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Isolation and Identification of Starch from Terminaliacatappa (Talisay) Fruit: A Potential Substitute for Commercial Flour

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Abstract

The potential of Terminaliacatappa (Talisay) fruit starch as a substitute for commercial flour in baked products was investigated. Starch was isolated from the carbohydrate-content of the Talisay fruit and was identified qualitatively using iodine test. The amount of starch was analyzed quantitatively using colorimetric method and direct acid hydrolysis. The isolated starch was incorporated to the commercial flour in different proportions in preparing baked products as in crinkles. The baked products was subjected to sensory evaluation test to determine the acceptability of the baked product containing Terminaliacatappa fruit starch. The responses in the sensory evaluation test was treated analytically using Mean and Analysis of Variance Tukey. It was found that starch was present in the Terminaliacatappa fruit as indicated by the blue coloration obtained upon adding iodine solution to the sample. Colorimetric analysis yields 1.15 to 2.45% starch while direct acid hydrolysis yields 12% of starch in the sample. The baked product (crinkles) containing 75% Talisay fruit starch in combination with 25% commercial flour was found to be very acceptable in terms of color, aroma, texture and flavor similar to the one baked from pure commercial flour.

Keywords; *Terminaliacatappa, Iodine Test, Colorimetry, Direct Acid Hydrolysis, Sensory Evaluation Test.*

I. INTRODUCTION

In the past four decades, poverty in the Philippines has remain a challenge as evidenced by the proportion of households living below the official poverty line, making poverty reduction much slower than in neighboring countries. The present economic situation of the nation seems to be in a critical state where poverty prevails especially in rural areas. The main concern of the Filipinos is to alleviate poverty and one way of doing this is by reducing the dollar requirements for the importation of raw materials such as wheat flour that makes the cost of production of baked products higher. Another concern is to reduce starvation among the poor by introducing an alternative source of food.

The TALISAY (*Terminaliacatappa*) tree,also known as the Indian Almond or Umbrella tree belongs to family Combretaceae, and is commonly found along coastal areas, roadsides and parks. It is adapted to this type of habitat because it is salt and drought tolerant, best grown under full sun and is also resilient to strong winds during the rainy season. This tree provides protection and shelter for any passers-by due to its large broad leaves and branches that extend horizontally, which then form tiers or levels [1].

Terminaliacatappa is a common inland tree found not only in the Philippines but also in the Old World Tropics as a large deciduous tree. It reaches a height of twenty to twenty five meters with horizontally whorled branches so that it is grown for its

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umbrella-type shade. As the tree gets older, its crown becomes more flattened to form a spreading, vase shape.

It bears smooth and ellipsoid fruits about three to six centimeters long with fibrous and fleshy pericarp and a hard endocarp. The fruit is easily dispersed by air and water because it is light and corky. At various stages of ripeness, it may open fully to reveal the edible kernel within the hard endocarp, or it may open partially to reveal the fleshy mesocarp surrounding the fibrous inner layers.

Gilman and Watson [2] described the fruit of Terminaliacatappa as a tan colored fruit measuring one to three inches in length and has an oval or elongated shape. It has a dry or hard fruit covering. Since it does not attract wildlife, once it falls to the ground it becomes a litter and a problem to waste management.

The fruit is said to be edible, tasting similar to almonds. Physiochemical analysis of sun dried mesocarp of fruits revealed about 12.65% ash, 84.93% carbohydrates, 0.37% oil, 316 mg/g glucose, 0.1% protein, 1.30 mg/g tannin, 1.95% moisture with 3434.5 kcal calorific value [1].In addition to this [3] utilized matured Talisay fruits in making wine through fermentation. Since Terminaliacatappa fruit has a high carbohydrate content, there is a possibility that one type of carbohydrates present is starch which is the main component of flour.

Starch $(C_6H_{10}O_5)_n$, is a naturally abundant nutrient carbohydrates and the major carbohydrate reserve in plant tubers and seed endosperm where it is found as granules [4]. It is a polymer composed of D-glucose molecules joined together by glycosidic bonds to form several millions amylopectin molecules accompanied by a much larger number of smaller amylose molecules. The principal source of starch is corn (maize) with other commonly used sources being wheat, potato, tapioca and rice.

