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Utilization of Unwanted Weed, Paragis Leaves (*Eleusine indica* Linn.) in Cookie Production

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ABSTRACT

Paragis is a common grass which is abundant and can be seen everywhere but is regarded as having no economic value. To add value to this grass, the study generally aimed to formulate cookies with powdered *paragis* leaves and mashed bananas; and specifically, it aimed to evaluate the sensory quality of the product. A 3 x 3 factorial design was used, with three levels for both powdered *paragis* leaves (0, 5, 10 % w/w) and mashed bananas (0, 15, 20 % w/w). Sensory evaluation was done to determine the product's acceptability in terms of color, taste, aroma, texture, and flavor using a sensory panel. Acceptability ratings were subjected to response surface regression analysis using STATISTICA software. Results revealed that the combination of powdered *paragis* leaves and mashed bananas showed a significant effect on the color, aroma, texture, taste, flavor, and general acceptability of the product. The optimum combination was 8.8 % and 1.3 to 1.8% of mashed bananas and powdered *paragis* leaves, respectively, based on the volume of flour. It can be concluded that *paragis* leaves could be utilized in cookie production, providing potential value to this unwanted commodity using the optimum combination.

Keywords: *paragis leaves, cookie production, banana, optimization*

INTRODUCTION

Paragis, also known as wiregrass, dog's tail, or goosegrass has a scientific name of *Eleusine indica* (L.) Gaertn (Garcia et al., 2003; Pizon et al., 2016; Amoah et al., 2017). This grass is abundant and can be seen everywhere, but are regarded as having no economic value. It is only utilized as carabao's food, but not until recently that the grass hit high popularity in social media, saying that it may offer health-beneficial components, and it is believed to cure illnesses potentially. According to the reports, Paragis indeed possesses many medicinal properties. It is believed to have a diuretic effect (Gruyal et al., 2014), antiurolithiatic effect (Amoah et al., 2017), antihelmintic activity (Morah & Otuk, 2015), antibacterial activity (Al-Zubaire et al., 2011; Mora & Otuk, 2015), antidiabetic effect (Garcia et al., 2003; Okokon et al., 2010), antifungal activity (Alaekwe et al., 2015), antiplasmodial effect (Okokon et al., 2010), antioxidant activity (Al-Zubairi et al., 2011; Iqbal & Gnanaraj, 2012), and antihypertensive activity (Tutor & Chichioco-Hernandez, 2018). It could also be used against airway inflammatory processes like influenza and pneumonia, according to De Melo et al. (2005). The hepaprotective effect (Iqbal & Gnanaraj, 2012) and pharmaceutical action of E. *indica* were reported to have been due to the generous supply of phytochemicals and antioxidants. The grass contains alkaloids, flavonoids, cardiac glycosides, tannins, and saponins (Okokon et al., 2010; Gbadamosi, 2012; Alaekwe et al., 2015; Morah & Otuk, 2015; Etta et al., 2019). Acidic compounds, anthraquinones, and terpenes were likewise observed in E. indica extracts (Alaekwe et al., 2015; Mora & Otuk, 2015; Okokon et al., 2010). According to Gbadamosi (2012), this botanical plant, among others, supports increased energy and nutritional requirements in pregnancy, prevent malnutrition, and supplements phytochemicals in therapeutic activities. Moreover, safety in the administration of the weed was confirmed through toxicological studies of the plants (Gbadamosi, 2012), aside from the fact that it has been extensively used in traditional and herbal medicine applications in various countries, and possibly be included in general medical practice (Al-Zubairi et al., 2011). The potential of paragis in pharmaceutical and medical importance, therefore, cannot be discounted. As a commodity that is locally available and abundant here in Leyte and anywhere in the Philippines, and the neighboring countries, it calls for creating value to this disregarded grass. Hence, the development of a high-value product such as cookies that are incorporated with it.

