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## Evaluation of Talisay (*Terminalia catappa*) nuts by-products

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### Abstract

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Sensory evaluation or analysis is an invaluable tool in determining the consumers' acceptability of a product developed and eventually its market success. This is a sequel test after the chemical analysis and microbiological procedures have been conducted. The study determined the level of acceptability of the by-product of Talisay (*Terminalia catappa*) nuts specifically; Talisay Nuts Polvoron, Glazed Talisay Nuts, and Sugar-coated Talisay Nuts using sensory evaluation as to appearance, taste, aroma, sweetness, and texture. The responses of the food inclined participants are described yielding from the Hedonic Tests conducted and statistically treated. Results concluded that the developed products are remarkably acceptable and marketable.

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## Introduction

The value of conducting sensory evaluation underscores the level of acceptability of a product developed prior to its extension or commercialization. Hence, Singh-Achbarali and Maharaj (2014) considered it as an invaluable tool in determining the consumers' acceptability of a product and eventually its market success. It must be noted that characterization as to appearance, aroma, flavor, texture, and after-sensation of products cannot be accomplished or predicted by chemical or instrumental laboratory measurements.

According to Sidel & Stone (2004), sensory evaluation is a scientific discipline used to evoke, measure, analyze and interpret those responses to products as perceived through the senses of sight, smell, touch, taste, and hearing. Generally, grading methods for food and beverage products traditionally involved one or two trained "experts" assigning quality scores on the appearance, and flavor of the products based on the presence or absence of predetermined defects. Yang (2015) posited that sensory analysis help in grasping the characters of various food products. Thus, by using the traditional methods of evaluation, some products with different sensory characteristics, such as those identified by a product profile, but with no product defect will obtain the same quality score. This is where sensory evaluation becomes an invaluable tool.

In support, Singh-Achbarali and Maharaj (2014) contended that without sensory evaluation, development efforts reflect the personal feelings, views and choices of the product developer, product development team, marketer/s and/or top management and results that may be used to base product development trade-offs and decisions, product development successes will be few and development timelines very long. Watts (1989), also affirmed that there is no one instrument that can replicate or replace the human response making sensory evaluation component of any food study essential. Meiselman (1993), on the other hand, stressed the need for integration of sensory and hedonic dimensions rather than separation of these dimensions.

The current study is inclined to product development derived from Talisay nuts out from Talisay seeds as the trees grow abundantly in some areas in Surigao del Norte particularly in Malimono and nearby areas. Since only a few researchers have studied the possibility of developing a new product from the Talisay seeds and nut extracts, the researchers have unlocked its possibility through this study. As the by-products already underwent chemical analysis and microbiological procedures, the researchers would then determine the level of acceptability of the products through sensory evaluation or analysis reducing the subjectivity aspects in rating prior to its extension and or commercialization venture.

## Materials and methods

### *Quality Participants*

Study participants were critically determined. They were adequately considered to arrive at meaningful conclusions (Dikilitas and Griffiths, 2017). Eight (8) administrators, eleven (11) Food and Services Management (FSM) faculty, and eight (8) Bachelor of Technical Teacher Education major in FSM students from Surigao State College of Technology (SSCT), Surigao City. They are actively engaged in food-related undertakings and inclined to food quality control processes and production.

The evaluative survey questionnaire was adopted from Lawless and Haymann (1998) as it was befitting for use to capture the responses of the participants. The Hedonic test answers the characteristics of the products by appearance, taste, aroma, sweetness and texture coupled with their responses on how they feel about the product hence the food action rating. With sensory analysis, evaluators are able to probe areas of interest that are intrinsic product attributes, like flavor profiles and off flavors, as well as extrinsic measures such as market penetration and consumer perception (Schiano, Hardwood, and Drake, 2017).

### *On Analysis Tools*

The study utilized a sensory evaluation survey using in particular hedonic tests to determine the level of acceptability of the by-products from Talisay nuts

namely; Talisay Nuts Polvoron, Glazed Talisay Nuts, and Sugar-coated nuts. Frequency, Mean and Standard deviation were used to analyze the data with the support of histograms to illustrate the results from the hedonic test of the by-products. Multiple Correspondence Analysis was also employed.

