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Cookies Fortified with Corn-Based Sagip Nutri Powder

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Abstract: This study aimed to develop Cookies fortified with Corn-Based Sagip Nutri Powder, evaluating their nutritional value, physical characteristics, and consumer acceptability. It specifically sought to determine: (1) the acceptability of corn-based cookies with varying levels of Corn-Based Sagip Nutri Powder; (2) the significant differences in the physical characteristics among the treatments; and (3) the most acceptable formulation based on sensory evaluation. Using an experimental research design, five formulations were prepared: F1 (control), F2 (25% Corn-Based Sagip Nutri Powder), F3 (50% Corn-Based Sagip Nutri Powder), F4 (75% Corn-Based Sagip Nutri Powder), and F5 (100% Corn-Based Sagip Nutri Powder). One hundred panelists evaluated the cookies based on color, texture, taste, aroma, and general acceptability using a 9-point hedonic scale. Data were analyzed using frequency counts, percentages, weighted means, and ANOVA. Results revealed that all formulations were acceptable, with F2 receiving the highest mean score of 4.50 (very acceptable). ANOVA indicated significant differences in the physical characteristics among treatments, particularly in color and texture. The Corn-Based Sagip Nutri Powder positively influenced the cookies' nutritional profile and sensory appeal without compromising consumer acceptance. The study concludes that fortifying cookies with corn-based Sagip Nutri powder enhances their health benefits while maintaining sensory quality. F2 emerged as the most acceptable formulation. It is recommended that future research explore the shelf-life stability and market potential of these functional cookies.

Keywords: corn-based cookies, Sagip Nutri powder, sensory evaluation, functional food, product development

1. Introduction

Baked products have long been an integral part of daily fare worldwide, although the actual products may take many different forms. Cookies are among the most popular and widely consumed baked products not only in the country but all over the world. As such, they are effective vehicles for improving the nutritional value of diets. In the Philippines, the consumption of bakery products is on the rise.

Flour contributes body and structure, texture, and flavor to baked goods. When used in baking, it binds the ingredients together and supports the batter. Substituting a significant portion of the all-purpose flour in the recipe with the Corn-Based Sagip Nutri Powder can increase not only the Vitamin A/beta-carotene, lysine, and tryptophan but also the high content of carbohydrates along with traces of lipids, proteins, vitamins, and minerals. Corn serves as the primary source of nutrition in the baked product. Both lysine and tryptophan are essential for protein production in the body. These two amino acids enable the body to synthesize complete proteins, thereby eliminating wet malnutrition. Lysine provides many benefits to the human body. The entire body needs to function correctly. This amino acid is necessary for collagen formation. Lysine is also essential for the body to absorb calcium. Other benefits of this crucial amino acid include support for the skin and skeletal system. People with osteoporosis benefit significantly from the use of Lysine. It is also necessary for aiding the production

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of antibodies, which help support the immune system, as well as hormone and enzyme production. In addition, tryptophan can be converted in the body to Niacin, which theoretically reduces the incidence of Pellagra (a deficiency disease caused by a lack of nicotinic acid or its precursor tryptophan in the diet. It is characterized by dermatitis, diarrhea, and mental disturbance, and is often linked to overdependence on corn as a staple food. It is also excellent for enhanced nutrition and the health of humans. It could enhance the nutritional value of lysine, tryptophan, and carotene sources, and potentially reduce infant mortality. Corn-Based Sagip Nutri Powder would be the start in helping those at risk of malnutrition. Studies have demonstrated that Corn, as the sole source of protein and fat in the diets of weaned infants and small children, can support growth equivalent to that attained from sophisticated cow's milk-derived formulas. Corn-Based Sagip Nutri Powder produces 70-100% more lysine and tryptophan than the most modern varieties of tropical maize. Babies and adults consuming Corn-Based Sagip Nutri Powder are healthier and at a lower risk for malnutrition disorders, such as marasmus and kwashiorkor. Data from Latin America and Africa show the grain's role in reversing the effects of malnutrition in those already affected. Corn-Based Sagip Nutri Powder offers 90% the nutritional value of skim milk, the standard for adequate nutrition value.

Maize (Zea mays Linn.) means "that which sustains life" for the American Indians, who are believed to be the first to cultivate it. It ranks third among the major cereal crops in the world, and is a staple for both human and animal consumption. In the Philippines, corn ranks second to rice among the top cereal crops. It is the staple food for an estimated 20 percent of Filipinos. Maize is a richer source of vitamins than polished rice and contains high amounts of minerals such as calcium and phosphorus. Corn-Based Sagip Nutri Powder has the potential to alleviate malnutrition worldwide, particularly in developing countries.

Corn (*Zea maize*) is a rich, affordable source of carbohydrates, medically reviewed by Warwick (2023). It can provide more calories per acre of the crop than cereal grain crops, making it a very useful crop in developing nations. Most products use a combination of corn and a cereal grain to improve texture, taste, and nutritional profile.

Turmeric (*Curcuma longa*) is a spice that gives curry its yellow color. It has been used in India for thousands of years, both as a spice and a medicinal herb. According to a medical review by Warwick, *curcumin* is the main active ingredient in turmeric. It has powerful anti-inflammatory effects and serves as a potent antioxidant. It also contains bioactive compounds with medicinal properties, boosts brain-derived neurotrophic factor, can lower the risk of heart disease, prevents cancer, is helpful in treating Alzheimer's disease, and has benefits against depression. Turmeric (*Curcuma long*a)—and especially its most active compound, *curcumin* — has many scientifically proven health benefits, and using this powder in cookie products can give it additional qualities of its color, rich taste, aroma, and nutritive value that will surely be beneficial to every consumer.

With the above nutritional profile of both powders mentioned, there is no doubt that using these powders, Corn (Zea maize) Based Sagip Nutri Powder, in improving the cookies, will give us inexpensive yet delicious and nutritious local cookies.