Starch is composed of small granules; the size of which varies depending on its source. Amaranth and rice starch granules are one to two micrometers in size, whereas granules of potato starch have a size of approximately one hundred micrometers. According to Stoker and Stephen [5], the ratio of amylose and amylopectin molecules varies depending upon the plant source. In potato, the ratio is twenty-one percent to seventy nine percent, in maize it is twenty eight percent to seventy two percent, in wheat it is twenty six percent to seventy four percent and in tapioca it is seventeen percent to eighty three percent.

Talisay fruit had been analyzed by many authors [1]-[6] to contain a large amount of carbohydrates but the presence of starch in it had not been established. Talisay fruit is usually seen as litter and is not given enough attention to be a potential source of flour. Compared with other sources such as wheat, potato, maize and rice which need to be cultivated, Terminaliacatappa fruit is very abundant during the months of June and July and can be collected readily without any additional expenses incurred.

Matos et al. [7] determined the chemical composition and nutritional properties of the Terminaliacatappa seeds to establish the possibility of using them for human and/or animal consumption. Proximate analyses showed that the seed contained 4.13% moisture, 23.78% crude protein, 4.27% ash, 4.94% crude fiber, 51.80% fat, 16.02% carbohydrate and 548.78 Kcal Calorific value.

Bermosa [8] enumerated some uses of starch such as in making jellies, gum, and candies; as food thickener; in making yogurts and puddings. Other special food starches improve the flavor, texture, shelf-life and processing of a variety of baked products. It is also used as bakery fillings for cream, fruit pies and doughnuts. Moreover, it is very useful as dry mixes for cakes, muffins, brownies and cookies aside from a very important ingredient in icings and frostings.

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Whole wheat flour is a powdery substance, a basic food ingredient derived by grinding or mashing the whole grain of wheat. Whole wheat flour is used in baking of breads and other baked goods. This flour is the most widely used of all flours that can be used universally for a wide range of baked products such as yeast breads, cakes, cookies and pastries.

The University advocates poverty alleviation as revealed in its community extension programs, and the researchers utilized their knowledge in Analytical Chemistry by isolating and identifying the presence of starch in the carbohydrate-content of Terminaliacatappa (Talisay) fruits. With this attempt, Terminaliacatappa fruits which are usually seen as litters could be utilized, thus contributing to the issue of solid waste management in the community.

This study aimed to establish the potential of Terminaliacatappa fruit starch as a substitute for commercial flour in some baked products as in crinkles. This study specifically isolated and identified starch from the carbohydrate-content of the fruit by applying qualitative and quantitative analysis. Towards the end, this established the acceptability of the baked product (crinkles) from the Terminaliacatappa fruit starch.

II. METHODS

A. Research Design

This study made use of the experimental design where both qualitative and quantitative analysis of the presence of starch in the Talisay fruit was conducted.

B. Participants

Thirty respondents consisting of fifteen students, thirteen faculty and two staff from the College of Education, Arts and Sciences were selected to participate in the Sensory Evaluation Test where they were asked to determine the acceptability of the baked product (crinkles) from Terminaliacatappa fruit starch in terms of color, aroma, texture and flavor. It was explained to the participants that Talisay fruit was found to be edible so that they will not worry for any toxic effect.

C. Instrument

A researcher-made instrument (Likert Scale) consisting of four scales was used in the Sensory Evaluation Test. The color, aroma, texture and flavor of the baked products (crinkles) were rated based on their acceptability as very acceptable (4), acceptable (3), less acceptable (2) and not acceptable (1). Four different compositions of crinkles were used where Talisay fruit starch was incorporated in different proportions as in twenty-five percent Talisay fruit starch with seventy-five percent wheat flour; fifty percent Talisay fruit starch with fifty percent wheat flour; seventy-five percent Talisay fruit with twenty five percent wheat flour and one hundred percent wheat flour.