**Result and discussion**

*On Sensory Evaluation of the Talisay Nuts Polvoron*

Table 1 presents the summary of results from Hedonic Rating Test for Talisay Nuts Polvoron. In calculating the score for each product, a descriptor was assigned for each score value

respectively: Liked extremely = 9, like very much = 8, like moderately = 7, like slightly = 6, neither like nor dislike = 5, dislike slightly = 4, dislike moderately = 3, dislike very much = 2, dislike extremely = 1.

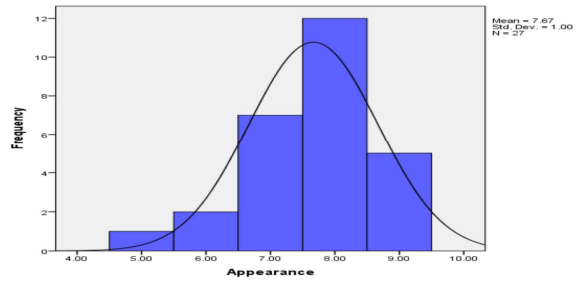
**Table 1.** Summary of Results from Hedonic Test for Talisay Nuts Polvoron.

Characteristics	Total Score	Average Score	Qualitative Description
Appearance	200	7.67	Like Very Much
Taste	212	7.85	Like Very Much
Smell	213	7.89	Like Very Much
Texture	205	7.59	Like Very Much

Legend:	Parameter Scale		
1-1.88	Dislike extremely	5.45-6.33	Like slightly
1.89-2.77	Dislike very much	6.34-7.22	Like moderately
2.78-3.66	Dislike moderately	7.23-8.11	Like very much
3.67-4.55	Dislike slightly	8.12-9	Like extremely
4.56-5.44	Neither like nor dislike		

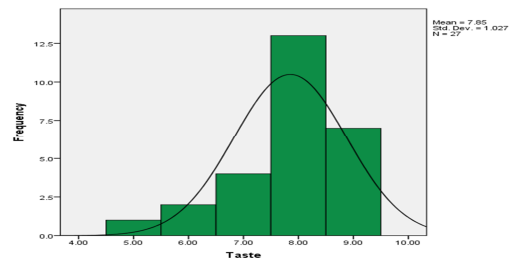
The results showed that the participants “like very much” the appearance, taste, smell and the texture of the product. Their remarks for the product reflected as good and appetizing. The aroma and texture is just right. There was only a little suggestion that the talisay nut was “less tasted” hence, adding more of grounded talisay nuts to the polvoron would make it more flavorful.

The following histograms described the assessors’ Hedonic evaluation results:



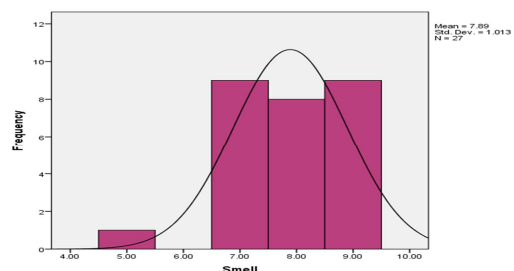
**Fig. 1.** Appearance Evaluation.

As gleaned from Fig. 1, results reflected that the highest frequency can be traced to the given rating of 8 with the rating 5 as the lowest frequency. Correspondingly, a mean of 7.67 and sd of 1.00 was garnered denoting that in terms of appearance, the Talisay Nuts Polvoron was deemed “acceptable”. Only a few slightly disliked and nobody disliked the product.



**Fig. 2.** Taste Evaluation.

As gleaned in Fig. 2, results showed that the highest frequency can be traced to the given rating of 8 and 5 as the lowest frequency. Further, a mean of 7.85 and sd of 1.027 which means that many of the participants “like the product” a lot and only a few slightly like with no one who dislike the product as to its taste hence, it taste “good” thereby showing that the product is acceptable to the tasters.