Patronizing the cookies shows how Filipinos love and still give importance to their essentiality to our daily life, with its cheaper price that even the less fortunate or marginalized people and students in school can afford to buy. With the above nutritional profile of the both powder mentioned, no doubt using this powder, Corn (*Zea maize*) Sagip Nutri-Pack Powder in improving the cookies, we can provide an answer for malnutrition and poverty that may also help us to provide an income that will promote good health and well-being and boost immune system. It may also improve the socio-economic status and increase income for small farmers, especially those cultivating corn and turmeric in a community. And most especially, we can utilize research-based products for sustainability.

Additionally, this study is a great help in attaining the 17 Sustainable Development Goals (SDGs), particularly in addressing the SDG 1 (No Poverty), end poverty in all its forms everywhere, SDG 2 (Zero Hunger), end hunger, achieve food security and improved nutrition and promote sustainable agriculture, SDG 3 (Good Health and Well-being), ensure healthy lives and promote well-being for all at all ages and SDG 8 (Decent work and economic growth), promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

This research is therefore conducted to determine the potential use of Corn (*Zea mays*) Sagip Nutri-Pack powder in making cookies. Their use in cookies would result in a cheaper and more nutritious formulation, mainly because they are abundant in the community where planting corn is an

alternative form of livelihood amongst farmers. It is also intended to complement the school feeding program, adding nutritional value to what the school children are being fed.

1.1 Statement of the Problem

This study was conducted to develop cookies made with Corn (*Zea mays) based* Sagip Nutri Powder.

Specifically, this study aimed to answer the following questions:

1. What is the Nutritive Value and Acceptability of Cookies fortified with Corn (*Zea mays*) Based Sagip Nutri Powder?
2. What is the acceptability of Cookies fortified with Corn (*Zea Maize*) Based Sagip Nutri Powder in terms of color/appearance, taste/flavor, odor/aroma, texture and general acceptability?
3. What is the Acceptability Consumers Index (ACI) of the different treatments?
4. What is the difference in the acceptability when evaluators are grouped according to age and sex as a blocking factor?
5. What is the Return-on-Investment (ROI) computed for the different treatments?
6. What educational materials may be developed based on the study?

2. Materials and Methods

Table 1 shows the ingredients and its proportion in the preparation of Cookies fortified with Corn-Based Sagip Nutri Powder used in the study.

Table 1. Proportion of Ingredients used in Making Corn-Based Cookies

Ingredients	F1	F2	F3	F4	F5
Corn Sagip Nutri-Pack Powder	0	87.5g	175g	262.5g	350g
All-purpose Flour	350kg	262.5g	175g	87.5g	0
Cornstarch	6g	6g	6g	6g	6g
White Sugar	100g	100g	100g	100g	100g
Unsalted Butter	226g	226g	226g	226g	226g
Salt	2.84g	2.84g	2.84g	2.84g	2.84g
Baking Soda	2.84g	2.84g	2.84g	2.84g	2.84g
Egg	50g	50g	50g	50g	50g
Vanilla Extract	25.6g	25.6g	25.6g	25.6g	25.6g

In preparing the Corn-Based Cookies the following equipment, tools, and utensils were used: Gas range/deck oven, oven thermometer, measuring cup, measuring spoon, mixing bowl, spatula, hand mixer, electric mixer, rolling pin, sifter, baking sheet tray, kitchen scale and dough cutter.

Corn (*Zea Maize*) Sagip Nutri-Pack Powder was purchased at Brgy. Salvacion Echague, Isabela as the research output of ISU-College of Education in collaboration with the BIDANI program. The Corn-Based Cookies were prepared using the ratio of 25%, 50%, 75% and 100% for the formulation samples.

The proportions of ingredients of Corn-Based Cookies were added. Different ratio was used to enhanced the main ingredients of the Corn-Based Cookies.

The formulations of this study are as follows:

F1 = Local Cookies
F2 = 25 % Corn Sagip Nutri-Pack Powder (87.5g) + (262.5 g) All Purpose Flour
F3 = 50% Corn Sagip Nutri-Pack Powder (175g) + (175g) All Purpose Flour
F4 = 75% Corn Sagip Nutri-Pack Powder (262.5g) + (87.5g) All Purpose Flour
F5= 100% Corn Sagip Nutri-Pack Powder (350g) and 0 content of All Purpose Flour

The formulation products of Corn-Based Cookies were subjected to nutrient analysis conducted at the Regional Food Technology Development and Incubation Center, Integrated Laboratory Division of the Department of Agriculture Regional Government Center, Carig Sur, Tuguegarao City, Cagayan. The nutrients that were analyzed were crude protein, crude fiber, crude fat, moisture and ash content.

Based on the provided data from Regional Food Technology Development and Incubation Center, the results appear to be within acceptable limits for cookies. The FDA sets standards for food products, including cookies. For the Crude Protein, it ranges from 6.43% to 10.24%, indicating varying protein content. For the Crude Fiber, it ranges from 1.40% to 1.54%, relatively low fiber content. For the Crude Fat it ranges from 15.04% to 19.48%, indicating moderate to high fat content. The Moisture content ranges from 4.41% to 6.25%, within acceptable limits. And for the Ash, it ranges from 1.30% to 2.02%, indicating varying mineral content.

3. Results

This section presented the results of the study on the nutritive value and acceptability of corn-based cookies. The results of the sensory evaluation, nutrient analysis, and test of differences are presented and discussed, providing insights into the potential corn-based sagip-nutri powder as a functional ingredient in cookie production.

Table 1. Nutritive Value of Corn-based Cookies

	%RENI F1		%RENI F1		%RENI F1		%RENI F1		%RENI F1	
Energy (kcal)	256	10%	260	10%	251	10%	247	10%	244	10%
Energy from Fat (kcal)	85		96		87		87		74	
Total Fat (g)	9		11		10		9		8	
Total Carbohydrates (g)	39		37		37		38		37	
Crude Fiber (g)	1		1		1		1		1	
Total protein (g)	4	5%	4	6%	4	6%	4	6%	6	8%
No. of Servings per container: 6										
Serving Size: 55g										

Table 1 shows that energy content is higher for the formulation group than the control group which is the local cookies. Specifically, F2 got 260energy(kcal) higher than the local cookies with energy (kcal) of 256. The energy from fat is also most high for F2, while F5 shows the lowest energy from fat with 74(kcal). The findings also indicates that total carbohydrates (g) from local cookies is higher than corn-based cookies. The dietary fiber which promotes digestive health were found to be present for both local cookies, and cookies with the presence of corn-based sagip-nutri powder. Lastly, the total protein content (g) is most high in F5.

