Development and Evaluation of Sugar from Chico (*Manilkarazapota*) Fruit

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Abstract *–Sugars are commercially produced from sugar beets and sugar cane. This study aims to develop sugar from Chico fruit at two different maturities, ripe and over-ripe. It also seeks to determine the sugar profile of the extracted Chico juice, the product yield, and the sensory evaluation of the developed sugar based on the perception of the respondents. Utilizing experimental design the study revealed that the fructose (%w/v) of the ripe Chico was 6.25 and 7.25 for the over-ripe. The five litres extracted juice from the ripe fruits yielded 700.4 grams and 2, 300 grams from the over-ripe. The sensory evaluation (colour, aroma, and taste) of the produced sugar from over-ripe were evaluated as like very much and like moderately for the ripe. The Chico sugars were used in coffee and compared to commercial sugar and the results revealed that the aroma of the over-ripe was rated as like very much and like moderately for the taste while the ripe were rated like moderately for aroma and like slightly for the taste. The study concluded that the aroma and taste of the two Chico sugars were significantly different from each other. The aroma and taste of the commercial and Chico sugars were also significant when used in coffee. Therefore, the developed sugar from Chico especially over-ripe can be used as an alternative sweetener.*

Keywords *–Chico, development, sugar*

INTRODUCTION

Sugars are desirable for their pleasant and acceptable taste and it also plays many significant roles in our food supply as a carbohydrate. Sugars are the source of calories, as food preservatives and sweetener in food or drink and, perform many essential technical and biological functions. But despite the facts that sugar have a variety of functions for the human body, sugar and its sources also explicit problems [1].

As the number of people having diabetes increases, managing and treating diabetes without any other effects in the body is still a problem that must be answered in medical science. For that, researching and conducting a study about plants and fruits with better properties and activities are utilized for it will eventually help in determining its therapeutic application [2]. Finding of natural alternatives that decreases risk factors are gaining focus in research for the reason that the availability of medications in treating diseases are expensive but also produces side effects while the cost of plants and fruits that can be used as medicine that can also help for the prevention and treatment of diseases. Many studies have been conducted to identify and determine the effects of different plants and fruits in different diseases and illnesses [3].

Furthermore, sugar can be obtained from various fruits and Philippines are known for its immense extent of sweet fruit crops. More than 300 species of edible fruit-bearing plant species are present in the Philippinesand commonly, during the fruits peak season, bulks of it are just lead to waste because of spoilage. Such waste is caused by the very short shelf life of fruits and the absence of other uses or products for the fruits aside from consuming it in its fresh state.

As mentioned, there is a vast amount of fruits in the Philippine archipelago such as banana, pineapple, mango, papaya, calamondin, jackfruit, rambutan, dalanghita, marang, lanzones, star fruit, durian, soursop, passion fruit, santol, guava, chico and many more [4]. Chico which is in early times was carried by the Spanish in the Philippines and eventually adopted everywhere in the old world tropics. From the Philippines, it gained popularity throughout Southeast Asia as a fruit tree because of its nutritional value when consumed as fruits [5].

Chico is scientifically known as *Manilkarazapota*, it is a fruit with a sandy outer surface that is brown in colour and flesh that also have colour black with white smooth seeds. The fruit is juicy, has a sandy texture,

and a sweet flavour that resembles a mixed flavour of beetroot and brown sugar which is the common source of commercial sugar. Chico fruit is accepted by people of all ages because of its flavour. It is commonly known in different countries as tsiko, chico, tree potatoes, chikoo, sapote sapodilla, zapotechico, sapodilla plum, baramasi, ciku, sapota, beef apple, and naseberry. Chico fruit is also rich in nutritional properties and it acts as a good bulk laxative because of its dietary fibre (5.6 g/100g). Chico is also a good source of different minerals namely potassium, copper, iron, and vitamins like retinol, ascorbic acid, folate, niacin, pantothenic acid, and poly-phenolic compound which is accounted for the chico to have its antiviral, anti-bacterial, anti-inflammatory, and anti-parasitic properties[6].Chico is also a crop of the tropical region that contains a large amount of nutritional value and natural energy for it contains simple sugars which also rejuvenates and replenishes the body [5].

