Quality Retention of Dried Pineapple Peels and Cores

Muhamad Nurhaqim Bin Muhamad Hanim, Nurul Asyikin Binti Md Zaki

Faculty of Chemical Engineering, Universiti Teknologi Mara

Abstract—**The research project is conducted to satisfy two main objectives which are to study the effect of microwave power on the drying characteristics of pineapple peel and core and to observe the antioxidants activity of fresh and dried pineapple peels and core after the completion of drying process procedure. The experiment covered only on the pineapple wastes which are the peels and the cores. There are three different microwave power level are used such as 100 Watts, 300 Watts and 600 Watts in the experiment. Dried samples from these different powers is weighed every 1 minutes to obtain the percentage of moisture reduction. Graph of drying curve and drying rate curve is used to interpret the obtained data that covered every minutes of the samples of pineapple peels and cores take to dry. Both dried samples of pineapple peels and core of 600W required only 21 minutes to finish the drying process while for 300W samples they took an extra 11 minutes for the cores and an additional 15 minutes for the peels. Both samples of the 100W have required the longest time which is consuming 129 minutes for the cores and 131 minutes for the peels. All of the samples were dried from an initial of 100 grams wet samples. The antioxidant activity determination section shows 600 (core) has a large amount of antioxidant content by having 68.9% inhibition followed by fresh peel (65.2%), 100W(peel) (61.3%), 300W(core)(61%), fresh core (59..5%), 300W(peel) (57.2%), 100W(core) (53.4%) and 600W(peel) (41.7%). For the total phenolic content part, the result is as the following; 600W (core) (18.57%), 300W (core) (16.29%), 100W(peel) (15.70%), 300W(peel) (9.87%), 100W (core) (8.40%), 600W(peel) (6.81%), fresh peel (4.82%) and fresh core (4.26%). The core shows a significant amount of antioxidant activity and it has to further use in industries such as pharmaceutical and biological. It is good for human health to protect against diseases. The peel also need to be considered to further use like the core as it also shows significant antioxidant values.**

Keywords—moisture content, drying rate, 2,2-diphenyl-1-picrylhydrazyl (DPPH), total phenolic content (TPC)

1. INTRODUCTION

Pineapple is one the fruit that rich with nutrients such as vitamin C, carbohydrates, potassium, calcium and any other materials. There are many parameters can be studied on the pineapple content which moisture taking the highest value in comparison with ash, content, total sugars, reducing and non-reducing sugars. Mostly, the highest nutritional value consists in pineapple waste. Based on (Shekhar and Anju 2014) study, they said the ascorbic acid is a source of vitamin C that acts as antioxidant in human body. The antioxidant is important to prevent human body from diseases as it plays as a fighter that remove any unwanted substances such as bacteria, pathogen and microorganisms (Debnath, Dey et al. 2012). Antioxidant has an ability to trap free radicals; atoms or molecules containing unpaired electron that may oxidize nucleic acid, proteins, lipids or DNA and can start degenerative disease (Aruna Prakash 2016). Possible drying method also method also required to be studied as an initiator before determining the antioxidant activity and moisture content in the pineapple waste.

Every pineapple canning factories cannot escape from producing wastes from their production. The wastes are produced when the pineapples go through the sorting process. There are two types of wastes which are pineapple peels and the centre core. The trimming and off cuts during the sorting process also consume to the production of wastes. From the research study at East London, the factories produce 60,000 tons of waste every year. In the cannery production process, an approximately a third of pineapples entering the cannery leave as waste material. The total of 353 kg of waste material was produced with comprises of 298 kg of peels, 18 kg core/trimmings and 37 kg sludge (Pollack and Perez 2008).

Based on the data reported by (Pollack and Perez 2008), almost 2.5 million tonnes of pineapples were produced. 520,000 tonnes and 150,000 tonnes of the amount were exported as canned pineapple and pineapple juice, correspondingly. In terms of pineapple processing, there are many wastes are generated such as peel, core, stem, crown and leaves contributing to 50% (w/w) of total pineapple weight (Ketnawa, Chaiwut et al. 2012). The efficient ways to overcome the problem is by utilize those wastes to be use as a potential raw material. According to (Bartholomew, Paull et al. 2002), pineapple peels can be used to create paper, banknotes, and cloth as they have an abundant of cellulose, hemicelluloses and carbohydrates content. Other study conducted by (Nigam 1998) and (Omojasola, Jilani et al. 2008) also reported the waste form pineapple can be used in culture broth and cellulose production respectively.

