The Effects of Incorporation of Banana Pseudostem Flour at Different Proportions on the Sensory Properties, Proximate, and Mineral Composition and Microbial Quality of Baked Brownies

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Abstract This study assessed the effects of incorporating banana pseudostem flour (BPSF) into all-purpose flour (APF) in five treatments, T0 (100% APF), T1 (15%), T2 (30%), T3 (45%) and T4 (60%) on the sensory and chemical properties based on proximate composition, mineral & microbial contents of baked brownies. This experimental study used a crossover design to gather data from 322 experts and consumers, and data were analyzed through SPSS. Findings revealed that the banana-like flavor was slightly noticeable in all treatments with BPSF. T0, T1 & T2 were dark brown while T3 & T4 were brown, all with a slightly noticeable banana-like odor and slightly fine texture except T3. The respondents rated all the brownies' sensory attributes as liked very much. Statistically, significant ($P < 0.05$) differences existed between treatments in each of sensory attributes and based on general acceptability, T1 (15% BPSF) emerged as the most acceptable formulation. The moisture (15.9 – 13.3

g/100g), protein (7.9 – 5.76 g/100), and crude fat (19.8 – 17.1 g/100g) contents decreased as the level of BPSF increased. The values of carbohydrates (55.1 – 60.8 g/100g), crude ash (1.65 – 3.02 g/100g), and total dietary fiber (3.92 - 7.17 g/100g) increased as the amount of BPSF flour increased. A similar trend was shown for the mineral contents: magnesium, calcium and sodium except for potassium, as BPSF content increased, values of such minerals increased as well. The formulated brownies were safe for consumption as all microbial parameters conformed to the standard limits. Hence, BPSF is a potential ingredient for producing nutritious pastry products.

Keywords Banana By-Products, Physical Evaluation, Chemical Analysis, Pastries, Flour

1. Introduction

Banana is the world's second most-produced fruit in volume, for about 16% of the global fruit supply [1]. They are also abundant in the Philippines, the world's third-largest banana producer [2]. Therefore, every year after harvesting, many bare pseudostems are burned or cut and left behind as waste worldwide. Every year, about a hectare of banana can produce 220 tons of biomass waste [3], which can contaminate water sources and harm the ecosystem and the health of living microorganisms [4], [5]. However, banana pseudostem core can be consumed [6]. It can be used as a food source or ingredient; for example, it is eaten as a vegetable in Southeast Asia and Indo-Malesian Region [7], traditionally utilized as a food ingredient in Indian cuisines [1], and used to make candies and pickles [8], [9].

The consumption of banana pseudostem has numerous health benefits. It has high fiber content, which aids in weight loss [10-12]. It's also suitable for people with diabetes because it has a low glycemic index and a lot of nutritional fiber [4], [11], [12], and antioxidant [13], with [14] pointing out that consuming a lot of dietary fiber is beneficial to human health. It is also high in potassium, essential for muscular function, including cardiac muscle function, and aids in preventing high blood pressure and maintaining body fluid [15], [16]. Moreover, the banana pseudostem contains a significant amount of vitamin B6, producing hemoglobin and insulin, thus improving the body's ability to fight infection [17], [18]. It is also a diuretic, which aids in the detoxification of the body. Its juice is used to prevent and treat kidney stones [14].

Yet, banana pseudostem core is mostly composed of 90% moisture, making it impossible to be stored for a long time [6]. It undergoes enzymatic reaction, turning to brown, affecting banana pseudostem-made items' sensory assessment and economic value. Hence, it needs to be processed to improve its nutritional and sensory qualities [19]. Also, it is the plant's second most abundant source of starch, making it a good source of food or has the potential to be processed into flour [4], [6], [9], [20-23], which could be used in a variety of baked goods, soups, and other dishes [8].

Processing banana pseudostem into flour can improve their shelf life [20], and the use of such as a partial replacement for wheat flour can increase dietary fiber consumption. It also improves the nutritional value of white bread and some essential macro and micro minerals [21], and other pastry products like brownies, described as food with less balanced nutrients and a lower food value that the body can use [24]. Hence incorporating BPSF in its production improves its nutritional value.

Few investigations dealt with making banana pseudostem into flour [4], [20], [21], and pastry products

such as wheat bread [20], food bar [25], and biscuits [23]. The limited research on utilizing BPS in food production encourages the researchers to focus on such areas, which will eventually pave its way to being popular in the market.

