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Development of Spray-Dried Guyabano (*Annona muricata Linn.*) Extract in Three Process Schedules

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Abstract The study investigated the production performance of spray dried guyabano (Annona Muricata Linn.) leaves extract in three process schedule in terms of its physicochemical properties and recovery percentage. Three process schedules were applied in the fresh concocted guyabano leaves. Various settings in temperatures- ranging from 185 C to 195 C, in pressure- ranging from 400 psi to 500 psi and in percentage of added carrier from 10.36% to 17.41 % were established. The sensory characteristics of the spray dried guyabano leaves extract in three process schedule were analyzed and compared with the use of organoleptic evaluation score card utilized by tea experts and enthusiast. Data gathered were described and analyzed using Analysis of Variance. The pH level of the three samples was measured and compared to a freshly brewed guyabano tea with the use of Milauwkee pH 600 and dissolution test was conducted to measure the suspension rate of the three powdered samples. Results showed that there is a significant difference in terms of the quality attributes among the three processes. P1 and P2 has the same respondents' evaluation in terms of taste and color compared to P3. In terms of pH level pure guyabano leaves extract and P2 sample was determined weakly acidic while P1 and P3 samples was determined weakly alkali. In terms of dissolution rate, it was found out that P1 sample having 13.40% of added carrier has the fastest dissolution performance in three different temperatures of water as compared to P2 with 17.41% and P3 with 10.36% of added carrier. In terms of recovery percentage, P2 has the highest recovery value of 6.7 while P3 got the lowest percentage recovery of 0.79 It is recommended that further study should be conducted to optimize the production quality of spray dried guyabano leaves extract in terms of product recovery. Nutrients analysis and other laboratory test should be taken into consideration in optimization process and to develop marketable quality of herbal products.

Keywords: *spray drying, pH level, maltodextrin, process schedule, optimization*

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1. Introduction

Herbal plants have been part of human cultures and practices for a long period of time and are utilized as food and medicines. Herbal medicines are being patronized by the Filipinos especially the indigenous people as an alternative medication for some diseases. However, lack of knowledge and improper preparations of such products can lead to disaster such as over dosage and chronic organ failures. Furthermore, excess amounts of accumulating toxic compounds from plants in the human body can result to human genetic failure [1]. This study aims to develop a valuable product from herbal plant which is guyabano and determine its acceptability.

Commonly known as guyabano, soursop, graviola, guanabana, paw-paw and sirsak, A. muricata L. is a member of family Annonaceae with extensive traditional use. Just like other species of Annona such as A. squamosa and A. reticulata, A. muricata are generally used as a medicine for treating ailments and used as a preventive aide in wide areas of human diseases particularly parasitic infections and cancer [2]. Its pharmaceutical properties are antibacterial, antiulcer, anthelmintic, anti-inflammatory and free radical scavenging activity. Regardless of its medicinal uses, its edible leaves, fruit and bark are proof of being a high economic valued product and it offers livelihood to the local residents [3]. Guyabano's fruit is used as lactating aide to increase mother's milk production after childbirth. Additionally, it also serves as natural medicine for arthritic pain, neuralgia, arthritis, rheumatism, dysentery, diarrhea, fever, malaria, skin rashes, parasites and worms. On the other hand, its leaves are used for treating insomnia, diabetes, headaches and cystitis. Internal administration of the leaf's decoction is believed to exhibit anti-rheumatic and neuralgic effects, hence, cooked leaves are topically used to treat abscesses and rheumatism [2].

Initial research carried out by the National Cancer Institute was followed by researches conducted by over 20 independent labs regarding guyabano's anti-cancer properties since 1976. In today's generation where cancer is still one of the scariest disease, National Cancer Institute found out that guyabano stems and leaves were very effective in destroying malignant cells. Moreover, in some parts of the world such as West Indies and Peruvian Andes, leaves are used as soporific and sedative when drank as a tea. It is proven to be useful in relieving pain and used for

antispasmodic purposes. Furthermore, the leaves are also used in Brazilian Amazon as treatment for liver problems.

