Original Research Article

Revolutionizing Milk Tea: Harnessing Mesocarp Flour to a Tapioca Pearl for Sustainable Innovation

Abstract – *Nypafruticans known as nypa is a fast fruit-bearing mangrove palm with immeasurable potential. This dissertation used the mature fruit mesocarp, a byproduct of the Nypa palm, thus the byproduct is underrated for some reason and mostly they are neglected due to lack of public knowledge of its most potential. This research used the Nypa Fruiticans – Mesocarp fruit from Brgy. Sabang, Surigao City. The quest for sustainable alternatives in exploring mesocarp flour as a potential substitute for traditional tapioca pearls in milk tea beverages begins with a comprehensive determining of mesocarp flour's functional properties, using the ANNOVA ONE WAY test p>0.05, the result of all the data is 0.098 therefore Pearl made from the Mesocarp flour is considered to be the sustainable innovation. The functional properties of both pearls made from cassava and mesocarps have no significance difference. Further, practical application forms a core component of this study, involving mesocarp flour formulations to replicate tapioca pearls, the cooking process and consumer acceptance are rigorously analyzed to determine their compatibility and desirability in this popular beverage, analysis of variant showed that Pearls once made from Mesocarp of Nypa fruticans incorporated to the milk tea beverage has 4.3 overall acceptance and the best organoleptic test with texture, aroma, and color is 4.3 (likes). Additionally, this research contributes a nuanced understanding of mesocarp flour's potential against traditional tapioca pearls, considering cost-effectiveness, scalability, and consumer preferences thereby fostering innovation in sustainable beverage production.*

INTRODUCTION

Nipa, scientifically known as Nypa fruticans, is a truly classified mangrove palm that grows dominantly in coastal regions and mostly be found in Asia. Several countries in South and Southeast Asia are rampaged by Nypa Fruticans which can be observed in rural brackish water swamps and tidal muddy banks in some rural areas, particularly in the Philippines.

According to DENR National Capital Region Philippines, through its Conservation and Development Division (CDD) and West Field Office (WFO), World Agroforestry Philippines added that a kind of palm (Nipa) that grows along the waterlines can be one possible alternative to the problem of the food scarcity that the country will soon be facing.

Nipa thrives in Mangrove areas in Surigao City, particularly in Brgy Villafranca Gigaquit, and some parts of Brgy. Sabang, Surigao City, and utilizing its immense potential for being a major solution for food insecurity, its immeasurable uses from leaves to sap are viral in the economy today. Husk and shell, have a promising contribution to biofuel and chemicals, while the mesocarp is to be exploited as food, despite its potential, utilization of mesocarp had been neglected and almost forgotten and has been underrated because of the lack of public knowledge about its countless functional properties.

The mature fruit of mesocarp contains a considerable amount of carbohydrates 51. 89% and very low-fat content of 0.48% to 1.16% and low protein content of 0.7% to 2.4%, with these unique chemical compositions offer the potential of Nypa mesocarp to be processed into flour (Ulyarti, Nazarudin, and Dian Wulan Sar 2017).

Nypa flour though not familiarly used however evidence proven that flour from Nypa has been used for human consumption and in countless bakery products, this research was conducted to replicate tapioca pearl using the starch concocted in Nypa flour as the exemplary ingredients in Milk Tea beverages that is one of the beverages that concentrated to metropolitan around the globe. Evidence of its popularity has expanded to the rest of the areas across the Philippines. Despite these excellent traits and delights brought by traditional tapioca pearls, the tillage and output production is nonetheless slow-growing and environmentally taxing. In the advent of the growing concern for sustainability, section twelve (12) of the Sustainable Development Goal (SDG) highlighted the reduction of ecological footprint in the field of food and beverage industry. Proponents have turned their attention to potential alternative ingredients such that, one gifted candidate is the mesocarp, a by-product of the Nypa palm, which has shown the potential to be processed into flour that would serve as a sustainable alternative for tapioca pearls. With this in mind this research roots around exploring mesocarp as a viable and eco-friendly option to meet the tapioca pearl demand in milk tea beverages, to expand utilization of the underutilized by-product of Nypa palm sustainability to economy and agronomy.