Cookies are convenient and comfort food not only for children but for growing adults as well. One common dietary problem associated with children is the reduced or limited dietary fiber intake due to opting for foods from highly popular fast food chains. Incorporating high fiber such as *paragis* leaves into snack items may, therefore help achieve the recommended dietary fiber intake of these picky children. *Paragis* grass can contribute to about 21.57% to 29.17% of crude fiber (Garcia et al., 2003; Morah & Otuk, 2015; Suwignyo et al., 2017), to as high as

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64% as reported by Jackson et al. (1996), with digestibility coefficient of 69.6 (Regmi et al., 2004). Furthermore, macro and microminerals were reported present in paragis grass (Serra et al., 1997; Gbadamosi, 2012); among which are Co, Cu, Fe, Ca, K, Mg, Na, P. But incorporating grass in foods expectedly could impart undesirable taste and aftertaste in the product. Hence, the need to mask these undesirable traits with flavorful components. One common and effectively-known flavorant in the bakery industry is banana.

Banana is a type of fruit from herbaceous plants of the genus *Musa*. It is utilized in foods, rope, fiber, paper, placemats, hair softener, mats, medicines, and textiles production (Kumar et al., 2012). It has good nutritional value (fiber, fat, protein, ash, carbohydrate) according to Menezes et al. (2011), Odenigbo et al. (2013), and Ashokkumar et al. (2018); and are highly desirable in the diet because it imparts positive effects to human health (Singh et al., 2016). The medicinal application of banana includes antifungal and antibiotic activity, reduction of risk to high blood pressure and kidney stones, and cholesterol-lowering properties (Kumar et al., 2012). This crop is also a valuable source of vitamin B6, vitamin C, and potassium (Singh et al., 2016; Ashokkumar et al., 2018). Adeyemi and Oladiji (2009) reported that the crop could contain 0.271, 0.886, and 326.70% of Zn, Mn, and Mg, respectively. Like *paragis*, banana also contains several bioactive antioxidant compounds, namely phenolics, carotenoids, biogenic amines, and phytosterols (Singh et al., 2016). Aside from beneficial components, the leading reason banana is widely utilized in the bakery industry is its flavor. Most components in it are alipathic esters, alcohols, and carbonyls (Tressel & Drawert, 1973), specifically iso-amyl acetate (Rao et al., 2018), which contributes widely to the desirable sensory attributes of cakes, cookies, and other pastries.

Although banana has been used extensively in cookies, the right combination of *paragis* leaves and banana is yet to be determined to attain the optimum sensory quality of the product. It is given that raw materials may contribute a significant effect on the quality of manufactured products. In cookies, the substitution of cashew-apple residue (Ebere et al., 2015), dried *moringa* leaves (Dachana et al., 2010; Abdel-Samie & Abdulla, 2014; Emelike et al., 2015; Mouminah, 2015), cladodes (Msaddak et al., 2015), and composite flour made from cassava, soybean, and mango (Chinma & Gernah, 2007) to wheat flour had a significant effect on the sensory qualities of the product. Aduana (2019) also reported that the addition of giant swamp taro flour significantly affected the color and general acceptability of the product but noted no significant effect on texture, flavor, and taste acceptability. Many of these studies established the limitation of the levels of substitution and incorporation in cookies because it was observed that these commodities had an adverse effect on the quality of the product. Hence, this study was undertaken to determine specifically the effect of *paragis* powder and banana flesh on the sensory quality of cookies.

METHODOLOGY

Procurement of Raw Materials

The paragis leaves were collected within the Visayas State University (VSU) grounds, while banana and the other ingredients such as all-purpose flour, eggs, sugar, baking powder, and butter were purchased at the Baybay Public Market, Baybay City, Leyte.

Preparation of Raw Materials

The paragis leaves were inspected and sorted. Wilted leaves were removed and trashed. The good quality leaves were washed and sanitized with ten ppm chlorinated water. Then, the leaves were placed in clean drying aluminum trays and dried at 60-70^{o}C for 8 hrs in a mechanical dryer. Dried *paragis* leaves were allowed to cool first, then milled and powdered using pulverizer (High-speed Multi-function Comminutor).

