DRYING AND GRINDING OF PINEAPPLE FRUIT FIBRE USING FREEZE DRYING TECHNIQUE

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***Abstract*—Malaysia being that a tropical country has favorably provided a suitable environment for various fruits to be cultivated. Such that one of the many fruit would be pineapple. Pineapple in general consisted of moisture and the rest would be the total solids in which of the total solids would be carbohydrates while fibers makes up to the rest. Pineapple fibers are considered to be in the pulp, shell, crown, leaves and the cores. In this paper the fiber of the pineapple core was used as the material because often in time they are being disregarded as waste or feedstock to animals. However, the level of protein in the core is higher than the flesh. Therefore, because of the core has higher protein value, they also have twice the amount of total soluble sugar. Pineapple being a tropical fruit that is rich in nutrient, ascorbic acid, minerals, fibers and antioxidants has make them after banana and citrus the third most traded fruit internationally. As the fruit industry evolves there is a demand for fruits to be consumed in different ways. This demand most likely arises due to the fact that fruits like pineapple has high moisture content and they are deemed as highly perishable product. Therefore, techniques like drying and grinding were introduced and implemented. With this the correlation between the desired to utilize the pineapple waste into a product and the problem face in fruit industries can be solved in this paper. This paper will focuses on the drying and grinding of the pineapple fruit fiber using freeze drying technique and a simple analysis on the taste, stickiness, scent, color and size of the product were provided.**

Keywords— Pineapple, Fibers, Cores, Moisture content, Drying, Grinding, Freeze drying

I. INTRODUCTION

Pineapple dub as the queen of fruit due to its excellent flavour and taste is one of the fruit crop that is commercialized to the world. Although, it is often said that the crown resemble of that a king thus, marking it presence as a superior fruit from the rest of the *Bromeliaceae* family. Certainly with its golden-yellow like colour making it stand out from the rest of the fruit had only strengthened such claim. In the hands of an Italian explorer, Christopher Columbus first discovered pineapple in a land which is later on identified as America (Joy & Anjana, 2015). Over the time the domesticated pineapple fruit that we know today is far different than before due to the result of modernisation or in other word mutation for better fruit. Consumed fresh or cooked this fruit is seasonal and the compositions varies on the origin, season, process and time of harvest (Farid Hossain, 2015). On average, ripe pineapple fruit consist of 85% moisture, 0.7 % citric acid and 14% total soluble solid (Rosdan, Amin, & Ghazali, 2012). Pineapple is a peer among fruits especially it contains some amount of calcium, potassium, vitamin C, carbohydrates, crude fibre, water and different minerals (Farid Hossain, 2015).

Pineapple in general consisted of 80 % moisture and the rest would be the total solids such as sucrose, glucose and fructose (Farid Hossain, 2015). To be more specific ,85% (Farid Hossain, 2015) of the total solids would be carbohydrates while fibres makes up to the rest. Pineapple fibres are considered to be in the pulp, shell, crown, leaves and the cores. The cores of the pineapple are considered softer (Kumar, Chandra, & Kumar, 2016) in terms of texture and have been used as a source of fibre in many diets for the humans and also the animals. Although to compare the content of moisture is definitely higher in the flesh than in the core but the level of protein in the core is 35% (Kumar et al., 2016) higher than the flesh. Incidentally because the core has higher protein value, they also have twice the amount of total soluble sugar in the core when compared in the flesh. The concentrations are also higher in value and thus, it can be said that the cores of the pineapple are much sweeter in taste than in the flesh.