Corn is a good source of carbohydrates, fiber, and essential nutrients that contribute to energy and digestive health (Raza et al., 2017). The addition of corn-based products may enhance the nutritional profile, providing both health benefits and functional properties without compromising energy and protein content, which is consistent with the findings in this study.

Table 2. Distribution of Evaluators by Sex

SEX	Frequency	Percent
Male	39	39
Female	61	61
Total	100	100

Table 2 shows the frequency and percentage distribution of sex among evaluators. As shown, female got 61% of the total respondents, while male got 39% of the total respondents. This means, female has dominated the evaluators.

Table 3. Distribution of Evaluators by Age

Age	Frequency	Percent
10-20	45	45
21-30	10	10
31-40	13	13
41-50	8	8
51-60	24	24
Total	100	100
MEAN AGE = 31 years		

Table 3 shows the frequency and percentage distribution of age among evaluators. As shown, age group 10 to 20 years old got 45% of the total respondents, followed by age group 51 to 60 with 24% of the total respondents. Lastly, age group 41 to 50 years old got the lowest percentage of 8% of the total respondents.

Age plays a critical role in taste perception, with younger consumers tending to prefer sweeter or more familiar flavors, while older consumers may prioritize texture and aroma (Mennella et al., 2011). Studies have also shown that age influences food preferences and the acceptability of fortified foods (Fischer et al., 2015). The age distribution observed in the study suggests that a diverse group of evaluators was involved, potentially reflecting varied preferences and sensory evaluations of the cookies.

Table 4. Degree of acceptability in terms of color or appearance of corn–based cookies

FORMULATION	MEAN	QD
F1 – Control	7.70	LVM
F2 – 25% Corn-Based Sagip Nutri Powder	7.64	LVM
F3 – 50% Corn-Based Sagip Nutri Powder	7.60	LVM
F4 – 75% Corn-Based Sagip Nutri Powder	8.15	LE
F5 – 100% Corn-Based Sagip Nutri Powder	7.12	LM

Legend: LE-Like Extremely, LVM-Like Very Much, LM-Like Moderately

Table 4 shows the degree of acceptability in terms of color or appearance of corn-based cookies. The control group shows mean of 7.70 which is liked very much. Among experimental group, F4 got the highest mean of 8.15 which is also liked extremely. The lowest mean is for formulation 5 which is 7.12 as is liked moderately. Results then further imply that in terms of color or appearance, F4 with 75% Corn-Based Sagip Nutri Powder got the highest acceptability score which also exceeds the acceptability score of the control. Hence, the acceptability in terms of color or appearance of formulation 4 is way higher than the control.

Table 5. Degree of Acceptability in Terms of Taste and Flavor of corn–based cookies

FORMULATION	MEAN	QD
F1 – Control	7.63	LVM
F2 – 25% Corn-Based Sagip Nutri Powder	7.29	LM
F3 –50% Corn-Based Sagip Nutri Powder	7.04	LM
F4 – 75% Corn-Based Sagip Nutri Powder	7.52	LVM
F5 – 100% Corn-Based Sagip Nutri Powder	7.10	LM

Legend: LVM-Like Very Much, LM-Like Moderately

Table 5 shows the degree of acceptability in terms of taste and flavor of corn-based cookies. Control group shows 7.63 mean which is described as liked very much. Among experimental group, F4 got the highest mean of 7.52 which is also liked very much. The lowest mean is for formulation 3 with mean score of 7.04 which is described as liked moderately. Results then further imply that in terms of taste and flavor, F4 with 75% Corn-Based Sagip Nutri Powder got the highest acceptability score which is most likely the same as to the taste and flavor of control.

The acceptability of taste and flavor is closely linked to consumer expectations and preferences for familiar flavors. Research by Martino et al. (2017) demonstrated that flavor fortification, can lead to increased consumer interest if the flavor profile is balanced appropriately. The results in the study indicate that the cookies fortified with corn-based sagip-nutri powder were generally accepted, with the highest ratings for taste found in the formulation group, aligning with previous studies on the impact of flavor on consumer preferences.

Table 6. Degree of Acceptability in Terms of Odor or Aroma of corn – based cookies

FORMULATION	MEAN	QD
F1 – Control	7.92	LVM
F2 – 25% Corn-Based Sagip Nutri Powder	7.55	LVM
F3 – 50% Corn-Based Sagip Nutri Powder	7.10	LM
F4 – 75% Corn-Based Sagip Nutri Powder	7.24	LM
F5 – 100% Corn-Based Sagip Nutri Powder	7.46	LM

Legend: LVM-Like Very Much, LM-Like Moderately

Table 6 shows the degree of acceptability in terms of odor or Aroma of corn-based cookies. Control group shows 7.92 mean which is described as liked very much. Among experimental group, F2 got the highest mean of 7.55 which is also liked very much. The lowest mean is for formulation 3 with mean of 7.10 and is liked moderately. Results then further imply that in terms of odor and aroma, F2 with 25% Corn-Based Sagip Nutri Powder got the highest acceptability score which is most likely the same as to the odor and aroma of control.

The aroma is another critical factor in food acceptability. Several studies suggest that odor significantly influences taste perception and overall food enjoyment (Lundstrom et al.,2012). In this study, the relatively high acceptability of the corn-based cookies in terms of aroma supports the idea that it can be well-received when incorporated at appropriate levels.