Bananas, on the other hand, were inspected and sorted. Ripe and good quality ones were used. It was washed with clean potable water, removing all adhering soil on the skin. Then, it was blanched at 87^{0}C for 5 minutes. The peels were carefully removed by hand, while the flesh was homogenized using an Osterizer until it became a creamy mash.

Processing of Cookies

Powdered *paragis* leaves and mashed bananas were measured and prepared according to the level specified in each treatment. The calculation was based on the weight of all-purpose flour (100 g).

Baking soda (1/4 tsp), powdered *paragis* leaves, and all-purpose flour (100g) were sifted and combined. Butter (25 g) was then creamed smoothly in another mixing bowl. Sugar (½ cup) was gradually added until the mixture became pale and creamy. Mashed bananas were added next. An egg was cracked and mixed onto the batter to combine. The dry ingredients were then added to the wet ingredients and were mixed (folding-in) using a spatula. A tablespoon of batter was scooped out, placed on a baking sheet, and then baked at 120^{o}C for 30 minutes. The freshly baked product was removed from the oven and was cooled at room temperature. It was then packed in polyethylene bags ready for evaluation.

Experimental Design

A 3 x 3 factorial experiment arranged in Completely Randomized Design (CRD) was used in the study. Three combinations of powdered *paragis* leaves and mashed bananas were used with two replications (Table 1).

Table 1

Different Levels of Mashed Banana and Powdered paragis Leaves in Cookies

TREATMENT (TRT)	PARAGIS POWDER (%)	BANANA FLESH (%)
T_1	0	0
T_2	0	15
T_3	0	20
T_4	5	0
T_5	5	15
T_6	5	20
T_7	10	0
T_8	10	15
T_9	10	20

Sensory Evaluation

The acceptability of the product was evaluated in terms of color, aroma, taste, flavor, texture, and general acceptability using the 9-point Hedonic Rating Scale with scores of 1 to 9 corresponding to 'dislike extremely' and 'like extremely,' respectively. Descriptive scores of the samples were also determined. The samples were randomly coded with 3-digit numbers and were evaluated by 48 panelists composed of junior and senior BS Food Technology students. An Incomplete Block Design (IBD) laid out by Cochran and Cox (1957) was used in carrying out the sensory evaluation. The set plan of t=9, k=6, r= 8, b=12, E=0.94 Type II was followed, where t refers to the number of treatments, k as the number of samples to be presented to the panelist, r the number of replications based on the plan IBD, b the number of blocks, and E the efficiency factor.

Optimization

The sensory acceptability scores were used to make contour plots of the response studied. The optimum combination of powdered paragis leaves and mashed bananas was generated considering the mean acceptability level of 7.5 for all sensory attributes. The contour plots were superimposed to get the optimum combination of the independent variables studied.

Verification

The model's predictive ability was determined using a test sample taken from the inside of the optimum region and another from the outside region. These samples were processed following the same procedure done in the experimental set-up. Sensory evaluation was done by 32 panelists composed of BS Food Technology students. Predicted values were computed based on the equation generated by the software. A paired t-test was used to determine if there was a significant difference between the actual and predicted values.

Statistical Analysis

Results of the sensory evaluation were subjected to Response Surface Regression Analysis using STATISTICA software to determine the effects of independent variables on the sensory attributes of the product. Response surface plots were made in all parameters evaluated to visualize the different effects of the factor variables on the responses studied. Analysis of variance and parameter estimates were done to describe the regression models of each attribute. Plots were superimposed, and optimum conditions were determined.

RESULTS AND DISCUSSION

Effect on Color

Color is vital to attract consumers before they consume the product (Francis, 1991). In this study, the cookies' color ranges from 'light brown to dark green' (Table 2). In the absence of powdered *paragis* leaves and mashed bananas, the cookies' color was perceived as 'light brown.' Table 2 shows that increasing the amount of powdered *paragis* leaves to 10 % and 20% for mashed bananas, the product's color intensified and was described as 'dark green'. This is due to the chlorophyll content of *paragis* leaves (Chen et al., 2014).