The pineapple cores are often thrown out as a waste but as can be understood from above the cores rich in fibres is good for human health thus, it can be used as dietary fibre. Where, dietary fibre is mainly consisted of fruits and vegetables, a component of food that can resist the hydrolysis of the digestive system. The fruit fibre of the pineapple especially the cores and the shell are often blended together as juice. This application would be the most general and are often used as a source of fibre in dietary. While the more complex used would be the production of dried pineapple core. Where the pineapple core were taken and then dried to be used as an ingredient to enhance the flavour of food. The core can be dried as a whole or can be also dried in slices depending on the usage of the product

As of today similar to any general fruit, pineapple is preferably to be consumed fresh or processed as juice or canned. After all, pineapple after banana and citrus is the third most traded fruit internationally. That being said, the market for pineapple based product is one of the fastest growing in the world (Lobo & Paull, 2017). Claim like this can only be made as pineapple is proven to be a versatile fruit, such that the usage ranges from being animal feedstock to medicine.

As the food industry evolves undeniably there is a demand for fruits and vegetables to be consumed in different ways. Most likely these demands arises due to the fact that 80 % of fruits and vegetables are consisted of water therefore they are deemed as highly perishable (Changrue & Raghavan, 2006). To keep the fruits and vegetables to stay fresh as long as possible furthermore to retain it in its original form is not an easy task due to most storage technique required a very low temperature which would be difficult to execute throughout the distribution chain. From here, countless new technique was develop and among them was the drying and grinding technique.

However both of these technique was not recently discovered in fact it was first recorded in the 18th century (Vega-Mercado, Marcela Góngora-Nieto, & Barbosa-Cánovas, 2001) where the most basic and simple technique was applied, with the sun used in the drying process and mortar and pestle in the grinding process. Nevertheless

due to the poor quality and the contamination of the products this then leads to the emergence of new drying and grinding technologies (Sagar & Suresh Kumar, 2010).

Among the many drying technologies that are popular would be freeze, vacuum, microwave, and cabinet or tray, while notable from the grinding technology would be a blender. The introduction of these technologies has proven to be a help especially in increasing the shelf-life and reducing the transport cost. Although, undeniably there are flaws and challenges in using these technologies, such as reducing the moisture content to a certain level while maintaining the nutritional value is not an easy feat.

Where in this case, freeze dryer was chosen as the most suitable method when handling pineapple fruit fibre; this is because freeze dryer is suitable for both solids and liquids. For any typical freeze dryer there are 3-step process that is involved in which the first step requires the product to be frozen solid this is to ensure that the water present in the product is converted to ice. Where in the second step, the ice formed is removed by direct conversion from solid to vapour a process in which is called as sublimation. In the last step, the remaining water which was strongly bounded to the product was removed and converted into vapour, this process is then latter called as desorption.

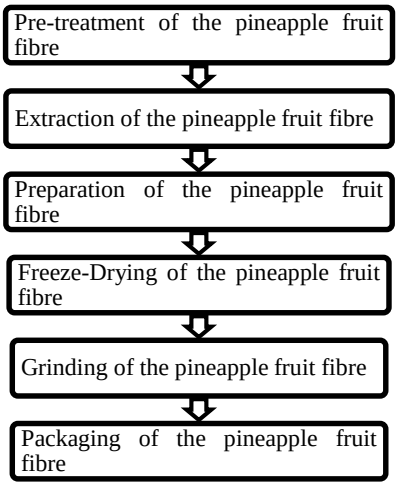
Although it is said that freeze drying is three step process but they are divided into two main stages which is freezing and drying. Likewise as the name suggest freezing is the process of sublimating a product in a water or solvent in order to obtain small ice crystals. Whereby, the drying process involves with only lowering the pressure of the machine to allow ice sublimation.

Other than drying, grinding was also included as a method that can significantly help in solving the problems faces in the fruit industries. Likewise drying, grinding is another process that has been used since the olden ages and has been frequently used in the food industries. Although, the technologies has then undergoes such improvement and changes however in general, grinding is a process where the size of a particulate is being reduced by using mechanical forces (Karam, Petit, Zimmer, Baudelaire Djantou, & Scher, 2016).