**Fig. 3.** Smell Evaluation.

As displayed in Fig. 3, on the aroma/smell evaluation result of the product, the highest frequency dwells on the rating 7 and 9 and the lowest frequency on the rating 5 with a mean 7.89 and sd of 1.013 depicting further that the product was “acceptable” in terms of its smell or aroma. This can be attributed to the aroma of the butter as part of the ingredient of the polvoron.

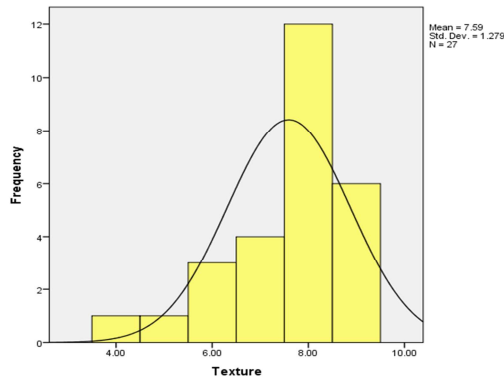


Fig. 4. Texture Evaluation.

As shown in Fig. 4, the raters evaluated the product as to texture as “acceptable” based on its mean of 7.59 and SD of 1.279. The texture came out as another characteristic that may lead to the acceptability of the product. Since the Talisay Nuts Polvoron is not coarsely textured, hence it was deemed acceptable.

*On Food Action Rating Results*

The result of the second phase of the sensory evaluation which is the food action rating test is presented in Table 2.

Table 2. Food Action Rating Test Results.

Food Action	Frequency (n=27)	Percent (%)
I would eat this only if forced to	0	0
I would hardly ever eat this	0	0
I don't like this but would eat it on occasion	0	0
I would eat this if available but would not go out of my way	6	22.2
I like this and would eat it now and then	10	37
I would eat this very often	2	7.4
I would eat this every opportunity that I had	9	33.3

As observed from the tabulated results, 37% of the testers affirmed that they like the polvoron and would eat it now and then, 33.3% said that they would eat this every opportunity that they had, 22.2% agreed that they would eat the product if available but would not go out of my way and 7.4% said that they would eat the product very often. None of those assessors dislike the polvoron. This is a good indication that the product is acceptable.

*Multiple Correspondence Analysis (Polvoron)*

Multiple Correspondence Analysis was conducted to explore the variation of the sensory evaluation of the customers on Talisay polvoron. Table 3 presents the eigenvalues and the inertia obtain from the data. These values indicate how much variance explained by the factors (F<sub>i</sub>). Since F<sub>1</sub> and F<sub>2</sub> got the two highest eigenvalues, these were factors considered as it cumulatively explained 80.84% of the variance.

Table 3. Eigenvalues and Proportion of Explained Variance.

	F1	F2	F3	F4	F5	F6	F7	F8
Eigenvalue	1.818	1.055	0.192	0.161	0.118	0.093	0.041	0.028
Variability (%)	42.736	38.100	7.678	6.433	4.728	3.723	1.628	1.117
Cumulative (%)	42.736	80.836	82.370	88.803	93.532	97.255	98.883	100.000

In Fig. 5, symmetric plot is displayed showing the cloud of both coordinates of observations and categories on the two principal axes.

Fig. 5 shows that administrative personnel and the students as respondents (positive part of F<sub>2</sub>) like a lot the texture, appearance, aroma, taste

and smell of the polvoron. There are some students (negative part of F<sub>2</sub>) who like a little the appearance and smell of the polvoron. Meanwhile, the faculty (positive part of F<sub>1</sub>) like a little the taste, aroma and texture. However, they dislike a little the appearance and smell of the polvoron.