Table 3 displays the overall mean color acceptability of the cookies, 7.323 that falls under the 'like moderately' category in the 9- Point Hedonic Scale. Response Surface Regression Analysis shows that the color acceptability of the cookies was significantly affected by the linear terms of powdered *paragis* leaves (Table 4). It reveals that a unit increase in the level of powdered *paragis* leaves results in a decrease in color acceptability by 0.894. Figure 1(a) illustrates that high acceptability ratings are oriented towards low levels of powdered *paragis* leaves. A similar trend was recorded by Aduana (2019), Dachana et al. (2010), and Ebere, et al. (2015), in cookies made from giant swamp taro powder, cladodes powder, and powdered cashew-apple fiber, respectively. Researchers like Abdel-Samie and Abdulla (2014), Emelike et al. (2015) and Msaddak et al. (2015), also observed the same in cookies added with *moringa* powder. Not only in cookies, El-Gammal et al. (2016) observed that crust and crumb color scores of pan bread decreased with increasing *moringa* leaves powder. According to Gustafson (2016), the color of baked products depends greatly on the ingredient used. Changes in the color are brought about by varying composition of raw materials that is mostly agricultural commodities. These commodities possess enzymes and components such as flavonoids and phenolics, which may affect desirable and undesirable changes in the product's color (Ho, 2014).

Effect on Aroma

The aroma is considered the most important of the three components of flavor (taste, smell and trigeminal effects) (Figoni, 2008). This parameter is aided by means of

Table 2

Summary of the Sensory Quality Descriptions of Cookies as Affected by the Different Levels of Powdered paragis Leaves and Mashed Banana Flesh

TRT	VARIABLES		SENSORY ATTRIBUTES				
	X_1 (%)	X_2 (%)	COLOR	AROMA	TEXTURE	FLAVOR	TASTE
1	0	0	Light brown	Absence of aroma	Crumbly	Strongly aroma butter	Just right
2	0	15	Brownish white	Slightly perceptible banana	Soft	Strongly perceptible banana flavor	Just right
3	0	20	Brownish white	Slightly perceptible banana	Soft	Strongly perceptible banana flavor	Sweet
4	5	0	Light green	Slightly perceptible to moderately perceptible *paragis*	Crumbly	Slightly to moderately perceptible *paragis* flavor	Slight bitter
5	5	15	Creamy green to light green	Well blended *paragis* and banana	Soft	Slightly to moderately perceptible *paragis* flavor	Just right
6	5	20	Creamy green to light green	Slightly perceptible to moderately perceptible *paragis*	Soft	Well blended *paragis* and banana flavor	Just right
7	10	0	Dark green	Slightly perceptible to moderately perceptible *paragis*	Soft	Moderately perceptible *paragis* flavor	Slightly bitter
8	10	15	Dark green	Slightly perceptible to moderately perceptible paragis	Very Soft	Slightly perceptible *paragis* flavor	Just right
9	10	20	Dark green	Well blended paragis and banana	Soft	Well blended *paragis* and banana flavor	Just right

TRT – treatment; X_1- powdered paragis leaves; X_2 – mashed banana

Table 3

Summary of Mean Sensory Acceptability Scores for paragis Cookies

TRT	VARIABLES		SENSORY ATTRIBUTES					
	X1 (%)	X2 (%)	COLOR	AROMA	TEXTURE	FLAVOR	TASTE	GENERAL ACCEPTABILITY
1	0	0	7.936	7.625	7.672	7.688	8.172	7.984
2	0	15	7.906	7.787	7.344	7.719	8.125	7.953
3	0	20	7.578	7.313	7.047	7.484	7.703	7.686
4	5	0	7.266	7.125	7.436	7.234	7.203	7.313
5	5	15	7.109	7.125	7.125	7.063	7.203	7.344
6	5	20	7.344	7.547	7.219	7.375	7.640	7.516
7	10	0	7.047	7.219	6.984	7.094	7.063	7.047
8	10	15	6.831	7.000	7.200	7.062	7.369	7.185
9	10	20	6.889	7.238	6.984	7.365	7.429	7.286
Over-all response mean			7.323	7.330	7.224	7.342	7.545	7.479

TRT-treatment; X1-powdered paragis leaves; X2- mashed banana n= 64; Values with the same letters are not significantly different from each other