All and all after fully understanding the techniques, methods and the characteristic of the pineapple fruit fibre, the process of creating new product can now be in full commence. In this paper the process of introducing a new product can be done by utilizing the pineapple fruit fibre and turning it into powdered like form by using the freeze drying technique which can significantly lower the shipping cost and increase the shelf-life but ultimately still retains the nutritional values of the pineapple fruit.

II. METHODOLOGY

The production of fruit fiber into a powder requires many steps and has its own flow of production. Hence below are the summarizations of the flows on how the production takes place:



At the start of the process, pineapple fruit fibre was collected from the cores of Yankee, a special type of pineapple fruit. Before collecting the cores, the outer part of pineapple fruit were first given treatments which consisted of washing and drying. The pineapples were then cut into segments and the cores were manually carved out from the flesh. All the cores were then transferred into a bowl and were given a quick washed with water. The separated cores were then roughly chopped into smaller pieces before putting it into the blender. This step is important as to ensure that every piece has been thoroughly crushed before the extraction process.

After blending all the cores together, a mixture of liquid (pineapple core juice) and solid (pineapple core) were obtained. Moving on, the mixture were then manually sieved and the solid can now be separated from the liquid. The fibre is then transferred into a beaker. This then marks the start of the freeze drying techniques. However before that, a total of three samples were prepared to run in this production.

In each beaker 10 g of maltodextrin was melted together with the juice from the pineapple core. For beaker A 100 ml of pineapple core juice was used to melt 10 g of maltodextrin while in beaker B 110 ml of pineapple core juice was used to melt the 10 g maltodextrin and lastly for beaker C 120 ml of pineapple core juice was used in order to melt the 10g maltodextrin. After that in each beaker, the same amount of fibre was then added. The initial weight was then weighted and after that, all the samples were then placed inside the freezer of the refrigerator for the juice inside the samples to be completely frozen before freeze drying it.

After 6 days in the freezer the samples were taken out and then placed inside the freeze dryer. After freeze drying the samples for another 6 days, the samples were taken out and the weight was taken and noted down in previously table. All the samples were then taken out from respective beaker for the grinding process. The material use was a simple mortar and pestle. All the weight was measured using a weighing scale and after obtaining the final product a taste and smell test was done on all three product. All the three product was then further differentiate based on the color, the stickiness and the size by using naked eyes.

III. RESULTS AND DISCUSSION

Below are table 1 which consist of all the data taken for beaker A, B and C.

Table 1: Data for Beaker A, Beaker B and Beaker C

Beaker	A	B	C
Weight of Core (g)	75.51	75.51	75.51
Amount of Maltodextrin Added (g)	10	10	10
Amount of Pineapple Core Juice Added (mL)	100	110	120
Weight of Core+Pineapple Juice Core+Maltodextrin (g)	183.86	185.78	186.91
After freezing in the refrigerator for 6 days (g)	110.32	111.47	112.15
After freeze drying for 6 days (g)	43.69	42.29	40.63

From Table 1, it can be seen that after freeze drying for 6 days, the weight of the pineapple fruit fiber decreases significantly from its initial weight for each beaker. The most drop in weight could be seen in beaker C while the least drop would be from beaker A. From here we can conclude that the differences between all three of these beaker would be the amount of pineapple core juice added. Where in this case the pineapple core juice added would serve as the moisture content of the pineapple inside each beaker. Another purpose of adding the pineapple juice was to act as stabilizer or as

bulking agent to the product, in other word the adding of pineapple juice into the mixture would increase the concentration hence enhancing the flavor and the taste of the product. Not only that the purpose of the pineapple fruit juice is to serve as a fluid medium where the basic requirement for the freeze drying technique is to first freeze the water present in the material before freeze drying it and whereby the method of freezing in this study was to use the refrigerator. There are other option when choosing the fluid medium such as tap water and distilled water but the most favorable choice was to use the pineapple juice from the core.

Inside beaker C the amount of the pineapple core juice added was the largest hence the moisture content is the highest while inside beaker A the amount of pineapple core juice added was the least hence the moisture content is the lowest. Therefore, from here, it can be concluded that the more moisture content inside of a product then the more weight will it losses inside the freeze dryer.