2. METHODOLOGY

2.1 Chemical and Material

The chemical and reagent used for the experiment are illustrated in Table 2.1. DPPH (2,2-diphenyl-1-picrylhydrazyl), ethanol, folin-ciocalteu reagent and sodium carbonate (Na_2CO_3) are responsible for the experiment that study about the antioxidant capacity inside the pineapple peels and cores. Besides, the desiccating agent is used only in determining dry matter and moisture content activity.

For the material part, there are several apparatuses are required to implement the experiment which are pineapple, petri dish, analytical balance, laboratory oven, microwave, hand gloves, desiccator, stopwatch, measuring cylinder, conical flask spectrophotometer, aluminium foil, knife, blender, pipette and sonicator bath.

2.2 Dry Matter Measurement

Laboratory oven was used to measure the dry matter of pineapple peel and core. First of all, both pineapple peel and core were sliced into pieces in random sizes. After that, they are put into two petri dishes and were tagged. Then, petri dishes with and without the samples were weighed. 100 grams for both samples were chosen as a weight before drying process. The samples and the petri dishes were weighed using an analytical balance with sensitivity of 0.01 gram. Next, the petri dishes containing the samples were put into the oven and were dried for 16-24 hours at 60^{o}C until constant weight is achieved. After the drying process was done, the samples were taken out and were put inside the desiccator to cold the sample at ambient temperature. The weight of samples after the drying process was measured and recorded. The dry matter is calculated using the equation 3.1 (Extension 2012) that shown below.

$$\text{Dry matter (\%)} = \frac{\text{Dry sample weight}}{\text{Wet sample weight}} \times 100 \quad (3.1)$$

2.3 Moisture Content Determination

Different microwave output powers were used as 100, 300 and 600 Watts to determine the total value of moisture content inside the pineapple peel and core. Like a method of dry matter determination, both peel and core were sliced into random sizes. Two petri dishes, containing the samples were placed at the centre of the microwave turntable. Constant weight was used in all drying experiment with 100 g for each sample. 1 min time-interval was chosen to record the moisture losses for both samples using an analytical balance (sensitivity of 0.01 g). The experiment was conducted until three consecutive constant weights for both samples were obtained. The measured and recorded data were expressed in a form of drying curves (moisture content against time) and drying rate curves (drying rate against moisture content).

$$\%W= \frac{A-B}{A} \times 100 \quad (3.2)$$

Where,

%W = Percentage of moisture in the sample,

A = Weight of wet sample (grams) and

B = Weight of dry sample (grams)

$$DR= \frac{\text{Percentage of moisture content}}{\text{Time interval}} \quad (3.3)$$

Where,

DR = Drying rate

2.4 Antioxidant Activity Determination

2.4.1 2,2 Diphenyl-1-picrylhydrazyl (DPPH) Method

The experiment was started by preparing a DPPH solution that act as free radical scavenger to evaluate the antioxidant activity inside the samples for the experiment by using method recommended by (Arslan and Özcan 2011) with some modifications. The samples for the experiment were divided into two sections; fresh and dried samples. The dried samples (peel and core) of different microwave power output from the moisture content determination experiment were used for this experiment. The fresh samples of pineapple peel and core were sliced into pieces for 100g and were blended in a blender to get in a liquid form. The fresh samples were measured in a measuring cylinder to get their volume. Then, the 1g of the sample were mixed with 20 mL of ethanol inside test tube. The mixture inside the test tube was placed in an ultrasonic bath at 50^{o}C for 30 minutes before transferred into a centrifuge. They were centrifuged to get the supernatant. The supernatant of the samples was pipetted and were transferred into a test tube.

Of the volume, 1mL of pineapple peel and pineapple core extracts were taken out and were mixed with 4mL of ethanol and 1mL of ethanolic solution of 0.15mM DPPH solution (Yuris and Siow 2014). The reaction was occurred inside conical flask and they were incubated for 30 minutes in the dark. The aluminium foil was used to cover up the whole body of conical flask.