"Acetogenins" is a natural compound found in guyabano tree which makes it special. Research showed that this compound can be destructive and can decelerate the growth of tumor cells without damaging the healthy cells. Oberlies et al., [4] researched the capability of acetogenins to block, or inhibit, the cell growth of tumor cells. They tried this on several cell types in vitro; non-cancerous cells from the intestinal tract of rats as well as cancerous cells from mice and humans.

Traditional herbal remedies are prepared in several rather standardized ways such as infusions (hot teas), decoctions (boiled teas), tinctures (alcohol and water extracts), and macerations (cold-soaking). These different processes usually vary based upon the plant utilized, and sometimes, what condition is being treated [5].

Freshly picked or shadow dried (air dried) mature (but not too old) leaves are usually used in preparing guyabano tea. Drying concentrates the medicinal properties of the plants and therefore it is more effective than the fresh leaves. Due to high temperature during the process, sun drying or oven drying is not recommended for it may result to the breakdown of medicinal and nutritive values causing them to lose their potency. The potency of the tea is good only for up to 7 or 8 hours without refrigeration [6].

Spray drying is a new technology that produce highly dispersed powder by evaporating the solvent [7]. Spray-drying process has been used for decades to encapsulate food ingredients such as flavors, lipids, and carotenoids. The evaporation of solvent during drying process is rapid and the entrapment of the interest compound occurs quasi-instantaneously. Encapsulating materials should be properly screened and optimization of the operating conditions must be strictly imposed [8].

Over the forecast period, it is expected that preference among Filipino for effective and safer remedies such as herbal/traditional products is expected to drive demand. The industry has increased by 10 percent over 2010, thus, showing that it is continuously growing and herbal products are getting even more popular [9].

Based on the studies about the health benefits of guyabano (Annona muricata Linn.) and the demand for herbal and traditional products among Filipinos, the spray dried guyabano leaves extract has a great potential to be utilized as a convenient and readily available herbal tea. Furthermore, development of this product will be beneficial to many farmers, consumers, local processors, and small entrepreneurs and may give a big contribution to tourism and economic industry.

2. Objectives of the Study

This study aimed to assess the production performance of spray dried guyabano leaves extract in terms of the physicochemical properties and the set process schedule.

Specifically, it aimed to describe and compare the quality attributes of the three process schedule-spray dried guyabano leaves extract from freshly brewed guyabano leaves in terms of taste, color and pH level.; to compare the production performance of spray dried guyabano leaves extract in three process schedules in terms of percentage of recovery and solubility Test and to determine the most favorable process schedule of spray dried guyabano leaves extract in terms of percentage of carrier added, temperature setting and pressure setting.

3. Methodology

I. Preparation of the guyabano leaves extract:

a. Raw materials: guyabano leaves and water

b. Tools and equipment: casserole, mixing bowl and weighing scale

c. Procedure

Shadow dried matured guyabano leaves were sorted and graded according to its physical qualities. Graded leaves were then washed and sanitized in 200 ppm chlorine solution for at least one minute and thoroughly wash with potable water, then initially weighed afterwards. The leaves were subjected for decoction procedure. With the use of a refractometer, the concocted guyabano leaves extract were checked for its TSS (total soluble solids) as the basis for the addition of maltodextrin as carrier.