9-point Hedonic range of score:

9- like extremely	7- like moderately	5-neither like nor dislike	3-dislike moderately	1-dislike extremely
8- like very much	6- like slightly	4-dislike slightly	2-dislike very much	

Table 4

Summary of Parametric Estimates for the Acceptability of all Sensory Attributes of the Cookies

	PARAMETRIC ESTIMATE					
PARAMETER	COLOR	AROMA	TEXTURE	FLAVOR	TASTE	GENERAL ACCEPTABILITY
Mean/Interc.	7.335*	7.326*	7.247*	7.337*	7.536*	7.475*
(1) *Paragis* (L)	-0.894*	-0.433*	-0.351*	-0.486*	-0.776*	-0.741*
Paragis (Q)	-0.125	-0.097	0.055	-0.178	-0.295*	-0.133
(2) Banana (L)	-0.146	0.043	-0.280*	0.069	0.112	0.048
Banana (Q)	-0.025	-0.053	0.070	-0.110	0.003	0.009
1L by 2L	0.049	0.069	0.325*	0.172	0.376*	0.231
R-squared	0.108	0.027	0.027	0.039	0.085	0.084

* - significant at $p < 0.05$

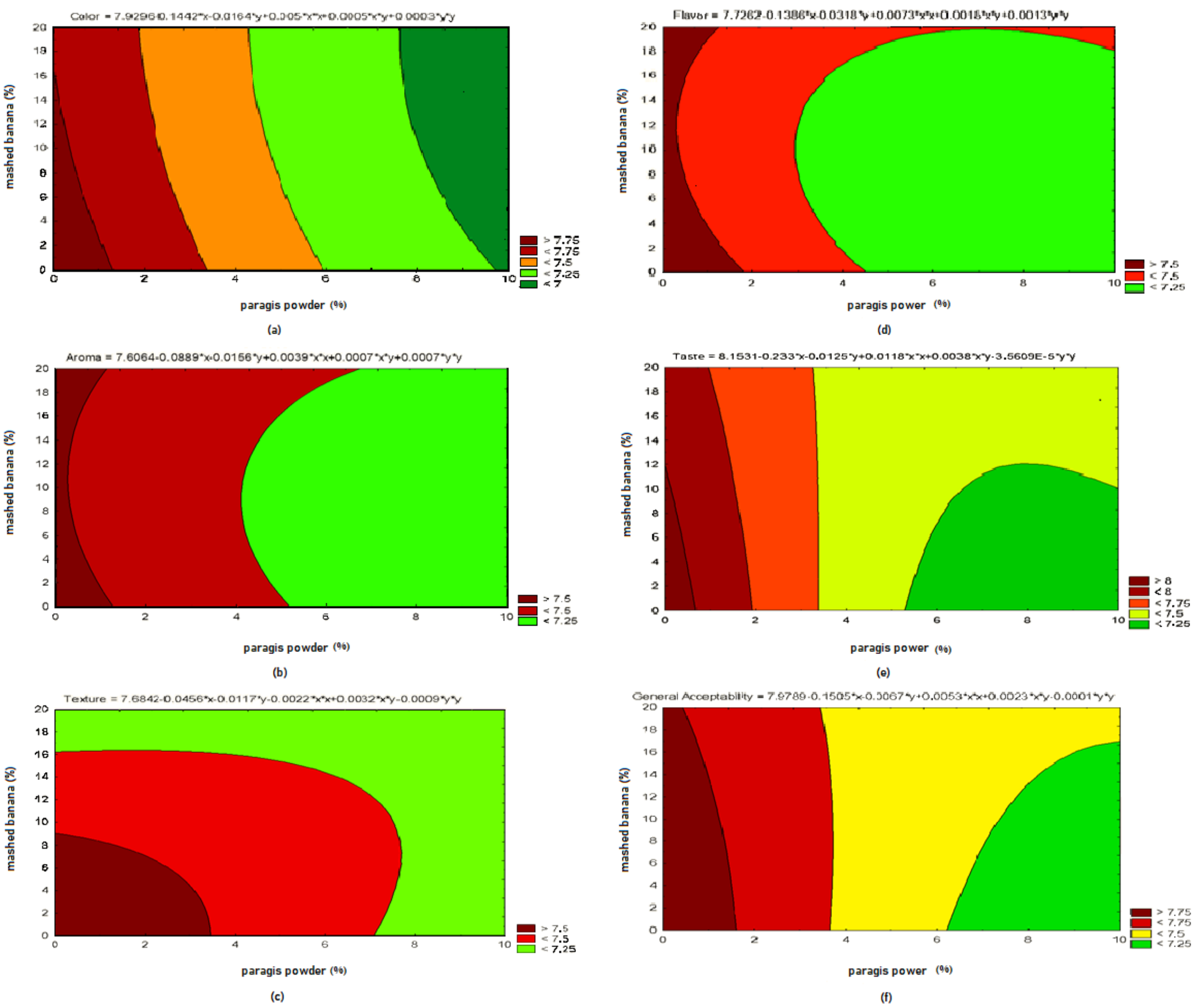

Figure 1. Response surface plots of the interaction of powdered paragis leaves and mashed banana, and their influence on the acceptability for (a) color, (b) aroma, (c) texture, (d) flavor, (e) taste, and (f) general acceptability

the human sense of smell.

In this study, the mean acceptability scores for aroma ranges from 7.000 to 7.781 which falls under the 'like moderately' category in the 9-point Hedonic rating scale (Table 3). The panelists scored highest on cookies with 15 % mashed banana (no powdered *paragis* leaves). Generally, high levels of powdered *paragis* leaves with high levels of mashed bananas caused the ratings to decrease (Table 3). Response Surface Regression Analysis of *paragis* cookies shows that there is a significant evident correlation in linear terms that exist between aroma acceptability and the different levels of powdered *paragis* leaves (Table 4). The response for aroma revealed that a unit increase in powdered *paragis* leaves significantly cause a decrease in acceptability by 0.433 in the forenamed parameter (Table 4). Also, El-Gammal et al. (2016) and Sengev et al. (2013) agree with this finding.