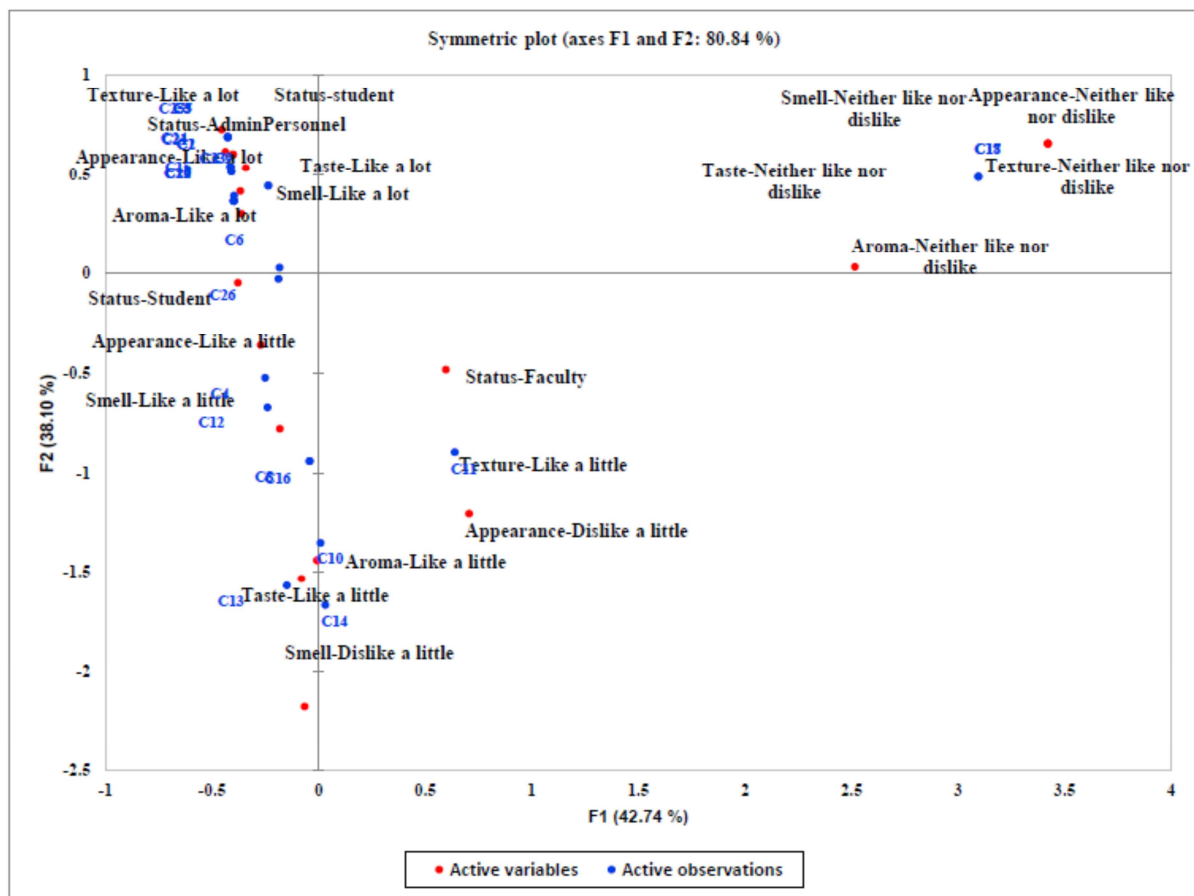
On Sensory Evaluation of the Glazed Talisay Nuts

Table 4 summarized the average rating on the characteristics of the glazed talisay nuts.

**Table 4.** Evaluation of Glazed Talisay nuts Characteristics.

Characteristics	Mean Score	Qualitative Description
Appearance	4.7	Like a lot
Aroma	4.8	Like a lot
Taste	4.7	Like a lot
Sweetness	4.7	Like a lot
Texture	4.7	Like a lot

As depicted by the average responses of the participants, it was found out that they like a lot the appearance, aroma, taste, the sweetness and the texture of the glazed talisay nuts. It can be inferred that most of the participants were fascinated by the look and the form of the product. Results also revealed that many love the distinctive pervasive and savory smell of it. It would also mean that the participants appreciate much the flavor and the sweetness of the glazed talisay nuts. Most of them also enjoyed the way it feels in the mouth when it is eaten as to its crunchiness.