D. Prcoedure

The first step was the collection of Talisay fruit and preparation of sample used in the investigation. The researchers asked the assistance of the Maintenance Office of the Lyceum of the Philippines University in Batangas in the collection of the fruits. Approximately ten kilograms of ripe fruits preferably the yellow variety were gathered, washed and peeled. The mesocarp (fleshy portion) was separated from the seeds and both were reserved for the analysis. Four different samples were used in the analysis, the fresh mesocarp, seed extract, dried mesocarp powder, and mesocarp powder that were soaked in water.

The second step was the isolation of starch from the mesocarp and the seeds of the fruit. The seeds were soaked in water overnight followed by grinding in a mortar and extracting its juice using a blender. Aside from the fresh mesocarp, some of it were oven dried and the dried products were ground or milled to powdered form. Some portion of the powdered sample was soaked in water and the remaining amount were kept in an airtight container.

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The next step was the analytical identification of starch in the samples to determine not only the presence of starch (qualitative) but also its concentration in the sample (quantitative). The presence of starch was determined by iodine test wherein one gram each of the samples were treated with iodine solution.

The amount of starch was identified from the samples by colorimetric analysis using spectrophotometer that measures the absorbance of particular wavelengths of light by a specific solution. Using this method, the sample was measured at multiple wavelengths from 400-700 nm, and the profile of its absorbance was compared to a standard. This device also determined the concentration of a known solute in a given solution. The test was conducted in the Lipa Quality Control Center.

Another method used in the analysis of starch was direct acid hydrolysis. In this method, the sample was treated with hydrochloric acid to hydrolyze the starch to glucose. The amount of starch was calculated based on the amount of glucose after subjected to titration. This test was conducted in the Standard and Testing Division of the Department of Science and Technology.

The fourth step is the incorporation of the isolated starch in baking baked products in combination with commercial flour in different proportions. The amount of the isolated starch varies in the proportion of twenty-five percentTalisay starch with seventy-five percent commercial flour; fifty percentTalisay starch with fifty percent commercial flour; seventy-five percentTalisay starch with twenty-five percent commercial flour.

And finally, the baked products were subjected to sensory evaluation test in order to determine the acceptability of the Talisay fruit starch as supplement to the commercial flour.The procedure can be summarized as in Figure 1.

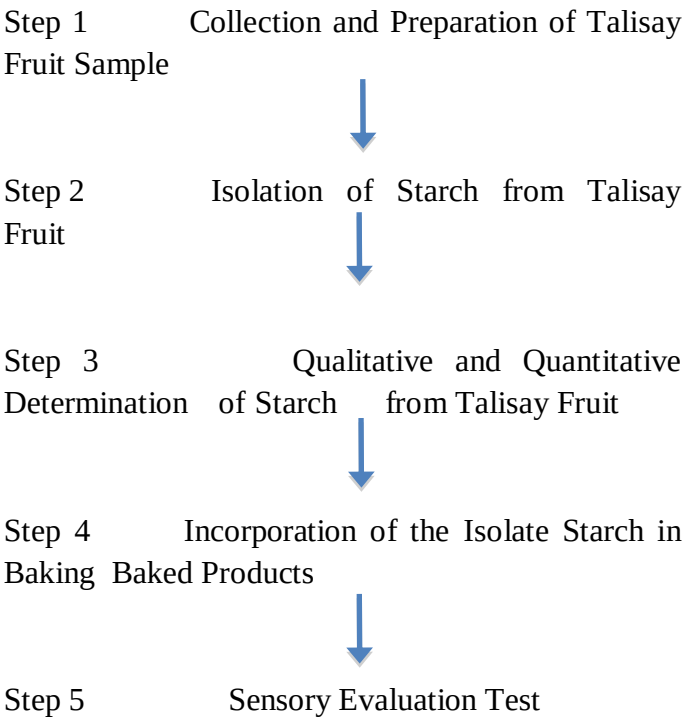

Figure 1. Isolation and Identification of Starch from Terminaliacatappa (Talisay) Fruit

E. Data Analysis

To determine the acceptability of the baked product (crinkles) from Terminaliacatappa fruit starch in terms of color, aroma, texture and flavor, the responses were analyzed by getting the mean in the Sensory Evaluation Test. Analysis of Variance Tukey was used to make a multiple comparison of color, aroma, texture and flavor across each concentration.