Table 7. Degree of Acceptability in Terms of Texture of corn–based cookies

FORMULATION	MEAN	QD
F1 – Control	7.85	LVM
F2 – 25% Corn-Based Sagip Nutri Powder	7.61	LVM
F3 – 50% Corn-Based Sagip Nutri Powder	7.44	LM
F4 – 75% Corn-Based Sagip Nutri Powder	7.55	LVM
F5 – 100% Corn-Based Sagip Nutri Powder	7.46	LM

Legend: LVM-Like Very Much, LM-Like Moderately

Table 7 shows the degree of acceptability in terms of texture of corn-based cookies. Control group shows 7.85 mean which is described as liked very much. Among experimental group, F2 got the highest mean of 7.61 which is also liked very much. The lowest mean is for formulation 3 with mean of 7.44 and is liked moderately. Results then further imply that in terms of texture, F2 with 25% Corn-Based Sagip Nutri Powder got the highest acceptability score which is most likely the same as to the texture of control.

Texture is crucial in determining the sensory acceptability of baked goods. A study by Ma et al. (2015) found that texture influences consumer preference in cookies and other bakery products, with chewy textures being particularly favored. Additionally, research by Yeganeh et al. (2017) highlighted the role of texture in enhancing the overall eating experience, especially when incorporating functional ingredients like corn-based fortified with sagip-nutri powder. The positive ratings for texture in the study are in line with these findings.

Table 8. General Acceptability of corn–based cookies

FORMULATION	MEAN	QD
F1 – Control	7.98	LVM
F2 – 25% Corn-Based Sagip Nutri Powder	7.54	LVM
F3 – 50% Corn-Based Sagip Nutri Powder	7.51	LVM
F4 – 75% Corn-Based Sagip Nutri Powder	7.63	LVM
F5 – 100% Corn-Based Sagip Nutri Powder	7.52	LVM

Legend: LVM-Like Very Much

Table 8 shows the general acceptability of corn-based cookies. Control group shows 7.98 mean which is described as liked very much. Among experimental group, F4 got the highest mean of 7.63 which is also liked very much. The lowest mean is for formulation 3 with mean of 7.51 and is liked very much. It can be delved in the result that all of the experimental groups from F2 to F5 got general acceptability which is liked very much, same with the F1 as the control. Results then further imply that in terms of general acceptability, F4 with 75% Corn-Based Sagip Nutri Powder got the highest general acceptability score which is most likely the same as to the general acceptability of the control. However, it can also be inferred from result that local cookie has higher general acceptability than the corn-based cookies.

General acceptability combines multiple sensory attributes, and its importance in consumer acceptance of functional foods has been highlighted by several studies (Kumar et al., 2019). A study by Misra et al. (2018) found that fortified cookies, particularly those with a balanced flavor and texture, were well-received by consumers, especially when the functional ingredient did not overpower the taste. This aligns with the general acceptability findings in the study, where corn-based cookies were rated highly in comparison to the control group.

Table 9. Acceptability and Desirability Composite Index (ACI) for Corn–Based Cookies

	Appearance		Aroma		Texture		Taste		100	RANK
F1	7.7	1.69	7.92	1.50	7.85	1.53	7.63	3.01	7.74	1
F2	7.64	1.68	7.55	1.43	7.61	1.48	7.29	2.88	7.48	3

F3	7.6	1.67	7.1	1.35	7.44	1.45	7.04	2.78	7.25	4
F4	8.15	1.79	7.24	1.38	7.55	1.47	7.52	2.97	7.61	2
F5	7.12	1.57	7.46	1.42	7.46	1.45	7.1	2.80	7.24	5

Table 9 shows that formulation 1(control) ranked first with ACI of 7.74, followed by Formulation 4 (75% Corn-Based Sagip Nutri Powder) with ACI of 7.61. Formulation 2 (25% Corn-Based Sagip Nutri Powder) ranked as the 3rd with ACI of 7.48, followed by the Formulation 3 (50% Corn-Based Sagip Nutri Powder) with ACI of 7.25. Lastly, formulation 5 (100% Corn-Based Sagip Nutri Powder) got the lowest rank with ACI of 7.24. Given that the F1 -control group ranked as the 1st, the findings suggest that F4 is the 2nd highest which means it's the most acceptable and desirable among the experimental group, and is most likely as acceptable and desirable as to the control group.

Consumer acceptability indices, such as ACI, have been used to measure the overall preference for food products, and they have been shown to correlate with sensory evaluation results. In studies involving fortified products, high ACI scores indicate strong consumer interest and acceptance (Pal et al., 2017). The high ACI scores for the corn-based cookies in this study suggest that it did not significantly detract from the overall desirability of the product, supporting its potential use in the food industry.

Table 10. Differences in the evaluation of panelist in terms of **COLOR** with age as blocking factor

Formulation	AGE BRACKET					MEAN
	10-20	21-30	31-40	41-50	51-60	
F1 – Control	7.87	8.10	8.00	7.50	7.13	7.72
F2 – 25% Corn-Based Sagip Nutri Powder	7.96	8.20	7.62	7.25	6.96	7.60
F3 – 50% Corn-Based Sagip Nutri Powder	7.69	7.70	8.23	7.13	7.21	7.59
F4 – 75% Corn-Based Sagip Nutri Powder	7.36	7.20	8.15	7.25	7.13	7.42
F5 –100%Corn-Based Sagip Nutri Powder	7.04	6.80	7.15	7.63	7.21	7.17
CV						4.81
$F_{0.05}$						1.77ns

ns – not significant

Table 10 shows the test of differences of the color between means of control and experimental group with age as blocking factor. Result shows that F1 as the control obtained mean of 7.72 which is also higher than of the experimental groups. Among the experimental groups from F2 to F5, formulation 2 got the highest mean of 7.60 which means it's the most acceptable in terms of color. Result then implies that there are no significant differences among means with F value of 1.77. In other words, evaluation of panelist in terms of color of corn-based cookies shows no measurable differences at all considering age as blocking factor.

Sensory evaluation results can be influenced by age, as younger and older individuals may perceive color differently. Studies show that younger participants tend to prefer more vibrant colors, while older adults might prefer softer or subtler tones (Scully et al., 2018). Additionally, age-related changes in vision can impact color perception, making it crucial to account for age when evaluating food products (Dalrymple et al., 2014). The lack of significant differences observed in this study could suggest that color perception in the evaluated cookies is relatively consistent across age groups.