Moreover, the sensory panel initially perceived the aroma of banana in the absence of paragis leaves. The incorporation of *paragis* leaves led to perceiving the leaf's odor than the banana, even at a 15% level of the latter (paragis powder is 5%). Only at the highest level of mashed bananas that blend of *paragis* and banana aroma was perceived (Table 3). The powdered paragis leaves dominate the aroma of the cookies. This implies that volatile compounds possessed by powdered *paragis* leaves may have dominated the mixture of aromatics and could have overpowered the complex aroma of banana. Sengev et al. (2013) attributed the decrease of sensory score to the herbal flavor imparted by moringa leaf powder in bread. A similar reason could have happened in *paragis* cookies.

Effect on Texture

Table 2 generally describes the texture of the product. The product without *paragis* powder and mashed bananas was crumbly. Incorporating mashed bananas in the formulation basically softens the product because the latter has high moisture content. On the other hand, in the absence of mashed bananas with a low level of *paragis* powder (5%), the texture was described similarly to the control (crumbly). However, as the level of *paragis* powder increases to 10% (no mashed banana), the product became soft. This finding is in disagreement with the report of Dachana et al. (2010). They reported that powdered *moringa* leaves in cookies diluted the gluten and produces hard dough having less cohesiveness, adhesiveness, gumminess and springiness, which resulted in a very hard cookie product.