III. RESULTS AND DISCUSSION

1. Isolation of Starch from Terminaliacatappa Fruit

The mesocarp or the fleshy portion of the Talisay fruit was oven dried then ground or milled using food processor in order to isolate the starch from other components in the sample. The moisture that was removed from the sample through drying contains water and other water-soluble components except starch because starch is water-insoluble. Starch granule is enclosed in a cell wall that is being destroyed when grinding the sample thereby exposing the granule itself. The same explanation

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was made by Englyst, Hudson and Englyst[9] when they analyzed starch in some foods such as rice, bread, legumes, cereals, pasta and tubers. According to them starch is in the form of intact granules because it is enclosed within a particulate matter or plant cell wall. During food processing such as milling, the particulate matter is disrupted and the cell wall is removed thereby increasing the surface area of the starch granule. Hassan et al. [10] isolated starch from mango seeds by cutting the seeds into small pieces followed by grounding in a laboratory blender similar to what was done with the Talisay seeds in the isolation of starch from other components. The soluble sugar was separated from starch by extracting with ethanol.

2. Identification of Starch through Qualitative Analysis

Table 1. Presence of Starch as Indicated by Iodine Test

Sample	Amount of Iodine Solution Added
Fresh mesocarp	5 drops
Seed extract	2 drops
Dried mesocarp powder	10 drops
Mesocarp powder soaked in water	12 drops

It was revealed from Table 1 that using one gram of seed extract requires only two drops of iodine solution before a positive result of blue coloration was obtained, one gram of fresh mesocarp requires five drops of iodine solution, one gram of dried mesocarp powder requires ten drops of iodine while one gram of soaked mesocarp powder requires twelve drops of iodine solution. The result shows that all the samples contain starch but the seed extract contains the greatest amount of starch because with only two drops of iodine solution, there was already the appearance of blue color which is an indication of the presence of starch.

The result could be explained by the fact that starch molecule contains amylose fraction which is responsible for the blue coloration. This is based on the idea of [11] stating that iodine binds inside the helical shape of amylose chain and forms dark blue color. The formation of the color is due to the charge transfer complexes. Molecular iodine is dissolved in potassium iodide and form polyiodide ions like I_3^-, I_5^- and I_7^-. These negatively charged polyiodide ions act as charge donor while the neutral iodine as charge acceptor. The electrons in the charge transfer complexes are excited or jumped to a higher energy level by light so that there is absorption of light and the brown color is perceived by the human eyes. In the presence of amylose, another charge transfer complex is form where amylose is the charge donor and polyiodide as acceptor. A new wavelength of light is absorb by the charge transfer complex which is dark blue to the human eyes.

3. Identification of Starch through Quantitative Analysis

Table 2 shows the result obtained from the colorimetric method of determining the amount of starch in Terminaliacatappa fruit using four different samples.

It was shown from Table 2 that the seed extract contains the greatest amount of starch which is 2.45% followed by the fresh mesocarp with 2.02%, then the dried mesocarp powder with 1.47% and the soaked mesocarp powder contains the least amount of starch which is only 1.15%. The result in the colorimetric test is similarto the result from Iodine Test where it is also the seed extract which contains the greatest amount of starch, however the percentage of starch that was isolated from the samples was very small. This could be due to the fact that starch is very sensitive to light so that some amount of it was destroyed during the storage process because the samples were not kept in light proof containers such as dark colored containers.

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Table 2. Amount of Starch as Determined by Colorimetric Method

Sample	% of Starch
Fresh mesocarp	2.02
Seed extract	2.45
Dried mesocarp powder	1.47
Mesocarp powder soaked in water	1.15

This is in conformance to the study made by Horrer, Flutsch, Pazmino, Matthews, Thalmann, Nigro, Leonhardt, Lawson and Santelia [12] which claimed that guard cells of the leaf stomata contains starch. The presence of starch in the guard cells is very evident at the end of the night compared to the rest of the leaf but 30 minutes after sunrise, starch is rapidly degraded. This degradation of starch is necessary for stomatal opening and biomass production.