**Fig. 5.** Symmetric plot.

The responses would then reveal that the glazed talisay nuts passed the expectation of the participants basing on the characteristics considered individually. Hence, it is safe to say that the product developers must sustain all characteristics that are much liked and enhance some characteristics that needs improvement after which it can be said that the product is now ready for commercialization. Table 5

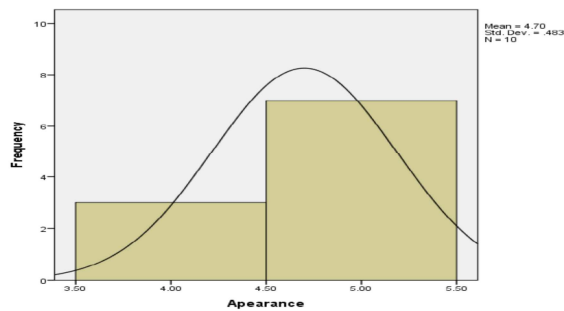
exhibits the average action/attitude rating of the participants concerning how they feel about the glazed talisay nuts.

As observed from the result, a mean response of 5.4 was obtained qualitatively equivalent to saying “I would buy this very often”. It shows that nearly every participant will really become fond of buying

the glazed talisay nuts over and over again. This is a manifestation that the said product is click to the market or to the target consumers especially those sweet lovers.

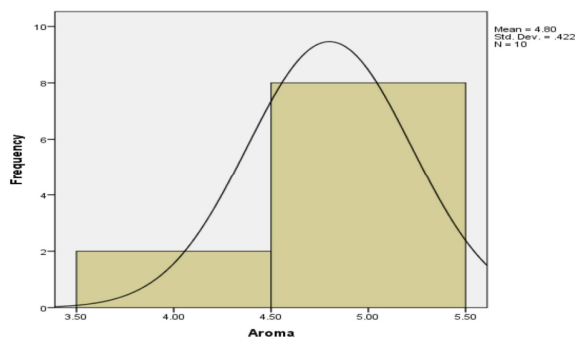
**Table 5.** Average Action Rating on Glazed Talisay Nuts.

	Food Action Rating
Mean	Qualitative Description
5.4	I would buy this very often



**Fig. 6.** Evaluation Results of the Glazed Talisay Nuts in Reference to its Appearance.

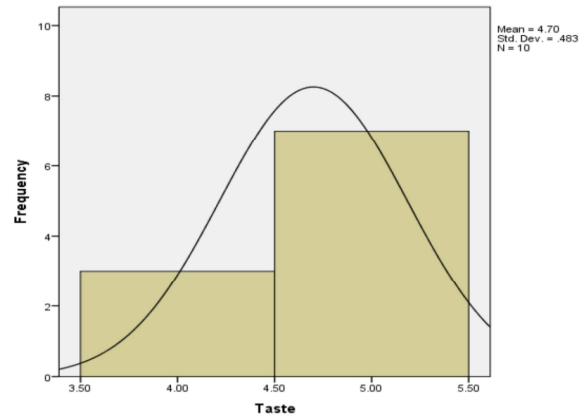
The participants rated the glazed talisay nuts positively (Fig. 7) as revealed by its mean = 4.70 and sd = 0.483 denoting further that they would like to buy it now and then. This manifest a good sign of acceptability as the participants are longing to buy the product now and then or frequently.



**Fig. 7.** Sensory Evaluation Results of the Glazed Talisay Nuts as to Smell/Aroma.

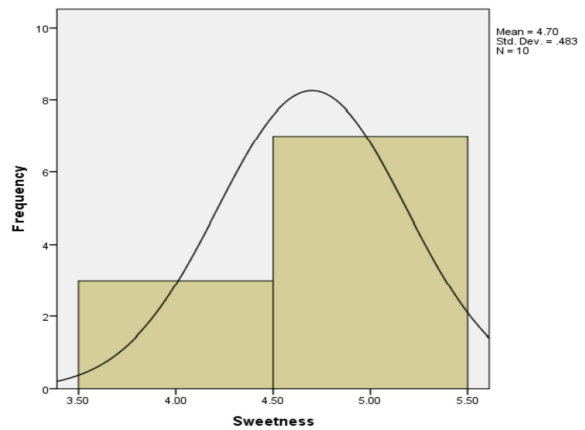
The participants rated the product positively (Fig. 8) based on its mean of 4.80 and sd = 0.422. It can be deduced then that the aroma has also gained approval or acceptability from the participants as they described it in such a way that “they would like it now

and then”. Maybe they are enticed by the aroma of the product as it passed to their aroma standards.