II. Spray drying

a. Raw materials: fresh concocted guyabano leaves extract and maltodextrin

b. Equipment: Spray Dryer

Table 1. Three process schedules applied in the decocted guyabano leaves extract

	Process Schedule 1	Process Schedule 2	Process Schedule 3
Added carrier	13.40%	17.41%	10.36%
Inlet Temperature	191-194 C	194-195 C	185-191 C
Outlet Temperature	69-73 C	78 C	75 C
Pressure setting	500 psi	400 psi	450 psi
The three samples have an initial total soluble solids (TSS) of 0.2 brix			

III. Product assessment

Spray dried guyabano leaves extract in three process schedules were made to assess the production performance in terms of the quality attributes, percentage of recovery and dissolution test. Sensory evaluation is the process of using our senses (taste, smell, touch, sight) and applying them to determine the acceptability of foods. The three samples of spray dried guyabano leaves extract (P1, P2, P3) was compared to a freshly concocted guyabano tea and subjected to sensory evaluation. In this study, purposive sampling technique was adopted to choose the panelists. Thirty (30) evaluators who are tea experts and enthusiast were chosen to evaluate the products.

Table 2. Organoleptic Score Card for the characteristics of spray dried guyabano leaves extract

Rating	Description	
	Color	**Taste**
5	Reddish brown	*Guyabano* tea Like
4	Dark brown	Slightly *Guyabano* tea Like
3	Light brown	Average guyabano tea like
2	Clear brown	Slightly not *Guyabano* tea Like
1	Clear	Not *Guyabano* tea Like

IV. Statistical Treatment

To compare the significant differences among the three process schedule of spray dried guyabano leaves extract in

terms of their sensory characteristics, analysis of variance (ANOVA) was employed.

4. Results and Discussion

Table 3 presents the computed mean scores for the taste and texture in the three process schedule of spray dried guyabano leaves extract.

It can be noted that the respondents have the same description of evaluation as slightly guyabano tea like for both P1 and P2 in terms of taste as evidenced by the mean scores of 4.53 and 4.10, on the other hand the mean score of P3 with respect to taste was rated 3.93 described as average guyabano tea like. The results implies that the respondents find the taste of spray dried guyabano leaves extract for both P1 and P2 is as comparable to the taste of a freshly concocted guyabano leaves.

In terms of color, both P1 and P2 have the same description of color perception as dark brown as indicated by its mean scores of 4.30 and 4.13. On the other hand, P3 was rated 3.46 described as light brown in color by the respondents. This means that three process schedule of spray dried guyabano leaves extract has an effects in the natural color and taste of the produced product as indicated by the different visual perception of the respondents.

As seen from Table 4 presents the ANOVA on the taste of spray dried guyabano leaves extract in three process schedule. Results showed that there is a significant difference on the quality attributes of the three process schedule in terms of taste as it was attested to by the obtained f-ratio (4.812) between and within groups. It can be noted that the sum of squares between groups is 5.756 with the degrees of freedom of 2 with the total mean score of 2.878 while the sum of squares within groups is 52.033 with 87 degrees of freedom as reflected to its total mean score of .598.

The foregoing result implies that the scores for overall evaluation of the spray dried guyabano leaves extract in three treatments in terms of taste were significantly difference as shown in Table 1. The taste of P1 and P2 was rated slightly guyabano tea like while P3 was average guyabano tea like.

As seen from Table 4 presents the ANOVA on the color of spray dried guyabano leaves extract in three process schedule. Results showed that there is a significant difference on the quality attributes of the three process schedule in terms of color as it was attested to by the obtained f-ratio (9.906) between and within groups. It can be noted that the sum of squares between groups is 11.667 with the degrees of freedom of 2 with the total mean score of 5.833 while the sum of squares within groups is 51.233 with 87 degrees of freedom as reflected to its total mean score of .589.

This implies that the scores for overall evaluation of the spray-dried guyabano leaves extract in three treatments in terms of color were significantly difference as shown in Table 1. P1 and P2 1 was observed and rated dark brown in color while P3 was a light brown color.

Table 3. Respondents evaluation in the quality attributes of spray dried guyabano leaves extract in three process schedule compared to a freshly concocted guyabano leaves extract.