After the incubation process completed, the samples inside the conical flask were taken out and placed on the table. The supernatant of the samples was pipetted for 1000µL and were transferred into a cuvette. Next, the cuvette was put into a spectrophotometer to measure the absorbance at 517nm. The experiment was repeated using the dried samples (peel and core). The blank for the experiment is the ethanol only while the control is the mixture of DPPH solution and ethanol. The data was recorded and was tabulated on the table. The graph of percentage inhibition of the antioxidants in every sample against concentration of the antioxidants was also plotted. The percentage inhibition was calculated using a formula shown in equation 3.4. Then, the graph of different sample against percentage inhibition was plotted.

$$\text{Inhibition } (\%)= \frac{A_o-A_A}{A_o} \quad (3.4)$$

Where,

A_o = Absorbance of control solution

A_A = Absorbance of the sample

2.4.2 Total Phenolic Compound (TPC)

The experiment is started by preparing 10% folin acid by mixing 10mL of folin-ciocalteu solution with 100mL of distilled water. After that, 7.5% Na_2CO_3 was prepared by combining 7.5g Na_2CO_3 powder with 100mL of distilled water.

Before started the analysis part, 0.5mL for each samples (100W(peel), 100W(core), 300W(peel), 300W(core), 600W(peel) and 600W(core) was mixed with 2.5mL of 10% folin acid and 2.5mL of 7.5% Na_2CO_3. Then, all of the samples were incubated for 30 minutes at room temperature. The analysis was run at 765 nm (Abdelhady, Motaal et al. 2011). The blank for this section is a mixture of 0.5mL methanol, 2.5mL of 10% folin acid and 2.5mL of 7.5% Na_2CO_3. Then, the standard calibration curve of gallic acid was plotted and the data obtained was tabulated.

3. RESULTS AND DISCUSSION

3.1 Dry Matter Measurement

Table 3.1: Dry matter of pineapple peels and cores.

Dry Matter (g)	
Peels	Cores
14.62	11.4

The Table 3.1 shows the value of pineapple peels and core after they have been dried in an oven for 24 hours and 60°C. Initial weights for both samples are 100 g. Those values are useful for the calculation of moisture content that has been conducted on the effect of microwave power on the drying characteristics of pineapple peels and cores experiment. The dry matter of peels is much higher in comparison with dry matter of cores as the water content in the pineapple cores is bigger than the pineapples peels. The final conclusion cannot be made by using these values and need to further analyse on the 3.2 section.

3.2 The Effect of Microwave Power on the Drying Characteristics of Pineapple Peels and Cores

Based on the Figure 3.1, it clearly illustrates the pattern of drying curve by six samples which are 100W (core), 100W (peel), 300W (core), 300W (peel), 600W (core) and 600W (peel). For this section, the graph patterns will be discussed briefly to know the relationship between moisture content and time.

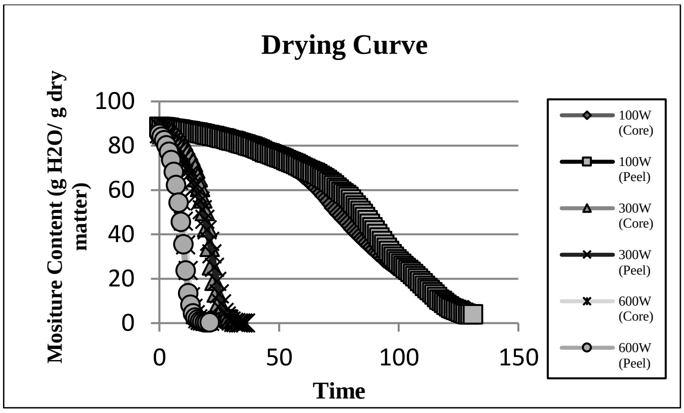

Figure 3.1: Typical Drying Curve for different microwave power level of pineapple peel and core.

According to the (Erdem, Karaaslan et al. 2014), the bigger power will have the fastest drying time compared to the smaller ones. From this experiment, 600W has the fastest drying time followed by 300W and 100W. The time recorded by the 600W is 21 minutes for both pineapple peel and core in order to dry the initial samples of 100g. For power level of 300W, the time taken is a bit longer which took 32 minutes and 36 minutes for the peels and the cores, accordingly. The most time-consuming part is when the samples are dried under 100W of microwave power. 131 minutes are required by the pineapple cores sample and 129 minutes for the pineapple peels.

Next, for the moisture content level for each sample, it shows slightly different for all samples. The 300W (peel) sample shows the smaller value with only has 0.07% while the highest moisture recorded by the 100W (core) sample with 5.8%. The 100 W (core) sample has the higher percentage of moisture content because the power is lower and not sufficient to further the drying and absorb the remaining moisture. But, when we compared with the 600W (peel), it has a higher value with 0.41% of moisture content. This shows that the power of 300W also can absorb more moisture when the time is increases. For the core samples, all of the power follows the trend with 600W has the smaller amount of moisture compared to 100W. The drying curve obtained from this experiment is follows the trend shown in the journal written by (Erdem, Karaaslan et al. 2014). All of the samples are decrease exponentially except the 100W (peel) as it takes time to reduce the moisture content at the time between 60 to 85 minutes. The speed of drying will be explained on the Figure 3.2 (drying rate curve).