Chico also has sterols and triterpenoids that account for its antihyperglycemic activities [2]. Additionally, because of the high moisture content of Chico (69.05 to 75.7%) and total soluble solids (TSS) content (17.4 to 23.7°Brix) it has a short shelf life [7] and processing it will be an advantage to increase its storage life of which in turn will also help for the fruits will not lead to waste [8].

OBJECTIVES OF THE STUDY

This study was conducted to develop sugar from Chico fruit at two different maturities. Specifically, it aims to determine the sugar profile of Chico fruit juice through testing and analysis; determine the level of evaluationand difference of the developed sugar based on sensory evaluation regarding its colour, aroma, and taste; anddetermine the level of evaluationand difference of the developed sugar when used in coffee based on the sensory evaluation regarding its aroma, and taste.

MATERIALS AND METHODS

Research Design

This study utilized experimental design. Ripe and over-ripe Chico fruits were the factors in the study. The sugar profile was analysed through testing and analysis and the physical properties of the developed sugar such as colour, aroma, and taste when tasted alone and when used in coffee was determined through a sensory evaluation of thirty taste panellists.

Development of Sugar

The Chico fruit were bought from the nearby market in Siniloan, Lagunaand all the other needed common materials were properly prepared. The fruits were weighed and then thoroughly washed with running water to gain its cleanliness state and the seeds were removed. Two different containers were prepared and sterilised to serve as containers for the ripe and over-ripe fruits.

The Chico fruits were put in a net bag then pressed using a manual pressing machine to extract its fluid content and to obtain five litres of juices at each maturity. The extracted juices were strained using a muslin cloth to remove any solid state and clumped small materials combined in the juices. After that, the obtained juices were put in a clean container. The extracted juices were added maltodextrin and mixed using a mixing machine. The mixed juices werefiltered once again using a large strainer with cheesecloth.

The mixed juices were transported in spray drying machine. The spray drying machine produces a dry powder or granules with the utilization of hot gas that dries the slurry or liquid. The extracted juice was process for less than one hour for each of the treatment.

Participants

The participants of the study were composed of ten vendors, ten consumers of sugar-related products, and ten coffee drinkers. The vendors and consumers also claimed that they are coffee drinkers.

Instrumentation

This studyutilized score sheet rubrics described by five-point Hedonic Scale Quality Scoring where 1-dislike very much, 2-dislike moderately, 3-like slightly, 4-like moderately, and 5-like very much.

Data Collection Procedure

Five hundred millilitres of extracted Chico fruit juices were submitted to ITDI-STD DOST to determine the sugar profile. The sugar profile were analysed using a High Performance Liquid Chromatography Test Method. The produced sugars from the laboratory together with the laboratory test results were subjected to sensory evaluation. To evaluate the physical characteristics of the developed sugars, the sugars were randomly labelled and served together with water and crackers for neutralization. For the evaluation of sugar when used in coffee, 6

ounces of water to 1 teaspoon of coffee to 2 teaspoons of sugar were prepared and randomly served together again with water and crackers to neutralize the taste buds of the participants. The samples were composed of different sugars such as the commercial sugar and the developed sugar at two different maturities. The data gathered for the two evaluations were retrieved and subjected to data analysis.

Data Analysis

All the experimental measurements were replicated three times and the gathered data were statistically analysed using Two Sample T-test and One-Way Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

Sugar Profile of Extracted Juice from Chico

Table 1 shows the sugar profile of the extracted Chico fruit juice at two different maturities. It was tested using High-Performance Liquid Chromatography Method. From the result, it shows that ripe Chico fruit juice gained 6.25 amount of fructose while over-ripe Chico fruit juice obtained 7.25 of fructose.