In terms of texture acceptability, the control had the highest mean acceptability rating of 7.67 (like moderately), which means that the incorporation of either powdered *paragis* leaves and mashed bananas would lower the acceptability rating for texture. The softness of the cookies could have caused a low acceptability rating on the forenamed parameter. Moreover, regression analysis was statistically evaluated in having a high significance in its linear, quadratic, and cross-product terms (Table 4). The linear effect of powdered *paragis* leaves and mashed bananas caused a negative effect on texture acceptability, but a consequent positive 0.325 units are anticipated for every unit change in the interaction of both factor variables (Table 4). Figure 1(c) illustrates that low acceptability was oriented towards high levels of both *paragis* powder and mashed bananas. This result was in agreement with Chima and Gernah (2007), Dachana et al. (2010), Barine (2015), Emelike et al. (2015), Mouminah (2015), Msaddak et al. (2015), and El-Gammal et al. (2016) who reported that there was a significant decrease in the liking scores on the texture of baked products added with various types of non-conventional baking ingredients. Hafez (2012) and Aduana (2019) reported otherwise. Majoram powder in a cake (Hafez, 2012) and giant swamp taro powder in cookies (Aduana, 2019) did not significantly affect the preference of the sensory panelists towards texture.

Effect on Flavor

The flavor is a perception of stimulating a combination of the taste, smell, and trigeminal effects (Figoni, 2008). The forenamed author also reported that flavor perception depends on many factors related to the product being evaluated and the person doing the evaluation.

In this study, the sensory panels described the control as having a 'strong buttery' flavor (Table 2), while both powdered *paragis* leaves and mashed bananas dominate the flavor of the product (Table 2) once incorporated into it. It was noted that the overall mean acceptability of the product is 7.34 (Table 3), which corresponds to the 'like moderately' category in the 9-point Hedonic rating scale. The regression analysis unveils that flavor acceptability is dictated by powdered *paragis* leaves (Table 4). Parameter estimates reveal that a unit increase in the level of powdered *paragis* leaves is estimated to reduce the response by 0.486 significantly. Figure 1(d) illustrates that flavor acceptability decreases when powdered *paragis* leaves and mashed bananas increase. A similar trend was observed in cookies (Dachana, 2010; Abdel-Samie & Abdulla, 2014) and bread (Sengev et al., 2013) incorporated with *moringa* powder.

Effect on Taste

The panelists generally perceived the cookies without powdered *paragis* leaves as 'sweet,' while cookies in the absence of mashed bananas (in the presence of powdered *paragis* leaves) are generally perceived as 'slightly bitter' (Table 2). Both treatment samples have taste acceptability corresponding to 'like moderately' of the 9-point Hedonic rating scale. The control, on the other hand, was scored 8.172, which falls under the 'like very much' category (Table 3). The Response Surface Regression Analysis estimated that a unit increase in powdered *paragis* leaves might cause a significant decrease in taste acceptability by 0.776; likewise, the square unit increase of such is estimated to decrease the response by 0.295 as well. Figure 1(e) illustrates the orientation of the surface, as described above. This result is similar to the reports of various authors, namely Chinma and Gernah (2007), Hafez Abdel-Samie, and Abdulla (2014), Emelike et al. (2015), Mouminah (2015), and El-Gammal et al. (2016). They observed that (2012), the addition of mango flour and powdered *moringa* leaves significantly decreased the preference of sensory panels to cookies and bread at increased levels of the forenamed ingredients. Studies on the addition of 20% powdered cashew-apple fiber and giant swamp taro flour are in disagreement with this finding (Ebere, 2015; Aduana, 2019). It was reported that the addition of the forenamed ingredients in cookies did not cause a significant effect on the taste acceptability of the product. Msaddak et al. (2015) also reported slight likeness in cookies with high cladodes powder supplementation on the product. On the other hand, the interaction of both powdered paragis leaves and mashed bananas may contrarily result in a 0.376 increase in the response for taste acceptability, which may be due to masking of mashed bananas on the undesirable taste imparted by powdered paragis leaves.