The drying rate curve shown on the Figure 3.2 demonstrates the relationship between drying rate and moisture content for all samples. The explanation of the drying rate curve starting from the right hand side of the graph as moisture content is reduce from 100g H_2O/g dry matter until the free moisture content is achieved. From this experiment, it clearly clarifies that higher microwave power level will have higher drying rate which is 600W has a significant ability to free a large amount of moisture content in comparison to the 300W and 100W. Moreover, if the perspective is change to the differences between drying rate characteristics of pineapple peels and cores, there is points to be discuss. For 600W (core), the drying rate is increasing steadily until moisture content at 55g H_2O/g dry matter before it makes constant drying rate till 45g H_2O/g dry matter of the moisture content. It continues steadily upsurge before decrease significantly, when drying rate achieves 11.79g H_2O/g dry matter.min^{-1}. The 600W (peel) shows the same trend as 600W (core) but with a smaller value and no significant constant rate value.

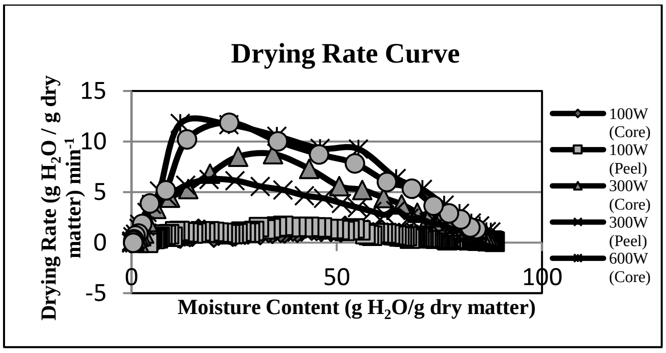

Figure 3.2: Typical Drying Rate Curve for different microwave power level of pineapple peel and core.

Next, 300W (core) starts with an insignificant drying rate with not even reach 1g H_2O/g dry matter.min^{-1} at 5 first attempts. Constant drying rate only appears at moisture content of 50 g H_2O/g dry matter before it decreases steadily until moisture content left only 4g. Then it shows downward trend significantly to the end. For 300W (peel), there is no constant drying rate visible to be observe. There is an only upward trend with steady amount of drying rate when the free moisture only has 26g H_2O/g dry matter. Like previous three samples, it shows significant downward trend until zero drying rate achieved. Both 100W (core) and 100W (peel) give very small values as shown on the graph. Microwave power of 100W cannot absorb the moisture really much as almost of the drying rate value falls below 1 (g H_2O/g dry matter).min^{-1}. It really tells that 100W not efficient as 600W and 300W in releasing moisture from the sample surface. Among of the samples, 600W will discharge very large amount of smoke at 20% to the end compared to the other power. This smoke will slowly disappear when the drying rate approaches zero.

3.3 Antioxidant Activity Determination

3.3.1 DPPH (2,2 Diphenyl-1-picrylhydrazyl)

From Figure 3.3, 600W (core) has the highest percentage inhibition with 68.9% followed by fresh peel, 100W (peel), 300 W (core) and fresh core with 65.2%, 61.3%, 61% and 59.5%, respectively. 600W has the lowest percentage of inhibition, only give 41.7% not even achieve 50% inhibition. 300W (peel) also show a good amount of inhibition along with 100W (core) with 57.2% and 53.4%, correspondingly. 600W has the lowest percentage of inhibition, only give 41.7% not even achieve 50% inhibition. 300W (peel) also show a good amount of inhibition along with 100W (core) with 57.2% and 53.4%, correspondingly.

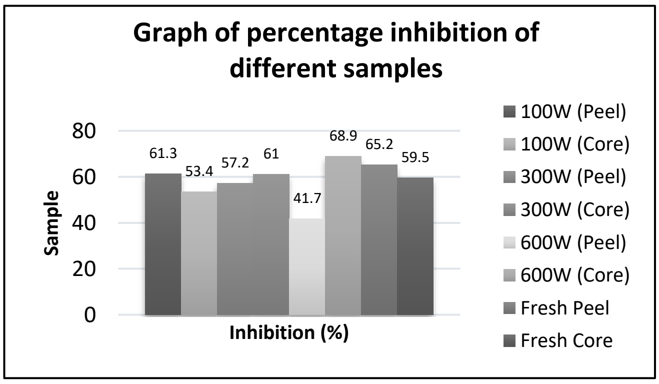

Figure 3.3: Percentage inhibition of different samples.