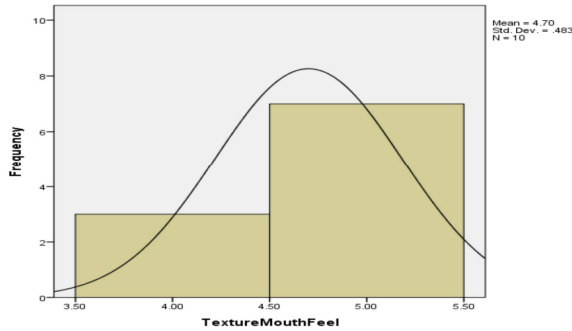
**Fig. 8.** Sensory Evaluation of the Glazed Talisay Nuts as to Taste.

The participants rated the taste constructively (Fig. 8) based on its mean = 4.80 qualitatively described as “I would like to buy it now and then” Still a good sign that they are impressed with the taste of the product, hence can held captive some of the sweet lovers to want it more.



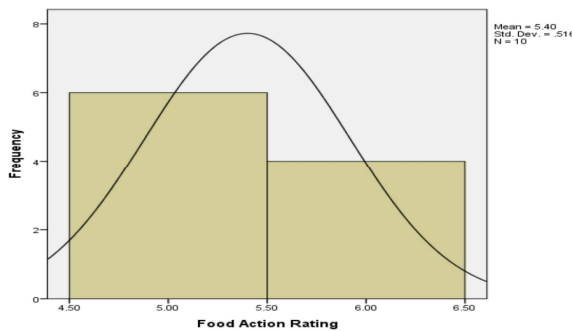
**Fig. 9.** Sensory Evaluation of the Glazed Talisay Nuts as to Sweetness.

As displayed, the sweetness of the product is positively rated based on its mean= 4.70 and sd = 0.483 thereby showing that the participants would like this and would buy this now and then. Conversely, it may mean that still they like the sweetness meaning it is not so sweet for them but acceptably sweet that may not lead them to experience throat pain resulting from sweetness overload.



**Fig. 10.** Sensory Evaluation Result for the Product as to Texture/Mouthfeel.

The product has shown acceptability (Fig. 10) as to texture/mouthfeel based on its mean = 4.70 and sd = 0.483 qualitatively described by the participants as “I would like this and buy it now and then”, meaning that it has passed its texture standards. This further connotes that they accepted and approved the texture of the product developed.



**Fig. 11.** Food Action Rating of the Participants as to the Glazed Talisay Nuts.

As shown in Fig. 10, the food action rating got a mean of 5.40 and sd = 0.516 qualitatively described as “I will buy this product very often” which further connotes that the participants are positive that the product can also gain same response from other target consumers should commercialization will be done.