Quality Attributes	Spray Dried Guyabano Leaves Extract					
	P1		**P2**		**P3**	
	Mean	**Description**	**Mean**	**Description**	**Mean**	**Description**
Taste	4.53	Slightly Guyabano Tea Like	4.10	Slightly Guyabano Tea Like	3.93	Average guyabano tea like
Color	4.30	Dark Brown	4.13	Dark brown	3.47	Light brown

Table 4. ANOVA table on the taste of Spray dried guyabano leaves extract in three process schedule (P1, P2, P3)

Source of variation	Sum of squares	df	Mean square	F	Sig.
Between groups	5.756	2	2.878	4.812	.010
Within groups	52.033	87	.598		
Total	57.789	89			

*Significant

Table 5. ANOVA table on the color of Spray dried guyabano leaves extract in three process schedule (P1,P2,P3)

Source of variation	Sum of squares	df	Mean square	F	Sig.
Between groups	11.667	2	5.833	9.906	.000
Within groups	51.233	87	.589		
Total	62.900	89			

*Significant

Table 6. pH level of the Guyabano Leaves extract in three process schedule compared to a freshly concocted guyabano leaves extract

	pH level		
Guyabano leaves extract samples	*Temperature*	*Average pH*	*Remarks*
Sample A - Freshly brewed	28.1 C	6.95	Weakly Acidic
Sample B – Process Schedule 1	44.4 C	7.15	(pH neutral) Weakly Alkali
Sample C – Process schedule 2	44.4 C	6.90	Weakly Acidic
Sample D – Process Schedule 3	44.4 C	7.65	(pH neutral) Weakly Alkali

Differences in terms of the pH level of the four samples were determined by measuring the initial temperatures of freshly brewed guyabano leaves extract and the diluted spray dried guyabano leaves extract samples ranging from 28°C to 44.4°C. Two trials of pH measurement were conducted in each sample to get the average pH levels using Milwaukee pH 600.

It can be observed in Table 3, that Sample A (freshly brewed guyabano leaves extract) and Sample C (P2) has the same level of pH as evidenced by its pH values of 6.95 and 6.90, respectively both determined as weakly acidic. On the other hand, Samples B (P1) and D (P3), determined as both neutral in pH with 7.15 and 7.65 pH values, remarked as weakly alkali.

This implies that the pure extract of guyabano leaves (Sample A) with 0.2˚Bx and (Sample B) 15˚Bx with 17.41% of added carrier has the same level of pH and was determined as weakly acidic. While the sample with 13.40% of added carrier at 12°Bx (P1) and the sample with 10.36% of carrier added at 9˚Bx (P3) was determined weakly alkali.

This finding can be explained by the study of Lunkes & Hashizume [10] entitled "Evaluation of the pH and titratable acidity of teas commercially available in Brazilian market" stated that the mean pH values for ready to drink teas ranged between 2.89 and 4.03, while for the brewed teas and yerba mate the values ranged between 6.75 and 7.89. The difference between the two groups was significant ($p < 0.05$). Regarding titratable acidity, the ready to drink teas showed mean values ranging between 3.77 ml and 12.68 ml. Brewed teas (including yerba mate) were not tested for titratable acidity because their pH values were greater than 7.0.

Table 7. Recovery percentage of Spray Dried Guyabano leaves Extract in Three Process Schedule

Process schedule	*P1*	*P2*	*P3*
Initial TSS	0.2 Bx	0.2 Bx	0.2 Bx
Added carrier	13.40%	17.41%	10.46%
Final TSS	12˚ Bx	15˚ Bx	9˚ Bx
Inlet Temperature	191-194 C	194-195 C	185-191 C
Recovery percentage	5.86%	6.57%	0.79%

Table 7 shows the recovery percentage of the three spray dried samples. The initial and final total soluble solids (TSS) of each sample were measured using a refractometer. This served as the basis in adding a drying agent in the feed in order to produce spray dried products.

It can be noted in Table 7 that there are differences in the percentage of recovery in each process schedule. P2 with 17.41% added carrier and dried at 195 C had the highest recovery percentage of 6.67%, while in P1 with 13.40% of added carrier and dried under 191 C had 5.86% of recovery. On the other hand P3 with 10.46% of added carrier and dried at 185 C got the lowest percentage of recovery with 0.79%.