MATERIAL AND METHODS

MATERIALS

The researcher used mature Mesocarp of Nypa fruticans (figure 1) were ontained from the mangrove area in Brgy. Sabang, Surigao City. Mature Nypa is characterized by its dark brown skin color. The rendering for Mature Mesocarp of Nypa in making flour was in the range of 20-40% ration of fruit weight.

The tools used in this research are knives, grinders, mixers, analytic scales, sieves, pans, and basins.

a *b*

FIGURE 1, *(a) Cross section of Nypa Fruticans, (b) Bunches of Nypa fruticans*

METHODS

For Flour

Tapioca pearl is made from the starch of cassava flour, to aim for a sustainable innovation, this research will use the underrated mesocarp a by-product of nypa fruticans to process into flour and use it to replicate tapioca pearls made from the starch of cassava. To obtain the Nypa flour, the endocarp of each matured mesocarp (MM) was scraped using knives, after which washed, cut, and dried below the solar for 6-8 hours to lessen the water content, with the use of a grinder dried-MM was grounded and sieved with 200 mesh sieve size to gain flour.

To support this action, Ulyarti et. al. in their study on the functional properties of Nypa fruticans Flour, concluded that the mesocarp of Nypa can be processed into flour. Therefore, Nypa flour is a promising substitute for common flour such as wheat and rice especially for producing low-calorie or high-fiber food that suffice health dietary concerns.

To evaluate the Swelling Power (SP), Solubility (Sol), Water Absorption Capacity (WAC), Swelling Capacity (SC), Bulk Density (BD), and Viscosity of Nypa Flour's functional properties, two sets of treatments have been conducted.

The traditional way of extracting starch is by sieving the grounded dried Mature Endosperm of Nypa fruticans (mesocarp) and that is the Un-bleached MMF on the other hand Bleached treatment conducted by soaking the matured mesocarp flour (MMF) in sodium metabisulphite (0.4 %) and mixed. After 15 minutes, the combination was filtered and rinsed with water twice, and the precipitates were dried beneath the sun. Both treatments were sieved using a 200 mesh sieve. As a result, the Unbleached NF was more acceptable and more suitable flour to be used (Risa Nofiani et.al. 2020).