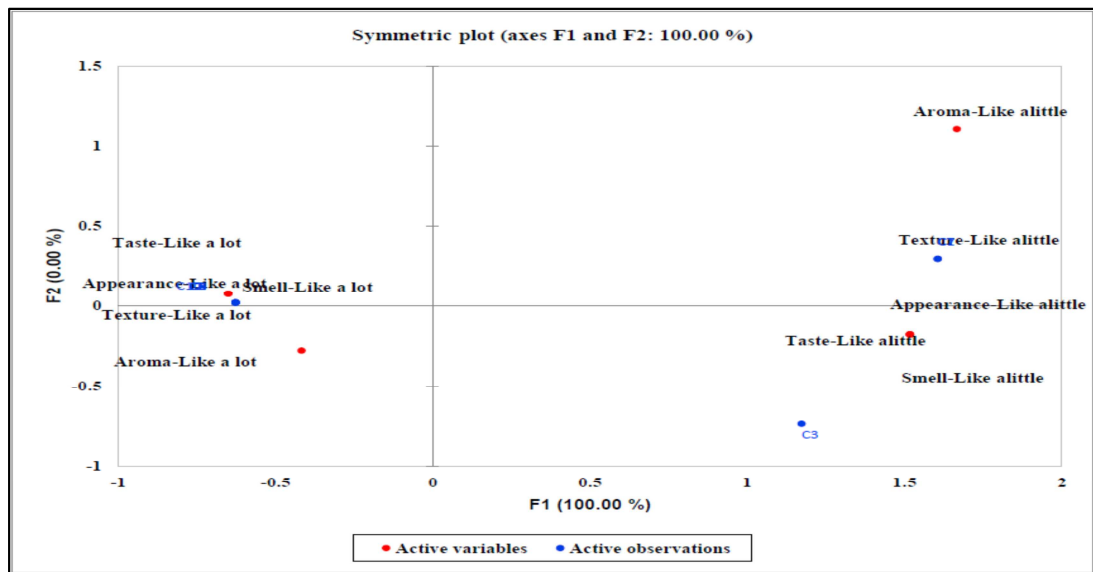
*Multiple Correspondence Analysis (Glazed Talisay Nut)*

MCA was also performed to explore the variation of the sensory evaluation of the customers on glazed Talisay nuts. Table 6 presents the eigenvalues and the inertia obtained from the survey data. These values indicate how much variance is explained by the factors. As observed from the results, there were only two factors, F1 and F2, obtained whose eigenvalues cumulatively explained 100% of the variance.

**Table 6.** Eigenvalues and Proportion of Explained Variance.

	F1	F2
Eigenvalue	0.928	0.072
Variability (%)	92.817	7.183
Cumulative (%)	92.817	100.000

In Fig. 12, biplot is displayed showing the cloud of both coordinates of observations and categories on the two principal axes.



**Fig. 12.** Symmetric plot.

From this chart, it can be seen that no customer dislike the attributes of the glazed Talisay nuts. In fact, those who like a lot the appearance also like a lot the taste, smell, texture and aroma fo the product when they tried it. On the other hand, those who only like a little the appearance, also like a little only of the taste, smell, texture and aroma of the glazed Talisay nuts. In other words, the taste of the glazed Talisay nuts is complementary to its appearance, smell, aroma and texture.

*On the Sensory Evaluation of Sugar-Coated Talisay Nuts*

Table 6 presents the sensory evaluation results of the characteristics of sugar-coated talisay nuts.

**Table 6.** Evaluation of Sugar Coated Talisay nuts Characteristics.

Characteristics	Mean	Qualitative Description
Appearance	4.7	Like a lot
Aroma	4.5	Like a lot
Taste	4.7	Like a lot
Sweetness	4.8	Like a lot
Texture/Mouth Feel	4.2	Like a little

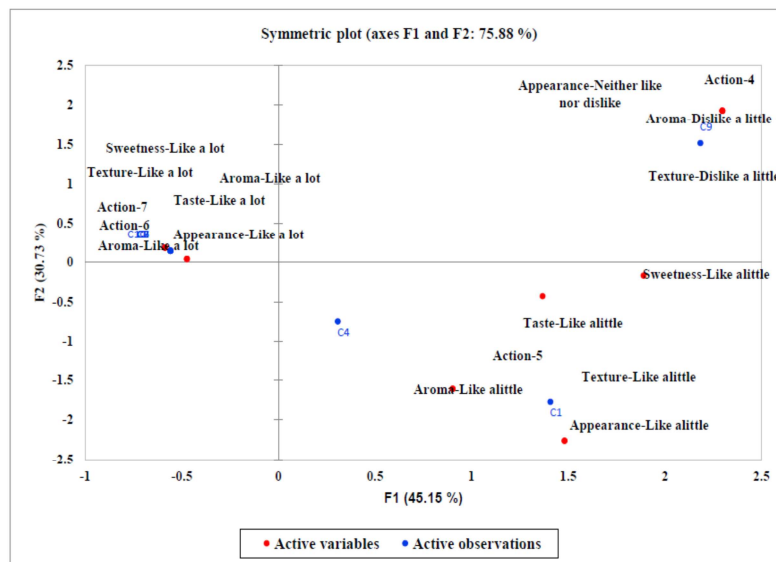
The results revealed that the participants “like a lot” the appearance, aroma, taste and sweetness of the product.