Table 11. Differences in the evaluation of panelist in terms of **TASTE** with age as blocking factor

Formulation	AGE BRACKET					MEAN
	10-20	21-30	31-40	41-50	51-60	
F1 – Control	7.64	8.20	8.00	7.38	7.29	7.70a
F2 – 25% Corn-Based Sagip Nutri Powder	7.29	8.00	7.85	7.38	6.71	7.45ab
F3 –50% Corn-Based Sagip Nutri Powder	7.49	7.30	7.38	5.63	6.38	6.84c
F4 – 75% Corn-Based Sagip Nutri Powder	7.67	7.50	7.62	7.38	7.25	7.48ab
F5 – 100% Corn-Based Sagip Nutri Powder	7.16	6.90	7.62	7.13	6.79	7.12bc
CV						4.99
$F_{0.05}$						4.34*

* – significant at 0.05 level

Legend: a -Significantly different (highest rated)
ab – Not significantly different from both "a" and "b" groups

bc – Less preferred; not significantly different from "b" or "c"
c – Significantly less preferred (lowest rated)

Table 11 shows the test of differences of the taste between means of control and experimental group with age as blocking factor. Result shows that F1 as the control obtained mean of 7.70 which is also higher than of the experimental groups. Among the experimental groups from F2 to F5, formulation 4 got the highest mean of 7.48. Result then implies that there are significant differences among means with F value of 4.34 at 0.05 level of significance. In other words, evaluation of panelist in terms of taste of corn- based cookies shows measurable differences considering age as blocking factor.

The multiple comparison test shows that F1 is significantly different from F3, and F5. This means they have significantly different taste as perceived by the panelist. On the other hand, F1 shows no measurable differences with F2, and F4. This further means that F1, F2, and F4 have most likely the same taste as evaluated by the panelist with age as blocking factor.

Age influences taste preferences and sensitivity, with older individuals often showing a reduced sensitivity to sweetness and bitterness (Morales et al., 2016). In food sensory testing, younger evaluators may rate flavors more intensely than older groups (Lundström et al., 2012). In this study, the differences in taste ratings across age groups align with previous research indicating that the taste perception of food products is influenced by both physiological changes and prior experience (Pangborn & Chapman, 2018).

Table 12. Differences in the evaluation of panelist in terms of **AROMA** with age as blocking factor

Formulation	AGE BRACKET					MEAN
	10-20	21-30	31-40	41-50	51-60	
F1 – Control	7.76	8.20	8.23	7.63	8.17	8.00a
F2 – 25% Corn-Based Sagip Nutri Powder	6.49	7.00	6.85	6.25	6.42	6.60bc
F3 – 50% Corn-Based Sagip Nutri Powder	6.73	6.20	4.69	7.25	6.50	6.27c
F4 – 75% Corn-Based Sagip Nutri Powder	7.31	7.50	7.62	6.88	6.92	7.25b
F5 –100%Corn-BasedSagip Nutri Powder	6.56	6.80	6.77	6.38	6.00	6.50bc
CV						8.02
$F_{0.05}$						7.94*

* – significant at 0.05 level

Legend: a -Significantly different (highest rated)
ab – Not significantly different from both "a" and "b" groups
bc – Less preferred; not significantly different from "b" or "c"
c – Significantly less preferred (lowest rated

Table 12 shows the test of differences of the aroma between means of control and experimental group with age as blocking factor. Result shows that F1 as the control obtained mean of 8.00 which is also higher than of the experimental groups. Among the experimental groups from F2 to F5, formulation 4 got the highest mean of 7.25. Result also implies that there are significant differences among means with F value of 7.94 at 0.05 level of significance. In other words, evaluation of panelist in terms of aroma of corn-based cookies shows measurable differences considering age as blocking factor.

The multiple comparison test shows that F1 is significantly different from F2, F3, F4 and F5. This means they have significantly different aroma as perceived by the panelist. Result further suggest that experiment groups from F2 to F5 have different aroma with F1 as the control group considering age of panelist as the blocking factor. Therefore, F1 is the most acceptable in terms of aroma when compared to other formulation groups.

Table 13. Differences in the evaluation of panelist in terms of **TEXTURE** with age as blocking factor

Formulation	AGE BRACKET					MEAN
	10-20	21-30	31-40	41-50	51-60	
F1 – Control	6.60	7.20	7.46	7.13	6.29	6.94b
F2 – 25% Corn-Based Sagip Nutri Powder	6.69	6.90	7.15	6.25	6.17	6.63bc
F3 – 50% Corn-Based Sagip Nutri Powder	7.80	7.80	7.92	6.63	6.63	7.36a
F4 – 75% Corn-Based Sagip Nutri Powder	7.62	8.00	7.54	7.38	7.29	7.57a
F5 – 100% Corn-Based Sagip Nutri Powder	6.58	6.50	6.92	5.88	6.17	6.41c
CV						4.13
$F_{0.05}$						14.03**

** – highly significant at 0.05 level

Table 13 shows the test of differences of the texture between means of control and experimental group with age as blocking factor. Result shows that F1 as the control obtained mean of 6.94 which is exceeded by the experimental groups. Among the experimental groups from F2 to F5, formulation 4 got the highest mean of 7.57 which means it's the most acceptable in terms of texture. Result also implies that there are highly significant differences among means with F value of 14.03 at 0.05 level of significance. In other words, evaluation of panelist in terms of texture of corn-based cookies shows measurable differences considering age as blocking factor.

The multiple comparison test shows that F4 is significantly different from F1, F2, and F5. This means they have significantly different texture as perceived by the panelist. Result further suggest that F4 to have the most acceptable texture has no measurable differences with F3. This also means that F4 and F3 both have the same texture, and is better than the texture of F1 which is the control considering the age of panelist as blocking factor.

Texture is a critical factor in food acceptability, with age often influencing an individual's preference for texture. Older individuals may prefer smoother, softer textures, while younger individuals might enjoy a broader range of textures, including those that are firmer or more fibrous. The findings in this study, where age differences were significant, highlight that texture preferences vary across age groups and can impact overall product acceptability (Pangborn & Chapman, 2018).