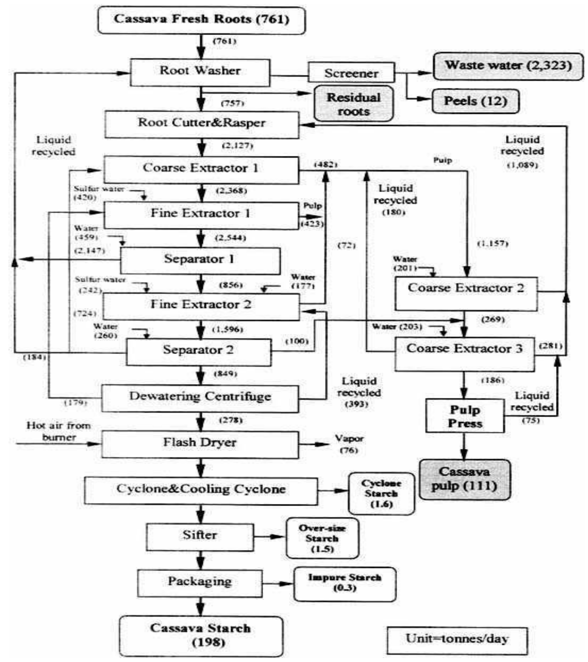


FIGURE 2, *Diagram for Cassava Starch Extraction*

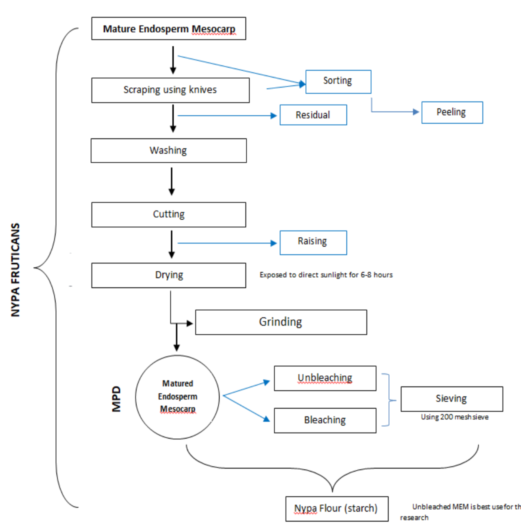


FIGURE 3, *Diagram for Nypa Flour/Starch Extraction*

Godswill et al., 2019 define WAC as the amount of water absorbed in food circumstances to achieve the desired consistency and excellent food items. Additionally, it can be utilized to explain the consistency, bulking, Jafari, Koocheki, & Milani (2017), crystallinity, integrity of starch in aqueous dispersion, and bulking of the product (Sharma, Singh, & Singh, 2015).

The starch granule's associative force is linked to the starch's capacity to absorb water and swell, a property known as the swelling index (SI) (Godswill et al., 2019). The primary classifications of SC include particle size, chemical content, and processing techniques (Chandra et al., 2015). It can serve as a foundation for excellent bakery product standards (Iwe, Onyeukwu, & Agiriga, 2016). According to Risa Nofiani et al. (2020), the SC value of the UONFEF was both noticeably longer and greater than that of the BONFEF. The approach outlined by Okaka and Potter (Okaka & Potter, 1977; Chandra et al., 2015) was used to determine SC.

According to Buckman, Oduro, Plahar, & Tortoe (2018) and Falade & Okafor (2015), SP data indicates the extent to which flour, in particular starch granules, can bind water to demonstrate its expansion or hydration ability to generate swollen starch granules. According to Yu, Ma, Menager, and Sun (2012), bleaching may break the hydrogen bonds that hold starch granules together, causing water to be absorbed by the hydrogen bonds and by proteins and non-starch polysaccharides.

The capacity of food that produces gas, liquid, or solid to dissolve in a liquid, gas, or solid solvent is known as sol in the food system. Flour solubility is the amount of flour that dissolves in water or other solutions (Godswill, Somtochukwu, & Kate, 2019).

The BD parameter sometimes referred to as the total solid content (TSC) parameter, is crucial for determining the weight of solid samples and the specifications for packing (Falade & Christopher, 2015; Shafi, Baba, Masoodi, & Bazaz, 2016). Particle size, moisture content, starch or flour surface characteristics, and food material handling all have an impact on BD value (Chandra et al., 2015; Shafi, Baba, Masoodi, & Bazaz, 2016; Das, Khan, Rahman, Majumder, & Islam, 2019; Ngoma, Mashau, & Silungwe, 2019). The greater the BD value, the bigger the particle size.

An agent that can raise viscosity is called a viscosifier. This ingredient is necessary in food to stabilize items like foam, emulsion, and frozen dairy (Wang & Cui, 2005). Because of the enlargement of the starch granules and the increased amount of β-glucan that results from the breakdown of starch molecules, flour can be employed as a viscosifier agent (Kaur, Sharma, Singh, & Dar, 2016).

For Tapioca Pearl Application

Tapioca pearls which are mainly made from cassava starch were the popular main ingredients for the globally known Milk Tea in the Beverages Industry. The pearls were shaped into spherical with gelatinized and un-gelatinized starch produced by heat–moisture treatment (Breuninger).

The undeniable property of the tapioca pearl is irreplaceable but with the aim of sustainable innovation, this research will bring forth and revolutionize tapioca pearl by utilizing the underrated mesocarp a by-product of Nypa Fruticans and convert it to Nypa flour/starch used to replicate the pearl made from cassava/tapioca starch. With this goal in mind, this research will serve its purpose to give public knowledge about the wide potential of the neglected Mesocarp of Nypa Fruticans.