It would imply that the product is good and appetizing. The aroma and sweetness win the taste of the consumers. On the contrary, the texture /mouthfeel of the product obtained the mean response of 4.22 which is qualitatively described as like a little.

This would mean that the consumers like the mouth feels but not enough to fascinate their fondness. In fact, there was suggestion that the sugar-coated talisay nuts would be tastier if it would be crunchier.

Crunchiness is really a value-added feature of nuts which will be looked into by food lovers.

With regards to how the participants feel about the sugar-coated talisay nuts, results were displayed in Table 7.



**Fig. 13.** Symmetric plot.

Legend:

Scale	Qualitative Description
1	I would buy this only if forced to
2	I would hardly ever buy this
3	I don't like this but but would buy it on occasion
4	I would buy this if available but would not go out of my way
5	I would like this and would buy it now and then
6	I would buy this very often
7	I would buy this every opportunity that I had.



**Table 7.** Evaluation of Sugar Coated Talisay Nuts.

	Food Action Rating
Mean	Qualitative Description
6.1	I would buy this very often

The average response of 6.1 reflects that the consumers would like to buy the product repeatedly. It further implies that the sugar-coated talisay nuts has gained approval from the representative future consumers. One way of capturing their desire to buy more is to consider the suggestions and aim for continual enhancement until the desired outcome can be seen.

*Multiple Correspondence Analysis (Sugar-Coated Talisay Nuts)*

Multiple Correspondence Analysis was conducted to explore the variation of the sensory evaluation of the customers on sugar coated Talisay nuts. Table 8 presents the eigenvalues and the inertia obtain from the data. These values indicate how much variance explained by the factors ( $F_i$ ). Since  $F_1$  and  $F_2$  got the two highest eigenvalues, these were factors considered as it cumulatively explained 75.88% of the variance.

**Table 8.** Eigenvalues and Proportion of Explained Variance.

	F1	F2	F3	F4	F5
Eigenvalue	0.903	0.615	0.210	0.149	0.124
Variability (%)	45.147	30.730	10.485	7.456	6.182
Cumulative (%)	45.147	75.877	86.362	93.818	100.000

In Fig. 13, symmetric plot is displayed showing the cloud of both coordinates of observations and categories on the two principal axes.

From the chart above (Fig.13), it can be inferred that those customers who would like to buy sugar coated Talisay nut very often (Action 6) and every opportunity that they had (Action 7) are those who like a lot the appearance, aroma, taste, texture and sweetness of the said product. It was also found out that those customers who would prefer to buy the product now and then (Action 5) only like a little the appearance, aroma, taste, texture and sweetness of

the product. On the other hand, those who said that they would buy sugar coated Talisay nuts only when available but would not go out of their way are those who like a little the sweetness of the product but dislike a little the texture and the aroma of it.

**Conclusion**

The Sensory Evaluation/Analysis is deemed a potent tool to test the level of acceptability of the Talisay Nuts Polvoron, Glazed Talisay Nuts, and Sugar-coated Talisay Nuts. It can be concluded then that the by-products developed from Talisay nuts have achieved a remarkable level of acceptability based on the responses of the participants and is potential for a business venture of the residents in areas where the plant is abundant.

**Recommendations**

The product developers are encouraged to put premium on the identified strengths of each product derived from the sensory evaluation results and give a dose of improvement on the identified weaknesses of the three products to ensure quality and high level of acceptability for future product commercialization.

**Acknowledgment**

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