Another quantitative analysis performed in order to determine the amount of starch in Terminaliacatappa fruit was acid hydrolysis. It was conducted in the Standard and Testing Division of the Department of Science and Technology. In the analysis, it was found that the dried mesocarp powdered sample yielded twelve percent starch, a little higher yield than the one obtained from colorimetric method. The result indicates that direct acid hydrolysis is a more accurate and reliable method of quantitative analysis compared to colorimetry because direct acid hydrolysis is a chemical method unlike colorimetric method which is just a physical method. According to Reyes and Gonzales [13], chemical methods of quantitative analysis result in the formation of a new substance and involve reactions such as precipitation, neutralization and oxidation thus increasing the purity of the sample unlike physical methods that involve the measurement of physical properties like density, refractive index, and absorption or polarization of light.

Table 3. Acceptability of Terminaliacatappa Fruit Starch inBaked Product

	25%		50%		75%		100%	
	M	VI	M	VI	M	VI	M	VI
color	3.10	A	3.27	A	3.60	VA	3.67	VA
aroma	2.60	A	2.63	A	3.40	A	3.63	VA
Texture	2.51	A	2.63	A	3.40	A	3.63	VA
Flavor	1.83	LA	2.13	LA	3.40	A	3.87	VA

Legend: 3.50 – 4.00 = Very Acceptable (VA); 2.50 – 3.49 = Acceptable (A); 1.50 – 2.49 = Less Acceptable (LA); 1.00 – 1.49 = Not Acceptable (NA)

Table 3 presents the acceptability of the Terminaliacatappa fruit starch in baked products (crinkles) in different proportion.As shown in Table 3, the color of the crinkles that contains seventy-five percentTalisay fruit starch is very acceptable as indicated by the mean of 3.6 which is almost the same as the color of the crinkles containing one hundred percent commercial flour whose mean is 3.67.The color of the crinkles containing fifty percent and twenty-five percent are both acceptable as indicated by their mean of 3.27 and 3.10 respectively.

As to aroma, the one which is very acceptable similar to the crinkles containing one hundred percent commercial flour is the one that contains seventy-five percentTalisay fruit starch with a mean of 3.5 and the one with the lowest mean of 2.6 but is still acceptable is the baked product (crinkles) that contains twenty-five percentTalisay fruit starch.

The texture of the crinkles containing seventy-five percent, fifty percent and twenty-five percentTalisay fruit starch are all acceptable based on the obtained mean of 3.40, 2.63 and 2.53 respectively.

As to flavor, the crinkles that contains seventy-five percentTalisay fruit starch is acceptable as indicated by the obtained mean of 3.40 while those crinkles containing fifty percent and twenty-five percentTalisay fruit starch are both less acceptable based on their obtained mean of 2.13 and 1.83 respectively.

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Based on the result, it is evident that if Talisay fruit starch is incorporated to the commercial flour in preparing baked products, a greater concentration of it must be added in order to make the product acceptable in terms of color, aroma, texture and flavor. This could be due to the fact that Talisay fruit starch is an additive that contributes to the palatability of a baked product. This conforms to the idea of [14] that in baked products, another raw material or ingredient should be added to wheat flour to impart considerable changes to its functionality.

The multiple comparison of coloracross each baked product at different concentration reveals that there was a statistically significant difference observed on the color of the crinkles using different proportions. This was observed since the computed F-value = 3.706 and p-value = 0.014. From the multiple comparison conducted, it was found that there is a significant difference observed in the color of the crinkles containing 25% Talisay fruit starch and the crinkles containing 100% commercial flour.