In producing tapioca pearls with cassava flour, the starch is wetted to 50% moisture content. The moist starch is putrefied and shaped into spherical particles by continuous mechanical shaking. The formed pearls are then sent to dry heat processing or roasting at 250–300°C. To reduce the moisture content of finished products, the pearls are set to cool before being processed to another drying treatment at 50–80°C temperature (William F. Breuninger et.al).

To produce pearl from Nypa flour, a modified version of flour/starch extraction is used in this research and the same process and treatment are applied in making tapioca using the the MM flour.

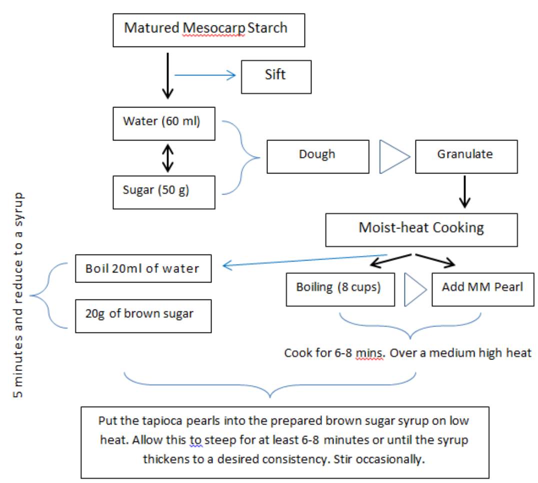


FIGURE 4, *Diagram for Making Pearl from MM starch*

RESULT AND DISCUSSION

To evaluate this (table 1), a COMPLETELY RANDOMIZED DESIGN will be used with two different conditions but the same method however varies accordingly with the period of the experiment.

The same weight of tapioca made from starch of cassava and mesocarp starch weighing 100g., the moist-heat method will be used for this experiment where the temperature will also be the same 200℃ and moist or water present will be 60ml however period will vary accordingly. For 100 g starch of each condition, it will make 50 pieces of medium-sized pearls suitable for tapioca-size pearls sold in the market for Milk Tea Beverages, not including some additives like sugar and milk.

The 50 pieces were subjected to 4 treatments and three replications so that 12 experimental units were obtained. The treatments were given to know the best use of Pearl made from MM starch, and each piece reacted in different periods when it was cooked.

A. Texture

With the same moist heat method, 50 pieces of tapioca were diluted and boiled to the same amount of water, and subjected to experiment at different levels of time with the same amount of temperature. The result is significantly not different therefore Pearl from Mesocarp has the same texture in terms of chewiness, hardiness, and gumminess (tale 1).

B. SPC

With the 50 pieces of the pearl cook under the same volume of water and amount of heat but differ in time or duration (table 1). The result is not significantly different therefore in terms of swelling capacity concerning time, Tapioca pearls made from cassava and Pearls made from Mesocarp have a common factor.

C. Solubility

This was carried out by getting the percentage from the number of pieces that reacted respectively in different durations to the total number of pieces experimented and the result of both has no significant difference (table 1).

D. WAC

Was determined based on Anderson et al. (Anderson et al., 1970; Bamigbola, Awolu, & Oluwalana, 2016). Both tapioca (50 pieces) were resuspended with 60 ml of distilled water, stirred, and cooked at different times or durations then centrifuged at 1.731 x no. piece react in time respectively. The result is significantly no different from each other (table 1).

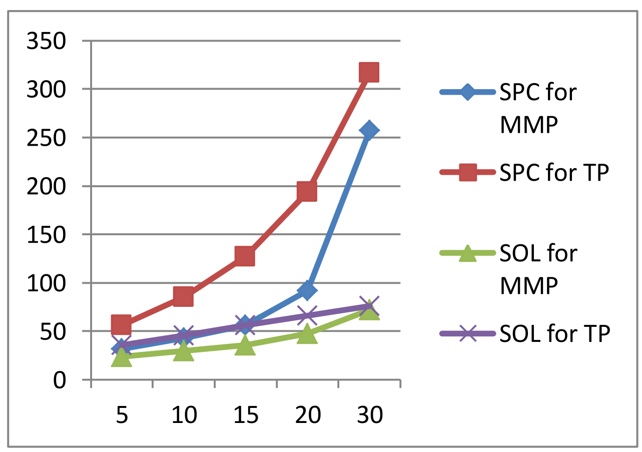
Table 1: AVERAGE VALUE OF TEXTURE, SWELLINGCAPACITY, SOLUBILITY AND WATER ABSORPTION CAPACITY