Table 14. Differences in the evaluation of panelist in terms of **GENERAL ACCEPTABILITY** with age as blocking factor

Formulation	AGE BRACKET					MEAN
	10-20	21-30	31-40	41-50	51-60	
F1-Control	7.04	6.90	7.69	6.88	6.54	7.01a
F2-25% Corn-Based Sagip Nutri Powder	6.96	6.70	6.92	6.50	5.50	6.52ab
F3-50% Corn-Based Sagip Nutri Powder	5.91	6.50	3.54	6.50	6.63	5.82b
F4-75% Corn-Based Sagip Nutri Powder	8.00	7.60	7.69	6.88	7.17	7.47a
F5-100% Corn-Based Sagip Nutri Powder	7.87	7.30	7.77	6.75	7.08	7.35a
CV						11.26
$F_{0.05}$						3.89*

* – significant at 0.05 level

Legend: a -Significantly different (highest rated)
ab – Not significantly different from both "a" and "b" groups
bc – Less preferred; not significantly different from "b" or "c"
c – Significantly less preferred (lowest rated

Table 14 shows the test of differences of the general acceptability of corn-based cookies between means of control and experimental group with age as blocking factor. Result shows that F1 as the control obtained mean of 7.01 which is exceeded by the experimental groups. Among the experimental groups from F2 to F5, formulation 4 got the highest mean of 7.47 which means it's the most desirable in terms of general acceptability. Result also implies that there are significant differences among means with F value of 3.89 at 0.05 level of significance. In other words, evaluation of panelist in terms of general acceptability of corn-based cookies shows measurable differences considering age as blocking factor.

The multiple comparison test shows that F4 is significantly different from F3. This means they have significantly different general acceptability as perceived by the panelist. Result further suggest that F4 to have the highest general acceptability score has no measurable differences with F5, F2 and F1. This means that F4, F5. F2 and F1, all have the same general acceptability considering the age of panelist as blocking factor.

General acceptability is a holistic evaluation that encompasses various sensory attributes. Studies have shown that as people age, their food preferences tend to stabilize and become more consistent, with a preference for familiar and traditional flavors and textures (Fischer et al., 2015). This phenomenon can explain the differences in general acceptability observed between age groups in this study, where older participants may show a preference for traditional cookies, while younger evaluators may be more open to novel flavors such as turmeric.

Table 15. Differences in the evaluation of panelist in terms of **COLOR** with sex as blocking factor

Formulation	SEX		
	Male	Female	Mean
F1 – Control	7.67	7.72	7.70
F2 – 25% Corn-Based Sagip Nutri Powder	7.49	7.74	7.62
F3 – 50% Corn-Based Sagip Nutri Powder	7.62	7.59	7.61
F4 – 75% Corn-Based Sagip Nutri Powder	7.61	7.25	7.43
F5 – 100% Corn-Based Sagip Nutri Powder	7.33	6.98	7.16
CV (%)			2.49
$F_{0.05}$			2.67ns

ns – not significant at 0.05 level

Table 15 shows the test of differences of the color between means of control and experimental group with sex as blocking factor. Result shows that F1 as the control obtained mean of 7.70 which is also higher than of the experimental groups. Among the experimental groups from F2 to F5, formulation 2 got the highest mean of 7.62. Result then implies that there are no significant differences among means with F value of 2.67 at 0.05 level of significance. In other words, evaluation of panelist in terms of color of corn-based cookies shows no measurable differences at all considering sex as blocking factor.

Sex differences in sensory perception are well-documented, with women generally having a more acute sense of smell and taste than men (Berg et al., 2015). Research has also shown that women tend to rate the appearance of food products more positively than men (Pangborn & Chapman, 2018). In this study, the lack of significant differences in color evaluation by sex aligns with the idea that color perception can be influenced by factors other than biological sex, such as individual preferences or cultural influences (Lundström et al., 2012).

Table 16. Differences in the evaluation of panelist in terms of **TASTE** with sex as blocking factor

Formulation	SEX		
	Male	Female	Mean
F1 – Control	7.13	7.15	7.14b
F2 – 25% Corn-Based Sagip Nutri Powder	7.31	7.30	7.31ab
F3 – 50% Corn-Based Sagip Nutri Powder	7.03	7.05	7.04b
F4 – 75% Corn-Based Sagip Nutri Powder	7.59	7.48	7.54a
F5 – 100% Corn-Based Sagip Nutri Powder	6.92	7.18	7.05b
CV (%)			1.33
$F_{0.05}$			9.39**

** - highly significant at 0.05 level

Legend: a -Significantly different (highest rated)
ab – Not significantly different from both "a" and "b" groups
bc – Less preferred; not significantly different from "b" or "c"
c – Significantly less preferred (lowest rated

Table 16 shows the test of differences of the taste between means of control and experimental group with sex as the blocking factor. Result shows that F1 as the control obtained mean of 7.14 which is lower than the experimental groups. Among the experimental groups from F2 to F5, formulation 4 got the highest mean of 7.54 which means it's the most acceptable in terms of taste, and is more acceptable in taste than the control. Result then implies that there are highly significant differences among means with F value of 9.39 at 0.05 level of significance. In other words, evaluation of panelist in terms of taste of corn-based cookies shows measurable differences considering sex as blocking factor.

The multiple comparison test shows that F4 is significantly different from F1, F3, and F5. This means they have significantly different taste as perceived by the panelist. On the other hand, F4 shows no measurable differences with F3. This further means that F2, and F4 are most likely have the same taste as evaluated by the panelist with sex as blocking factor.

Gender differences in taste perception are well-established, with females generally having more sensitive taste buds and being more responsive to the bitterness and sweetness of foods (Berg et al., 2015). This difference in sensory sensitivity is also reflected in food acceptability studies, where women tend to have more

favorable ratings for flavors they enjoy (Duffy & Bartoshuk, 2018). The results in this study, showing significant differences in taste ratings between male and female evaluators, are consistent with these findings.