According to (Jayson M.Acosta 2011), the lesser the absorbance, the higher the amount of antioxidant exist in the respective samples. Among of the samples, 600W (core) has the smallest absorbance value that lead to the highest percent inhibition compared to the others. Based on the graph, the core consists a large amount of antioxidant if expose to the drying process as both 300W (core) and 600W (core) show the greatest amount of antioxidant activity. For the fresh sample, the peel has more antioxidant than the core.

3.3.2 Total Phenolic Content (TPC)

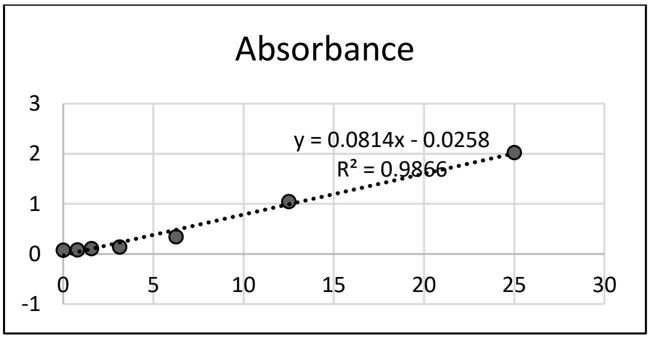

Figure 3.4: Standard calibration curve of Gallic acid.

Figure 3.4 shows the standard calibration curve as gallic acid as a standard solution. The value of R^2 is 0.9866 and fit to be a standard curve. The equation of the best fit is 0.0814x – 0.0258 that is useful to calculate the total phenolic content (TPC) of the samples.

Table 3.2: The total phenolic content for each samples.

Sample	Absorbance	TPC(mg GAE/g dry sample)
100W (Peel)	2.553	15.70
100W (Core)	1.372	8.40
300W (Peel)	1.604	9.87
300W (Core)	2.650	16.29
600W (Peel)	1.106	6.81
600W (Core)	3.021	18.57
Fresh Peel	0.783	4.82
Fresh Core	0.691	4.26

The calculated value of the total phenolic contents shown on the Table 3.2 and as the interpretation, 600W (core) has the higher TPC with 18.6 mg GAE/g dry sample. It followed by 300W (core) and 100W (peel) with 16.2 and 15.7 mg GAE/g dry sample, respectively. Fresh peel and core has the smallest value that only 4.8 and 4.3 mg GAE/g dry sample were appear. This indicates that the sample without drying has lower total phenolic content compared to the dried samples. Although in DPPH method, fresh samples shows significant antioxidant activity but in the total phenolic content method the value is contradict. The total moisture content in the sample may be contribute to this result.

4. CONCLUSION

As a conclusion, the effect of microwave power on the drying characteristics of pineapple peel and core has been studied. The antioxidant activity of fresh and dried pineapple peel and core using dpph method and total phenol content after drying process also has been observed. When the microwave power level used is 600W, it will shorten the drying time more than 300W and 100W. Moreover, the fastest drying time, the larger the drying rate. It can be seen on 600W and 300W as both can remove the moisture 11%/min and 6%/min, respectively. These are the highest value recorded for the respective power compared to the 100W as it only manages to remove an average of below 1%. So, in order to reduce the time of drying, higher power must be used. From the experiment, it clearly explain that the pineapple wastes have a significant value to provide to the human life. Both shows that the antioxidant activity exists in each of them. By applying the dpph method, the core at 600W has the highest percent inhibition. In the second division of the microwave power level (300W), the core also shows a greater value of antioxidant activity. For the fresh sample, the peel has a higher amount of antioxidant as it has bigger percentage inhibition in comparison to the core. This also happen in the sample of 100W which the peel is the dominant ones.

Antioxidant activity also has been observed by looking on the total phenolic content in the samples. 600W (core) is the higher one and also for 300W (core). This is following the previous data obtained from the dpph method as both are in the higher ranking. So, the core is the most important wastes and must be used for further purpose such as biological and pharmaceutical industry. The high antioxidant content is good for human health and can provide a better option in serving as a natural antioxidant. The peel also has a significant antioxidant activity but not as much as the core but the peels also must be use for the same purpose. Lastly, the pineapple wastes are the most valuable waste and they should be given to aid in protecting human health and diseases.

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