Table 4. Multiple Comparison of Color Across Each Proportion

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	p-value
color	25%	50%	-0.167	0.835
		75%	-0.500	0.062
		100% - APF	.56667*	0.026
	50%	25%	0.167	0.835
		75%	-0.333	0.338
		100% - APF	-0.400	0.188
	75%	25%	0.500	0.062
		50%	0.333	0.338
		100% - APF	-0.067	0.987
	100% - APF	25%	.56667*	0.026
		50%	0.400	0.188
		75%	0.067	0.987

*Legend: F-value = 3.706; p-value = 0.014; *Significant at p-value < 0.05; I = Interpretation; S = Significant; NS = Not Significant*

This significant difference in the color of the two baked products is due to the small amount of Talisay fruit starch that was incorporated to the commercial flour which affects the color of the baked product. As explained by [14] one of the factors that contributes to variation in baked product qualities is color that depends on the ingredients and their qualities, formulation and ingredient ratios, and processing technologies.

In the multiple comparison of aroma using different concentrations of Talisay fruit starch, a significant difference was observed. The computed F-value = 9.207 with p-value of 0.000, indicates that there is a significant difference in the aroma of the crinkles using different concentrations of Talisay fruit starch. Upon scrutiny of the result, it was observed that there is highly significant difference in the aroma of the crinkles containing twenty-five percentTalisay fruit starch and the crinkles containing one hundred percent commercial flour. There is a significant difference in the aroma of the crinkles containing twenty-five percentTalisay fruit starch and crinkles containing seventy-five percentTalisay fruit starch. There is also a significant difference in the aroma of the crinkles containing fifty percentTalisay fruit starch and crinkles containing one hundred percent commercial flour. A significant difference was also observed between the crinkles containing fifty percentTalisay fruit starch and the crinkles containing seventy-five percentTalisay fruit starch. It shows that the crinkles containing seventy-five percentTalisay fruit starch and the one baked from pure commercial flour have almost the same aroma.

Table 5 presents the multiple comparison of aroma across each baked product (crinkles) of different proportions.

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	p-value
aroma	25%	50%	-0.133	0.943
		75%	-.90000*	0.001
		100% - APF	-.96667*	0.000
	50%	25%	0.133	0.943
		75%	-.76667*	0.009
		100% - APF	-.83333*	0.003
	75%	25%	.90000*	0.001

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		50%	.76667*	0.009
		100% - APF	-0.067	0.992
	100% - APF	25%	.96667*	0.000
		50%	.83333*	0.003
		75%	0.067	0.992
	100% - APF	25%	1.10000*	0.000
		50%	1.00000*	0.000
		75%	0.233	0.700

Table 5. Multiple Comparison of Aroma Across Each Proportion

*Legend: F-value = 9.207; p-value = 0.000; *Significant at p-value < 0.05; I=Interpretation; S=Significant; NS=Not Significant; HS=Highly Significant*

The significant difference observed in the aroma of the crinkles could be explained by the fact that the aroma of a baked product is affected by the formulation and ingredient ratios similar to its color. According to Sokol [15] flours made from nuts may not be true flours, but if they are used in combination with wheat flour in different proportions, they can enhance the flavor, aroma and texture of various baked goods.

Table 6 shows the multiple comparison of texture across each baked product of different proportion. The computed F value = 13.001 and the p value of 0.000 reveals that there is a significant difference in the texture of the crinkles using different concentrations of Talisay fruit starch. There is highly a significant difference in the texture of the crinkles containing twenty-five percentTalisay fruit starch and the crinkles containing one hundred percent commercial flour. There is also a highly significant difference in the texture of the crinkles containing fifty percentTalisayfruit starch and the crinkles containing one hundred percent commercial flour.

Table 6. Multiple Comparison of Texture Across Each Proportion

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	p-value
texture	25%	50%	-0.100	0.967
		75%	-.86667*	0.001
		100% - APF	-1.10000*	0.000
	50%	25%	0.100	0.967
		75%	-.76667*	0.003
		100% - APF	-1.00000*	0.000
	75%	25%	.86667*	0.001
		50%	.76667*	0.003
		100% - APF	-0.233	0.700

*Legend: F-value = 13.001; p-value = 0.000; *Significant at p-value < 0.05; I=Interpretation; S=Significant; NS=Not Significant; HS=Highly Significant*

A significant difference in the texture of the crinkles containing twenty-five percentTalisay fruit starch and the crinkles containing seventy-five percentTalisay fruit starch was observed. The texture of the crinkles containing fifty percentTalisay fruit starch and the crinkles containing seventy-five percentTalisay fruit starch differ also significantly. Furthermore, the result reveals that the texture of the crinkles containing seventy-five percentTalisay fruit starch is almost the same as the texture of the one baked from pure commercial flour.