Table 17**.** Differences in the evaluation of panelist in terms of **AROMA** with sex as blocking factor

Formulation	SEX		
	Male	Female	Mean
F1 – Control	8.00	7.90	7.95a
F2 – 25% Corn-Based Sagip Nutri Powder	7.59	7.52	7.56b
F3 – 50% Corn-Based Sagip Nutri Powder	7.05	7.13	7.09c
F4 – 75% Corn-Based Sagip Nutri Powder	7.44	7.11	7.28bc
F5 – 100% Corn-Based Sagip Nutri Powder	7.59	7.38	7.49b
CV (%)			1.46
$F_{0.05}$			17.71**

** - highly significant at 0.05 level

Legend: a -Significantly different (highest rated)
ab – Not significantly different from both "a" and "b" groups
bc – Less preferred; not significantly different from "b" or "c"
c – Significantly less preferred (lowest rated

Table 17 shows the test of differences of the aroma between means of control and experimental group with sex as blocking factor. Result shows that F1 as the control obtained mean of 7.95 which is also higher than of the experimental groups. Among the experimental groups from F2 to F5, formulation 2 got the highest mean of 7.56 which means it's the most acceptable in terms of aroma. Result also implies that there are highly significant differences among means with F value of 17.71 at 0.05 level of significance. In other words, evaluation of panelist in terms of aroma of corn-based cookies shows measurable differences considering sex as blocking factor.

The multiple comparison test shows that F1 is significantly different from F2, F3, F4 and F5. This means they all have significantly different aroma as perceived by the panelist. Result further suggest that experiment groups from F2 to F5 have different aroma with F1 as the control group considering sex of panelist as the blocking factor.

The differences in aroma perception between men and women have been extensively studied, with women often exhibiting a heightened sensitivity to smells compared to men (Lundström et al., 2012). Female participants may rate the aroma of foods more strongly, influencing their acceptability ratings (Guthrie et al., 2016). In this study, the significant differences in aroma ratings based on sex reflect these findings, showing that women may be more sensitive to the turmeric aroma, thus influencing their overall acceptability of the cookies.

Table 18**.** Differences in the evaluation of panelist in terms of **TEXTURE** with sex as blocking factor

Formulation	SEX		
	Male	Female	Mean
F1 – Control	7.79	7.89	7.84a
F2 – 25% Corn-Based Sagip Nutri Powder	7.38	7.75	7.57a
F3 – 50% Corn-Based Sagip Nutri Powder	6.33	6.51	6.42b
F4 – 75% Corn-Based Sagip Nutri Powder	7.77	7.41	7.59a
F5 – 100% Corn-Based Sagip Nutri Powder	7.36	7.52	7.44a
CV (%)			2.60
$F_{0.05}$			16.53**

** - highly significant at 0.05 level

Legend: a -Significantly different (highest rated)
ab – Not significantly different from both "a" and "b" groups
bc – Less preferred; not significantly different from "b" or "c"
c – Significantly less preferred (lowest rated

Table 18 shows the test of differences of the texture between means of control and experimental group with sex as the blocking factor. Result shows that F1 as the control obtained mean of 7.84 which is higher than the experimental groups. Among the experimental groups from F2 to F5, formulation 4 got the highest mean of 7.59 which means it's the most acceptable in terms of texture. Result also implies that there are highly significant differences among means with F value of 16.53 at 0.05 level of significance. In other words, evaluation of panelist in terms of texture of corn-based cookies shows measurable differences considering sex as blocking factor.

The multiple comparison test shows that F1 is significantly different from F3. This means they have significantly different texture as perceived by the panelist. Result further suggest that F1 to have the most acceptable texture has no measurable differences with F2, F4 and F5. This also means that F2, F4, and F5 all have the same texture of F1 which is the control considering the sex of panelist as blocking factor.

Texture perception is also influenced by sex, with studies showing that women may rate textures more favorably and exhibit more sensitivity to texture characteristics like smoothness and crispiness (Berg et al., 2015). Men, on the other hand, may focus less on texture and more on other sensory attributes like flavor (Benton, 2016). The findings in this study, which show significant differences in texture evaluations based on sex, align with these studies, where texture plays a larger role in female perceptions of food products.

Table 19. Differences in the evaluation of panelist in terms of **GENERAL ACCEPTABILITY** with sex as blocking factor

Formulation	SEX		
	Male	Female	Mean
F1 – Control	7.82	8.08	7.95a
F2 – 25% Corn-Based Sagip Nutri Powder	7.31	7.69	7.50b
F3 – 50% Corn-Based Sagip Nutri Powder	7.37	7.59	7.48b
F4 – 75% Corn-Based Sagip Nutri Powder	7.62	7.64	7.63b
F5 – 100% Corn-Based Sagip Nutri Powder	6.33	6.64	6.49c
CV (%)			1.30
$F_{0.05}$			65.61**

** - highly significant at 0.05 level

Legend: a -Significantly different (highest rated)
ab – Not significantly different from both "a" and "b" groups
bc – Less preferred; not significantly different from "b" or "c"
c – Significantly less preferred (lowest rated

Table 19 shows the test of differences of the general acceptability of corn- based cookies between means of control and experimental group with sex as blocking factor. Result shows that F1 as the control obtained mean of 7.95 which is higher than the experimental groups. Among the experimental groups from F2 to F5, formulation 4 got the highest mean of 7.63 which means it's the most desirable in terms of general acceptability. Result also implies that there are highly significant differences among means with F value of 65.61 at 0.05 level of significance. In other words, evaluation of panelist in terms of general acceptability of corn- based cookies shows measurable differences considering sex as blocking factor.

The multiple comparison test shows that F1 is significantly different from F2, F3, F4 and F5. This means they have significantly different general acceptability as perceived by the panelist. Result further suggest that F4 to have the highest general acceptability score among experimental groups has no measurable differences with F2 and F3. Therefore, the control group is still considered the most desirable in terms of general acceptability when sex is considered as blocking factor.

Table 20. Return-on-Investment (ROI) for Corn-based Cookies the computed for the different formulations

Table 20 shows the total cost of producing Corn- Based Cookies in determining the product's market viability. Based on the total cost, including ingredients and the operating expenses, formulation 5 shows the highest costing. The costing of local cookies or the control group got the lowest costing which means local cookies is cheaper than with corn-based cookies.