Time	Temperature	MS: CS	Texture (GF)	SPC %	SOL %	WAC %
5 mins.	200°C	12:18	8:33,5.56	31.58,56.25	24,36	481.42,320.94
10 mins.	200°C	15:23	6.67,4.35	42.86,85.19	30,46	385.13,251.17
15 mins.	200°C	18:28	5.56,3.57	56.25,127.27	36,56	320.94,206.32
20 mins.	200°C	24:33	4.17,3.03	92.31,194.12	48,66	240.71,175.06
30 mins.	200°C	36:38	2.78,2.63	257.14,316.67	72,76	160.47,152.03

The numbers presented are the average of two conditions and the deviations means were not significantly different (p>0.05)

The swelling Power Capacity (SPC) of a Pearl made of Mesocarp Flour (table 2) is known to relate to amylose content, water holding capacity of starch molecules, hydrogen bond, and degree crystallinity of the pearl under different times of experiment. Different pearl condition processing in the same Sol study exhibited a significant difference (p>0.05). One of the factors that contributes to solubility is particle size; the smaller the particle size, the quicker the dissolution. The other factor is chemical composition, mainly lipids, and amylopectin. The presence of lipids and amylopectin in flour can contribute to reducing Sol, SC, and WAC.

Table 2: SWELLING POWER CAPACITY AND SOLUBILITY OF MESOCARP PEARL



Below (5, 10, 15, 20, 30) is the time duration; left (0, 50, 100-350) is the percentage

For the overall acceptant (table 3), with sensory evaluation using a nine-point hedonic scale (Likert Scale), the pearls made from mesocarp starch were added to the Milk tea beverages together with some additives like sugar, chocolate, and milk with the original milk both in the market. The evaluation was done in the eye of the needle from the taste, aroma, texture, and color.

Table 3: SENSORY EVALUATION TEXTURE, AROMA, AND COLOUR

SAMPLE	TEXTU RE	AROMA	COLOR	Overall Acceptance
Milk Tea with Tapioca Pearl	4.5	4.1	4.3	4.3
Milk Tea with Mesocarp Pearl	4.3	4.3	4.14	4.25
Difference	0.2	-0.2	0.0	

For the scale: (1) Strongly dislike, (2) Dislike, (3) Somewhat likes, (4) Likes, (5) Very Likes

After gathering the results from the 50 respondents and using the 5-point Likert Scale to interpret the data for the sensory evaluation texture, aroma, and color for the Milk Tea with Tapioca Pearl and Milk Tea with Mesocartp Pearl. For the Texture evaluation result, Milk Tea with Tapioca Pearl has a 4.5 rating while Milk Tea with Mesocarp Pearl has a 4.3 rating with only 0.2 differences. For the Aroma evaluation result, Milk Tea with Tapioca Pearl has a 4.1 rating while Milk Tea with Mesocarp Pearl has a 4.3 rating with only -0.2 differences. And for color evaluation results, Milk Tea with Tapioca Pearl has a 4.3 rating while Milk Tea with Mesocarp Pearl has a 4.3 rating with only 0.0 differences. Overall, Milk Tea with Tapioca Pearl and Milk Tea with Mesocarp Pearl have the same rating of 4.3

CONCLUSION

Using the ANNOVA ONE WAY test was $p>0.05$, the result of all the data is 0.098 therefore Pearl made from the Mesocarp flour is considered to be the sustainable innovation. The functional properties of both pearls made from cassava and mesocarps have no significant difference. Analysis of the variant showed that Pearl once made from Mesocarp of Nypa fruticans incorporated into the milk tea beverage has a 4.3 overall acceptance and the best organoleptic test with texture, aroma, and color is 4.3 (likes).

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