This implies that the amount of added maltodextrin and inlet temperature setting in each sample affects the yield quality of the final product. The findings supports the study of Koç & Kaymak-Ertekin [11] reveals that atomizing air flow and inlet air temperature had more effect than feed temperature and feed flow rate on the physical properties of spray dried maltodextrin. It also conforms in the findings of Weerachet J., Siriwan N. and Onuma T. [12] reveals that the drying air temperature and MD (maltodextrin) content had significant influence on the product quality.

The dissolution rates of each samples were determined by measuring the time of suspension of a 10 gram spray dried sample of (P1, P2 and P3) in 125 ml of water with three different temperatures (warm, cold and hot).

The data in Table 4, reveals that P1 sample has the fastest dissolution rate in three temperatures of water under constant stirring as evidenced by its recorded time of suspension with 43 seconds at 90°C. Average dissolution rate was recorded for P3 sample in both colder and warmer temperatures with 3.11 minutes and 3.39 minutes of time suspension. However the slowest suspension rate was observed in P2 and P3 samples. For the warmer and colder temperatures P2 was recorded at 4.55 and 5.28 minutes of suspension rate which determined slow suspension, while P3 was determined slow suspension with the recorded time of 1.19 minutes at the water temperature of 90°C.

This implies that the hotter the water temperature, the faster the suspension rate of spray dried products. It was also found out that P1 sample having 13.40% of added carrier has the fastest dissolution performance in three different temperatures as compared to P2 with 17.41% and P3 with 10.36% of added carrier.

The findings conform to the citation of Phisut [13] in the study entitled "Spray drying technique of fruit juice powder: some factors influencing the properties of product" stated that an increased maltodextrin concentration did not cause a reduction in powder solubility. This variation may be attributed to the fact that maltodextrin has a superior water solubility.

And according to Cano-Chauca et al. [14], maltodextrin was mainly used in the process of spray drying due to its physical properties, such as high solubility in water. Grabowski, Truong, & Daubert [15] also reported that the water solubility index of sweet potato powder increased as the amount of maltodextrin increased.

Table 8. Dissolution rates of the guyabano leaves extract in three process schedule

Temperatures	**P1**		**P2**		**P3**	
	Time suspended	Remarks	Time suspended	Remarks	Time suspended	Remarks
26.7 C	2.46 min.	Fast	4.55 min	Slow	3.11 min.	Average
11.4 C	3.01 min.	Fast	5.28 min	Slow	3.39 min.	Average
90 C	43 sec.	Fast	1.09 min	Average	1.19 min.	Slow

5. Conclusions and Recommendations

In conclusion, with the utilization of the three process schedule the production of spray dried guyabano leaves extract has become possible in this investigation. The produced guyabano leaves extract in powder form using process schedule 1 (P1) is of good color, taste and pH level that is comparable to a freshly brewed guyabano leaves, the dissolution performance was also excellent for both hot and cold water however the percentage of recovery is at its average level among the three process schedule.

In this sense, we believe that our study will be able to contribute on the utilization of the matured guyabano leaves for product development and herbal medicine promotion. The study could help the local guyabano farmers and herbalist in the different parts of the Philippines specifically in the MIMAROPA Region to increase their profit out of guyabano production, likewise the micro, small and medium enterprises or small food processor may engaged themselves in value adding product by utilizing indigenous material in the region with the use of the DOST High Impact Technology Solutions – Food Processing Equipment namely: spray dryer, vacuum fryer, water retort and freeze dryer through MIMAROPA FOOD INNOVATION CENTER.

It is recommended that further study should be conducted to optimize the production quality of spray dried guyabano leaves extract in terms of product recovery. Nutrient analysis and other laboratory test should be taken into consideration in optimization process to develop marketable quality of spray dried products.

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