Other fruits such as banana and mango composition rapidly change during aging. The amount of sugars specifically fructose increases from the ripe stage to the over-ripe stage from 3.61 to 4.80 in banana and 2.01 to 2.60 in mango [9].

Table 1.Sugar Profile of Extracted Juice from Chico.

Chico Fruit	Fructose, %w/v
Ripe	6.25
Over-ripe	7.25

Product Yield of Sugar Produced from Chico Fruit

Table 2 shows the product yield of sugar produced from Chico fruit at two different maturities. For the ripe maturity, it yields 700.4 grams of sugar and 2300 grams of for the over-ripe. It can be seen that the over-ripe Chico fruit yielded more amount of sugar than the ripe Chico fruit.

Table 2. Product Yield of sugar produced from chico fruit

Chico Fruit	Product Yield (g)
Ripe	700.40
Over-ripe	2300.00

Evaluation of the Ripe and Over-ripe Chico Sugar

Color of the Ripe and Over-ripe Chico Sugar

As seen on the table 3, data shows that the over-ripe chico sugar was the best in terms of color. It obtained a weighted mean of 4.53 and was evaluated by the respondents as like very much because of its pronounced pleasant colour while the ripe chico sugar gained a weighted mean of 4.43 which is also liked very much by the respondents.

In judging a certain food item colour plays as a significant aspect. It is a significant characteristic perceived by senses for consumers' acceptability [10]. It allows detection of defects that a food item possesses [11]. A dark product may indicate a decrease of quality in a certain product and is usually less appealing to consumers [12]. In addition, the first indication to observe quality is the colour of a food item and product appearances [13],[14].

Table 3. Level of evaluation of ripe and over-ripe chico sugar in terms of color.

Factor	Weighted Mean	Verbal Interpretation	Rank
Color			
Ripe	4.43	Like Very Much	2
Over-ripe	4.53	Like Very Much	1
GWM	4.48	Like Very Much	

Aroma of the Ripe and Over-ripe Chico Sugar

From the table 4, data shows that in terms of aroma, over-ripe chico sugar ranks first which is like very much by the respondents because of its detectable sweet scent and it obtained a weighted mean of 4.57 while the ripe chico sugar gained a weighted mean of 3.57 which is liked moderately by the respondents because its sweet scent is moderately detectable.

Aroma compounds are likely to change in a way [15]. The colour and appearance act as the first property that is perceived and attributed to attract consumers to a product but the property that has the largest effect in the desire to consume and accept a certain product is the aroma.

Table 4. Level of evaluation of ripe and over-ripe chico sugar in terms of aroma.

Factor	Weighted Mean	Verbal Interpretation	Rank
Aroma			
Ripe	3.57	Like Moderately	2
Over-ripe	4.57	Like Very Much	1
GWM	4.07	Like Moderately	

Taste of the Ripe and Over-ripe Chico Sugar

As shown in Table 5, the over-ripe chico sugar obtained the highest rank and gained a weighted mean of 4.80. It has a very sweet taste that was very much liked by the respondents. On the other hand, ripe chico sugar gained a weighted mean of 4.17 which has a slightly sweet taste and liked moderately by a group of respondents.

The colour and appearance of a certain product attract a person but because of the occurrence of aroma and taste, a person will eventually more likely to consume it. The different flavour attributes are important to a person satisfaction and a flavour that is tasted at a much higher level, degree or amount is more likely to be consumed [16]. The sweetness in the taste of fruits is caused by the diminishing polyphenol content due to ripening or maturity stage [17].

Table 5. Level of evaluation of ripe and over-ripe chico sugar in terms of taste.