Effect of General Acceptability

General acceptability is synonymously termed as over-all acceptability. The control and cookies with mashed bananas (without powdered *paragis* leaves) are generally having high acceptability ratings than cookies containing powdered *paragis* leaves. The Regression coefficients for over-all acceptability, on the other hand, showed a significant difference at $p<0.001$ as affected by linear terms of powdered *paragis* leaves (Table 4). This suggests that powdered paragis leaves have a major role in the decrease of the general acceptability of the product (0.741 reductions per unit increase of powdered *paragis* leaves). This was clearly illustrated in Figure 1(f), which shows that high general acceptability is oriented towards low levels of powdered paragis leaves. A similar trend was observed by Dachana et al. (2010), Emelike et al. (2015), Mouminah (2015) and Abdel-Samie and Abdulla (2016) in cookies added with moringa powder; El-Gammal et al. (2016) and Sengev et al. (2013) in bread with powdered *moringa* leaves; and in cookies with plantain flour and Bambara groundnut protein concentrate (Barine, 2015). Contrarily, Hafez (2012), Ebere et al. (2015), Msaddak et al. (2015), and Aduana (2019) reported that added majoram in cake, cashew-apple residue in cookies, cladodes powder in cookies, and giant swamp taro powder in cookies do not significantly affect the overall acceptability of these products.

Although this study reports a significant decrease

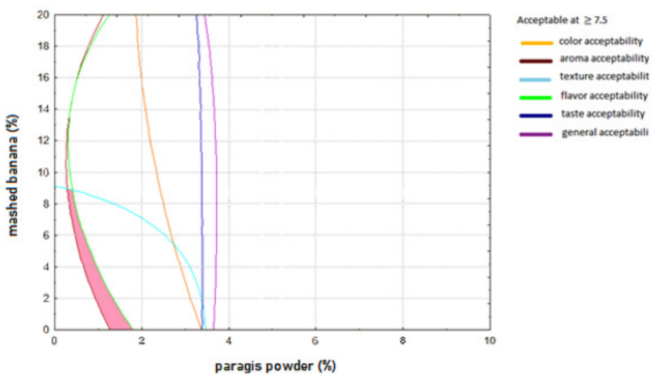

Figure 2. Superimposed contour plots of sensory attributes of paragis cookies at ≥7.5 acceptance rate in 9-point Hedonic rating scale

Table 5

Verification test results of the observed and predictive capacity of the model

PARAMETER	TRT	MEAN	SD	SE	*t*-value	DF	*p*
Color	T1	8.07	0.740	0.135	0.123	29	0.903^{ns}
Acceptability	T2	7.8					
Aroma	T1	7.93	0.858	0.157	0.532	29	0.599^{ns}
Acceptability	T2	7.33					
Texture	T1	7.71	0.876	0.160	-2.082	29	0.046*
Acceptability	T2	8.31					
Flavor	T1	7.87	0.583	0.106	-1.409	29	0.170^{ns}
Acceptability	T2	6.5					
Taste	T1	7.63	0.714	0.130	-0.894	29	0.378^{ns}
Acceptability	T2	6.67					
General	T1	7.93	0.583	0.106	-2.034	29	0.051^{ns}
Acceptability	T2	6.6					

T1 inside the optimum region (1.8% powdered *paragis* leaves, 8% mashed banana)
T2 – outside optimum region (5% powdered *paragis* leaves, 15% mashed banana)
^{ns}-no significant difference at $p>0.05$;*-significant at $p\leq0.05$

in acceptability in all sensory parameters, it is good to note that the overall mean acceptability of the cookies is 7.479 (Table 3), which corresponds to the "like moderately" category of the 9-Point Hedonic Rating Scale. This indicates that the product still has a fair chance of penetrating the market because of its high acceptability rating.

Optimum Formulation of Cookies

Figure 2 presents the superimposed contour plots of the different sensory attributes. The parameters, namely color, flavor, and aroma are the limiting factors of the product. The optimum combination of the two variables is 8.8 % for mashed bananas and approximately 1.3 to 1.8 % for powdered *paragis* leaves.

Verification

The model's predictive ability was determined using a test sample taken from the inside of the optimum region and other from the outside region. Table 5 shows a summary of the test between the predicted value versus the observed value of the product. The results show that the observed value of the treatment inside the region regarding of color, aroma, flavor, taste, and general acceptability was not significantly different from the predicted and actual values.

CONCLUSION

Paragis leaves could be exploited by cookie manufacturing industries as a potential source of beneficial components. The levels of powdered *paragis* leaves significantly affected the color, taste, aroma, texture, and general acceptability of the product. The recommended level for use is approximately 1.3 to 1.8 %, combined with 8.8% of mashed banana.

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