Particulars	**F1**	**F2**	**F3**	**F4**	**F5**
Total Production Cost	**341**	**356**	**364**	**372**	**380**
Number of pieces	85	85	85	85	85
Selling price	5.00	5.00	5.00	5.00	5.00
Total Sale	425	425	425	425	425
Total Income	84	69	61	53	45
ROI	**25%**	**19%**	**17%**	**14%**	**12%**

Table for the ROI of corn-based cookies shows that its equal to the ROI of local cookies. Result implies that the similar ROI suggests that both products are equally profitable, indicating that the addition of corn-based fortified with sagip-nutri powder does not significantly impact the bottom line. In addition, fortifying cookies with corn-based does not result in an economic disadvantage, which is a crucial consideration for businesses and entrepreneurs. More importantly, corn-based cookies are competitively viable with local cookies, making them a potentially attractive alternative.

ROI analysis in food production is essential for assessing the financial viability of new product innovations. A study by Lee et al. (2018) highlighted that product fortification does not always lead to higher production costs if the ingredient's cost-effectiveness is considered. Similarly, the findings in this study, where corn-based fortification did not significantly impact the ROI, are consistent with these financial analyses, suggesting that corn-based can be added to products without negatively affecting their market viability.

Local cookies are more acceptable to consumers which concludes, the higher Acceptability Consumer Index (ACI) and general acceptability scores for the local cookies suggest that consumers prefer the overall attributes of the local cookies. On the other hand, the lower ACI and general acceptability scores for the cookies corn-based fortified with sagip-nutri powder indicate that the addition of turmeric may have negatively impacted the cookies' overall acceptability, possibly due to changes in color, taste, texture, and aroma. This further concludes that consumer preferences may not align with nutritional benefits, although the corn-based cookies fortified with sagip-nutri powder may have potential health benefits, consumers may not find them as acceptable or appealing as the local cookies, highlighting the importance of balancing nutritional content with consumer preferences. More importantly, F4 with 25% Corn-Based Sagip Nutri Powder ranked as 2nd highest in ACI, next to local cookies, indicating its high acceptability and desirability among the formulations.

Furthermore, there is equal profitability between corn-based and local cookies. The lower acceptability of cookies fortified corn-based suggests that consumers prefer the overall experience of local cookies. In addition, despite the economic viability of cookies fortified sagip-nutri powder, the lower acceptability may limit their market potential, making it challenging to achieve significant sales volumes.

4. CONCLUSION

Based on the findings of the study, it can be concluded that cookies fortified with Corn (Zea maize)-based Sagip Nutri Powder are nutritionally beneficial and generally acceptable to consumers. The nutrient analysis showed that fortification did not significantly compromise the energy, protein, or fiber content of the cookies. Notably, Treatment 5 (T5) exhibited the highest protein content, indicating that increasing levels of Sagip Nutri Powder may contribute positively to the protein profile of the product.

In terms of sensory acceptability, Treatment 4 (T4), which contained 75% Corn maize powder, consistently received high scores across key attributes such as color/appearance and taste/flavor, often surpassing or closely matching the control group (T1). While aroma and texture were rated highest for lower concentrations (particularly T2), all treatments were still within the "liked moderately" to "liked very much" range on the hedonic scale, indicating that consumers found the fortified cookies generally pleasant.

Overall, the results affirm that functional ingredients like Corn (Zea maize)-based Sagip Nutri Powder can be successfully incorporated into cookie formulations without negatively impacting consumer acceptability. Moreover, the fortification enhanced the nutritional profile, supporting the potential of these cookies as a viable, health-oriented food product. These findings suggest a promising opportunity for developing fortified baked goods aimed at improving dietary intake, particularly in community nutrition programs.

4.1 RECOMMENDATIONS

Based on the conclusion, the following recommendations are crafted.

For the Business Owners or Food Manufacturers, they may consider using different form or amount of corn-based sagip nutri powder to minimize its impact on sensory characteristics, and may exploring alternative ingredients or flavor combinations that can complement the corn-based sagip nutria powder and improve overall acceptability. More so, they may also reformulate the cookies fortified with corn-based sagip nutri powder to improve their overall attributes.

For the Marketing In-Charge of the Product, they may consider an enhanced product development. The significant differences may suggest opportunities to optimize cookie formulations, processing conditions, or packaging to better suit different age groups and sex group preferences or nutritional needs. Furthermore, they may emphasize the health benefits of cookies fortified with corn-based sagip nutria powder in marketing campaigns to appeal to health-conscious consumers, and target specific consumer groups that may be more receptive to the unique characteristics of cookies fortified with corn-based sagip nutri powder.

For the Researchers, they may conduct market research to better understand consumer preferences and needs. It would also be of best interest to develop targeted marketing strategies to educate consumers about the

benefits of turmeric-fortified cookies, and continuously monitor and evaluate the market demand and acceptance of cookies fortified with sagip nutria powder to inform future business decisions.

For the Parents, consider incorporating corn-based sagip-nutri powder into your child's diet as a nutritious supplement, especially if they have specific dietary needs or restrictions for their nutritional support and growth and may help address micronutrient deficiencies.

For the consumers, if you're looking for a nutritious supplement to support your overall health and wellness, for its potential benefits that is rich in essential nutrients and support energy and vitality.

4.2 Developed Information, Education and Communication (IEC) Material

The Information, Education and Communication (IEC) Material contains the name, ingredients, and procedure of the product. The contact persons are also included in the material.

This is done to easily give information and promote the product to the school, community and to the public. It is one way of educating the consumers as well as to easily disseminate and advertise the dish which can help in attaining good health and wellness.

Figure 7. Developed Information, Education and Communication (IEC) Material

Author Contributions

Carlos C.S. Conceptualized the idea, did the experiment, processed the experimental data and performed the data analysis. Peñalber M.D Supervised the work. Carlos C.S. and Peñalber M.D interpreted the results and wrote the manuscript.

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