Factor	WM	Verbal Interpretation	Rank
Taste			
Ripe	4.17	Like Moderately	2
Over-ripe	4.80	Like Very Much	1
GWM	4.48	Like Very Much	

Aroma of the Commercial, Ripe and Over-ripe Chico Sugar when used in coffee

As seen on Table 6, data showed that the commercial sugar rank as the highest when used in coffee. It obtained a weighted mean of 4.87 and was like very much by the respondents because of its detectable sweet and bitter scent when used in coffee. It was followed by the over-ripe chico sugar that gained a weighted mean of 4.23 that is also liked very much by the respondents. In contrast, ripe chico sugar gained a weighted mean of 3.43 and was like moderately by the respondents because bitterness is the only scent that can be smelled when it is used in coffee.

Table 6. Level of evaluation of the commercial, ripe and over-ripe chico sugar when used in coffee in terms of aroma.

Factor	Weighted Mean	Verbal Interpretation	Rank
Aroma			
Commercial	4.87	Like Very Much	1
Ripe	3.43	Like Moderately	3
Over-ripe	4.23	Like Very Much	2
GWM	4.18	Like Moderately	

Taste of the Commercial, Ripe and Over-ripe Chico Sugar when used in coffee

As shown in Table 7, the commercial sugar rank as the highest when it comes in taste when the sugar was used in coffee. The commercial sugar was liked very much because the sugar and coffee flavour complement with each other and it obtained a weighted mean of 4.77. It was followed by the over-ripe chico sugar which is liked moderately by the respondents because the sugar and coffee flavour quite complement with each other and it gained a weighted mean of 3.67. On the other hand, ripe chico sugar is like slightly because the coffee is the only flavour that can be tasted and for that, it ranked as the lowest having a weighted mean of 3.13.

Table 7. Level of evaluation of the commercial, ripe and over-ripe chico sugar when used in coffee in terms of taste.

Factor	WM	Verbal Interpretation	Rank
Taste			
Commercial	4.77	Like Very Much	1
Ripe	3.13	Like Slightly	3
Over-ripe	3.67	Like Moderately	2
GWM	3.86	Like Moderately	

Majority of people have tried white sugar and raw sugar as sweeteners and it is also the most used sugar in different cafes. White sugar and raw sugar gives sweetness without changing the coffee flavour. The findings support that most of the consumers preferred sugar that just complements with the coffee flavour [18].

Table 8. Difference between the level of evaluation of the ripe and over-ripe chico sugar in terms of color.

Factor	N	Mean	Standard Deviation	SE Mean
Color				
Ripe	30	4.43	0.504	0.092
Over-ripe	30	4.53	0.507	0.093
T-Test Result			T= -0.77	P= 0.447^{ns}

ns-not significant

Analyzing the data with the used of Two-Sample T-Test shows that there is no significant difference between ripe and over-ripe chico sugar in terms of color and it was presented in Table 8.

As the result of the Two-Sample T-Test in Table 9, it shows that there is a significant difference between ripe and over-ripe chico sugar in terms of aroma. The production and development of a variety of volatile compounds during maturation causes the aroma properties of fruits. And during ripening, sugar levels

increases because fruit starch is converted into sugars, the breakdown of carbohydrate polymers by different carbohydrases causes the total transformation of starch to sugars. Also, the conversion of polysaccharides by cellular enzymes not only gives the typical sweetness but also leads for many aromatic flavour compounds. This process has the dual effect of altering the taste and aroma of the fruit. Fruits sweeter taste and scent are administered by the increase in sugar of the fruit [19].

Table 9. Difference between the level of evaluation of the ripe and over-ripe chico sugar in terms of aroma.

Factor	N	Mean	Standard Deviation	SE Mean
Aroma				
Ripe	30	3.57	0.568	0.10
Over-ripe	30	4.57	0.626	0.11
T-TEST RESULT			T= -6.48	P= 0.000*

**significant*

Taste of the Ripe and Over-ripe Chico Sugar

Analyzing the data with the used of Two-Sample T-Test shows that there is a significant difference between ripe and over-ripe chico sugar in terms of taste and it was presented in table 10. During the early stage of maturity it is where the highest level of polyphenol can be found that also incorporates noticeable styptic bitterness [17]. The polyphenol content of the fruit diminishes during the unripe stage to the over-ripe stage [20].

