes produce extracts with yield that were not much different. However, at the time of extraction of 30 minutes there was a significant decrease. This was because the water solvent penetration into the pandan leaves has decreased, which resulted in the fewer extract taken. In this study, 450-Watt microwave power produced the highest yield of 23.53% with the extraction time of 20 minutes.

3.3. Phytochemical test on pandan leaves extract

Phytochemical test was carried out to determine the presence of chemical compounds in pandan leaves extracts including alkaloids, flavonoids, saponins, and tannins [13]. Alkaloid Test, in the alkaloid test, the reaction used was Mayer reagent. The test results tested positively because it showed the formation of white precipitate in the pandan leaves extract solution. The phenomenon that occurs in the alkaloid test is expected that nitrogen in the alkaloids will react with K^+ ions from potassium tetraiodomercurat (II) to form potassium-alkaloid complexes precipitate. The reaction is as follows:

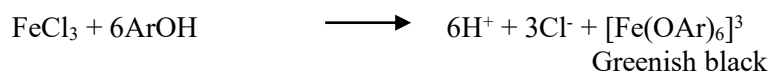


Flavonoid test carried out by the addition of HCl solution and Mg powder. The positive results of the flavonoid test were marked with the solution turning orange red. The orange-red complex resulting from the coordination covalent bond between the magnesium ion and the OH phenolic group of flavonoid compounds. The reaction is as follows:



The saponin test involved adding hot water and then 2N HCl solution into a test tube containing pandan leaves extract. The test results tested positively because after being shaken in a test tube arising foam.

The tannin test was done by adding a solution of Iron (III) chloride to pandan leaves extract. Iron (III) chloride solution will react with one of the hydroxyl groups present in tannin compounds. The test results were positively because the color of the test solution turned greenish black. The color arises due to the formation of complex compounds between Fe and tannins and indicates the presence of catechol tannins [14]. The reaction is as follows:



3.4. Determination of flavonoid (%) in pandan leaves extract

To study the phytochemical characteristics of the Pandan leaves extract (*Pandanus Amaryllifolius*), flavonoid content was determined as shown in Figure 3 below.

Figure 3. The effect of microwave power (Watt) on flavonoid (%).

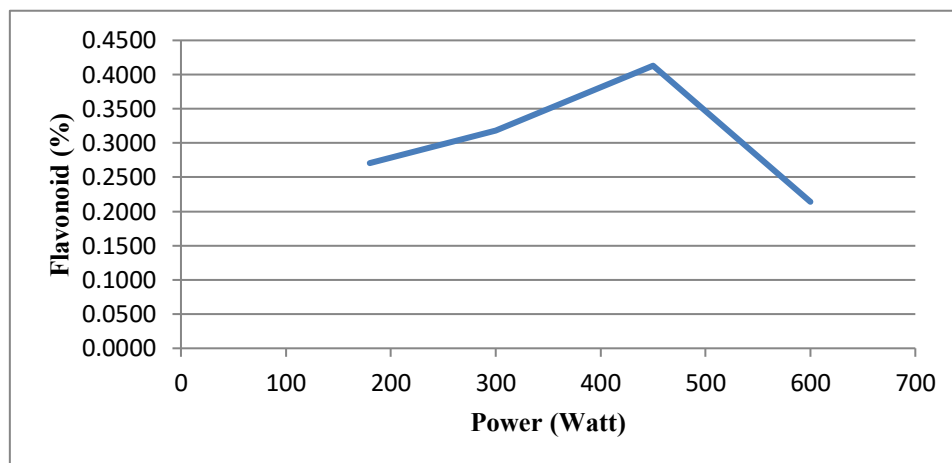


Figure 3 shows that the greater the power, the temperature will increase and the greater the yield obtained. This was caused by the increasing microwave radiation so that the active compounds in pandan leaves extract came out of the cell wall damaged by radiation. The more damaged the cell walls, the more active compounds came out and mixed with the solvent. Figure 3 showed the highest flavonoid concentration were 0.4130% with microwave power of 450 Watt. At 600 Watt microwave power the flavonoid level has decreased significantly to 0.2141 %. This occurs due to microwave radiation that is too high causing excessive swelling of pandan leaves. This condition causes excessive thermal stress so that rapid heat arises in the solution as a result of absorption of microwaves by the solvent. Excess thermal stress will cause damage to the chemical structure of the flavonoids so that the concentration decreases [15].

4. Conclusions

Water solvents are able to extract pandan leaves (*Pandanus Amaryllifolius*) using the Microwave Assisted Extraction (MAE) method. Extraction with microwave power of 450-Watt, temperature of 91-92 °C and time of 20 minutes was the best condition with a maximum yield of pandan leaves extract of 23.53%. Based on the phytochemical test, it was found that pandan leaves extract positively contain alkaloids, flavonoids, saponins and tannins. Using spectrophotometry method obtained the highest flavonoid concentration of 0.4130% at 450-Watt microwave power.

5. References

- [1] Ranitha M *et al.* 2014 *International Journal of Engineering and Technology* 2321-7308
- [2] Dewi E W 2009 *Pengaruh Ekstrak Pandan Wangi terhadap Waktu Induksi dan Lama Waktu Tidur Mencit* (Semarang: Universitas Diponogoro)
- [3] Faridah 2011 *Extraction Of Aroma Compound from Pandan Leaf to Enhance Rice Flavour* (Birmingham: School of Chemical Engineering The University of Birmingham)
- [4] Kayadoe V D 2015 *Molekul* **10** 88-96
- [5] Aghdase S, Vahid H and Behnam K 2017 *International Journal of Food Science and Nutrition Engineering* **7** 19-27
- [6] Lidstrom P *et al.* 2001 *A Review Tetrahedron Report* **589**
- [7] Taylor M *et al.* 2005 *Evalueserve Expert knowledge services*
- [8] Septya H K 2015 *Periodica Polytechnica Chemical Engineering Research Article*
- [9] Farah A *et al.* 2018 *International Research Journal of Pharmacy* **9** 22-29
- [10] Mohamad T G 2016 *Journal of Essential Oil Research* **28**
- [11] Rahul V K *et al.* 2018 *Journal of Biology* **7** 1
- [12] Gabriel A C *et al.* 2013 *Journal of Microwave Power and Electromagnetic Energy* **47** 1
- [13] Waziirroh E, Harijono and Kamilia K 2018 *IOP Conference Series: Earth and Environmental Science* **131**
- [14] Praptiwi and Mindarti 2006 *Majalah Farmasi Indonesia* **17** 32-36
- [15] Mukhaimin I 2018 *Chemical Engineering Research Articles* 2614-8757

Acknowledgments

This research is funded by Politeknik Negeri Bandung through its research and community services unit (Unit Penelitian dan Pengabdian Kepada Masyarakat).