The values from table 1 can be transforms into a graph of moisture content (weight) versus time taken for all beaker.

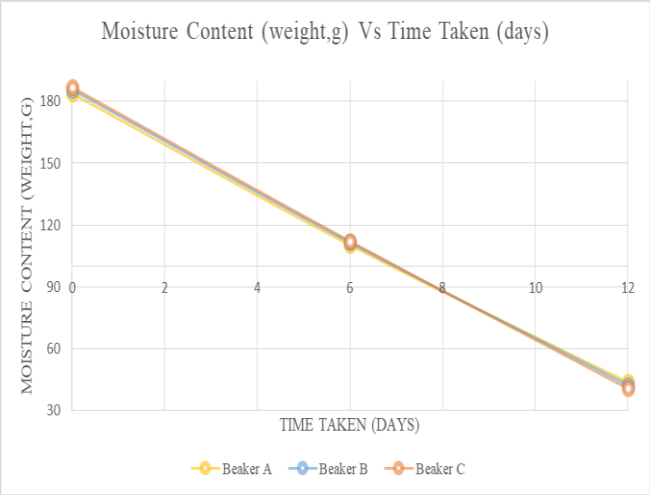


Fig. 1: A graph of moisture content (weight, g) against time taken (days).

From the graph above, it can be seen that the trend is declining thus further strengthening the claim made previously. The claim made can be furthered supported by facts where in beaker C because the moisture content is high and when it was left inside the refrigerator freezer for 6 days, the moisture content would freeze which in other word the liquid inside the beaker would turn into ice. From here, we can see that the initial weight began to decrease and when was left inside freeze dryer, all the ice would vaporized. Hence because of beaker C contains more moisture content incidentally they would produce more ice and hence more of them would vaporized. Therefore, the weight pineapple fruit fiber of beaker C would also be the lightest among all other pineapple fruit fiber.

Table 2 demonstrates the analysis done on each of the beaker. Each pineapple fiber were analyze in terms of the taste, the degree of the stickiness, the scent (smell), the color and the size.

Table 2: Comparison Beaker A, B and C

	Beaker A	Beaker B	Beaker C
Taste	Has a less sweeter taste and weak pineapple flavor	Has a sweet taste and mild pineapple flavor	Has a strong sweet taste and strong pineapple flavour
Stickiness	Less Sticky	Sticky	More Sticky
Scent	Weak scent of pineapple	Mild scent of pineapple	Strong scent of pineapple
Color	Dull yellow	Light yellow	Yellowish orange
Size	Small with less clump	Small but more clump	Small but with the most clump

From the table above, Beaker C emerges as the superior product as it has a better taste, scent and color. In term of the taste, earlier a statement regarding the pineapple juice acting as bulking agent or stabilizer was made and this can be proven when a taste test was made for all three beaker. Beaker C has a better taste because the amount of pineapple juice added was the largest which mean that more juice can act as the stabilizer between the fibrous solid hence when freeze drying the fiber the flavor becomes more concentrated thus producing a better taste. However, due to higher moisture content, the pineapple fruit fiber in beaker appear to be stickier and thus it tends to clump together as time passes by.

IV. Conclusion

To conclude, the drying and grinding of pineapple fruit fiber using freeze drying technique was successful. It was deem to be successful when the feasibility study shows that the pineapple core which is usually regarded as waste can be turn into edible use. The process in obtaining the product has indicate that the flow is not difficult and thus it is safe and acceptable when wanting to do mass production. From the findings the pineapple fruit fiber inside beaker C was chosen as the superior product and the obtained product are in a powdered like form. In which they can act as addictive inside food such as muffin or cookies or they can also be used as food supplement. For further research, one can used the product obtained in this thesis to study characteristics such as micronutrient fortification where the product can be further develop and strengthen.

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