Table 10. Difference between the level of evaluation of the ripe and over-ripe chico sugar in terms of taste.

Factor	N	Mean	Standard Deviation	SE Mean
Taste				
Ripe	30	4.17	0.648	0.12
Over-ripe	30	4.80	0.484	0.09
T-TEST RESULT			T= -4.29	P= 0.000*

**significant*

Table 11. Difference between the level of evaluation of the commercial, ripe, and over-ripe chico sugar when used in coffee in terms of aroma.

Source	DF	SS	MS	F	P
Factor	2	30.96	15.48	66.66	0.000*
Error	87	20.20	0.232		
Total	89	51.16			

**significant*

One-Way Analysis of Variance showed the significant difference between the commercial, ripe, and over-ripe chico sugar when used in coffee in terms of Aroma. As shown in the table 11, there is a significant difference between the commercial, ripe, and over-ripe chico sugar's aroma when used in coffee.

Table 12. Difference between the level of evaluation of the commercial, ripe, and over-ripe chico sugar when used in coffee in terms of taste.

Source	DF	SS	MS	F	P
Factor	2	41.62	20.81	61.38	0.000*
Error	87	29.50	0.339		
Total	89	71.12			

**significant*

One-Way Analysis of Variance showed the significant difference between the commercial, ripe, and over-ripe chico sugar when used in coffee in terms of taste. As seen on the table 12, there is a significant difference between the commercial, ripe, and over-ripe chico sugar's taste when used in coffee.

Adding sugar affects the taste of coffee. Pure cane sugar and dark muscovado sugar complement with the coffee scent and flavour. It signifies a balance between the coffee and sugar flavours and it was evaluated as the best sugar that can be used in coffee. All of the varieties of sugars (pure cane, caster, raw cane, demerara, sucanat, rapadura, light brown, dark brown, turbinado, light muscovado, dark muscovado, brown coconut, and date sugar) when used in coffee gained a difference between their aroma, sweetness, bitterness, viscosity, acidity, and taste [21].

CONCLUSION AND RECOMMENDATION

It is therefore concluded that the developed sugar from Chico at two different maturities can be used as an alternative sweetener for it was rated in all the physical properties as like very much to like moderately.

Additionally, the over-ripe Chico juice has a higher amount of fructose than the ripe Chico juice. Also, over-ripe Chico fruit yields more amount of sugar than the ripe Chico fruit. Likewise, the over-ripe Chico sugar is much better than the ripe Chico sugar for it is rated by the respondents in all the physical properties as like very much which in turns rank first than the ripe Chico sugar. Moreover, commercial sugar still ranked as the highest when it comes to its aroma and taste when used in coffee. Furthermore, the developed Chico sugars were not significantly different in terms of colour which is in contrast in

terms of its aroma and taste which implies that they are significantly different. And with regards to the aroma and taste of the commercial and Chico sugars when used in coffee showed that there is a significant difference between the commercial and Chico sugars' aroma and taste when used in coffee.

On the basis of the aforementioned findings and conclusions, the researchers recommends: utilization of the sugar from Chico fruit as an alternative sweetener and additives in coffee;over-ripe Chico fruit is the ideal maturity that must be used when developing Chico sugar for it always contains greater composition, properties, and acceptability than the ripe Chico fruits; andChico sugar developed using over-ripe Chico fruits is one of the option that can be used as a sweetener in other products that needed sweetness.

The study limited only on the sugar profile and sensory evaluation and these are considered as the weaknesses of the study and with that it is highly recommendedto continuously conduct study on the physicochemical components of sugar such as nutritional value, shelf life, glycemic index, and glycemic load.

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