The significant difference observed in the texture of the baked products may be due to the gelatinization of starch and the rising of the flour which gives rise to carbon dioxide making the baked product light and fluffy. More carbon dioxide is generated if more Talisay fruit starch is incorporated to the baked product, thus giving the baked product containing seventy-five percentTalisay fruit starch a better texture than the other baked products containing only fifty percent and twenty-five percentTalisay fruit starch. The same explanation was given by Shewfelt et al. [16] by saying that during baking process, there is expansion of carbon dioxide, gelatinization of starch, coagulation of protein and evaporation of water which all contribute to the texture of the baked product.

As shown in Table 7, there is a significant difference in the flavor of the crinkles using Talisay fruit starch in different proportion as compared to the crinkles containing pure commercial flour.

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Table 7. Multiple Comparison of Flavor Across Each Proportion

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	p-value
flavor	25%	50%	-0.300	0.405
		75%	-1.56667**	0.000
		100% - APF	-2.03333**	0.000
	50%	25%	0.300	0.405
		75%	-1.26667**	0.000
		100% - APF	-1.73333**	0.000
	75%	25%	1.56667**	0.000
		50%	1.26667**	0.000
		100% - APF	-0.467	0.078
	100% - APF	25%	2.03333**	0.000
		50%	1.73333**	0.000
		75%	0.467	0.078

*Legend: F-value = 13.001; p-value = 0.000; **Significant at p-value < 0.01; I=Interpretation; NS=Not Significant; HS=Highly Significant*

This significant difference is justified by the computed F value = 51.891 and computed p value of 0.000. There is a highly significant difference in the flavor of the crinkles containing twenty-five percentTalisay fruit starch and the one containing seventy-five percentTalisay fruit starch. A highly significant difference was also observed in between the crinkles containing twenty-five percentTalisay fruit starch and the one containing one hundred percent commercial flour. There is also a highly significant difference between the crinkles containing fifty percentTalisay fruit starch and the one containing seventy-five percentTalisay fruit starch. A highly significant difference was also observed between the crinkles containing fifty percentTalisay fruit starch and the one containing one hundred percent commercial flour. It reveals that the crinkles containing seventy-five percentTalisay fruit starch has almost the same flavor as the one baked from pure commercial flour.

The significant difference in the flavor of the baked products containing different amount of Talisay fruit starch is accounted to the fact that during the baking process caramelization of sugar accurs that enhances the flavor of the baked product. The Talisay fruit starch contains sugar in the form of glucose, which according to [1] is present in the amount of 316 mg glucose per gram mesocarp of the fruit. The sugar in it contributes to the enhancement of the flavor of the baked product because when sugar caramelizes it forms diacetyl, esters, lactones, furan and maltols which give good flavor to the baked product.

IV. CONCLUSION

The presence of starch from the carbohydrate-content of Terminaliacatappa fruit was identified qualitatively from the blue coloration obtained in the Iodine Test. Quantitatively, Colorimetric Method yields 1.15 to 2.45% starch while Direct Acid Hydrolysis yields twelve percent of starch. The baked product (crinkles) containing seventy-five percent Terminaliacatappa fruit starch in combination with twenty-five percent commercial flour has color, aroma, texture and flavor which is very acceptable similar to the baked product (crinkles) made from pure commercial flour. It is recommended that the presence of starch in other parts of the Terminaliacatappa be identified using other qualitative and quantitiative analysis. With the same sample used in this study, the Terminaliacatappa fruit starch is recommended to be incorporated in other baked products in different proportions. The nutritive value of the baked product be analyzed to finally determine if the Terminaliacatappa fruit starch is a good substitute for commercial flour.

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