Recently, studies on using BPS focused on making and assessing banana pseudostem flour like the study of Ho et al. [21] and Yuliatmoko [25]. Other studies dealt with producing pastry products, e.g., wheat bread [20], food bar [25], and biscuits [23]. Due to limited research on using BPS in food production, researchers felt the need to concentrate on this field. This study is vital as it informs the community and inspires them to consider alternative food ingredients that are locally available and ultimately benefit them and the environment. This will also tell them about the advantages of using banana pseudostem as a food source, particularly in times of food scarcity, such as the pandemic situation that we are currently experiencing, in which many people are jobless and hungry due to a lack of food supplies.

Thus, this study assesses the effects of incorporating banana pseudostem flour in five treatments: 0% (control), 15%, 30%, 45% & 60% on the sensory properties of baked brownies based on descriptive and acceptability, its proximate mineral composition, & microbial quality.

2. Materials and Methods

2.1. Raw Materials

Fresh banana pseudostem (*Musa balbisiana*) were collected from the Municipality of Moalboal. Other ingredients such as eggs, unsalted butter, vanilla, chocolate powder, chocolate chips, all-purpose flour, baking powder, brown sugar, granulated sugar, iodized, and salt were purchased in the local market.

2.2. Preparation of Banana Pseudostem Flour

The procedure of preparing the banana pseudostem flour is adopted from [4], [6], [9], [23]. The banana pseudostem were washed, and the outer sheath is removed to reveal the core. The core was cleaned, sliced into small pieces, and soaked in a 0.2% potassium meta bisulfate (KMS) concentration solution for 10 minutes to control enzymatic browning. They were dried using an electric oven at 120 °C, flipping every 20 minutes until no traces of water left. The dried samples were ground into flour using an electric pulverizer and then sieved. The 250g of banana pseudostem flour is separated and then packed into clean airtight plastic and stored in a cool place for laboratory analysis. The remaining flour is mixed with all-purpose flour for the formulations of brownies. The flours' ratios in brownies' five formulations are shown in Table 1.

Table 1. BPSF and APF ratios in five treatments of baked brownies

Percentage of Flour Blends	T0	T1	T2	T3	T4
BPS Flour	0%	15%	30%	45%	60%
All-purpose flour	100%	85%	70%	65%	40%

The procedure in the formulation of brownies was adopted from the study of [27].

There are five treatments of brownies (Table 1) prepared. All-purpose flour was substituted in 15%, 30%, 45%, 60%, and 100% all-purpose flour served as a control. The oven was preheated to 350 °F. Butter was creamed with the sugar, salt, and vanilla in a mixer for 2 minutes on medium speed in preparing the batter. The eggs were added and beaten for another 3 minutes at a medium speed. The banana pseudostem flour (BPSF), chocolate powder, and baking powder were added and mixed at a medium speed until completely incorporated. The batter was then spread into five aluminum pans (11- 3/4 "L × 9-3/8 "W" 2-5/16 "H), lightly coated with butter, labeled with the appropriate number representing the brownies treatment (Table 1). Brownies were then baked in a conventional oven at 350 °F for 20-30 minutes. Each pan was tested with a toothpick to ensure that they were cooked before removing. The pan of brownies was left to cool at room temperature and then cut into 25 pieces.

2.3. Laboratory Analysis

The compositions of the five treatments of brownies incorporated with BPSF and APF in different ratios were brought to FAST Laboratories in Cebu City, Philippines, for the analyses of Proximate Composition. The different parameters include moisture, crude protein, crude fat, carbohydrates, crude ash, and dietary fiber using the method of Air Oven Drying-Gravimetry, Kjeldahl, Mojonnier Extraction, by calculation, Gravimetric, and Enzymatic-Gravimetry, respectively. For minerals, the Flame AES and Flame AAS were used to analyzed Sodium, Calcium, Magnesium, and Potassium. Concerning the microbial quality of brownies, the Aerobic Plate Count, E coli, S. aureus count, Yeast, and Mold Count were determined using Pour plate, IMVIC, and Spread Plate Method. Such procedures were based on the official methods of analysis of AOAC International, 19th ed. 2012, AOCS standard procedure Ba 6a-05 & Shimadzu manual.

2.4. Sensory Analysis

This study employed a crossover design, adopted from [28], a repeated measurements design that each participant received different treatments of the formulated product during periods. The said participants involved in this study were the ten trained panelists and 322 consumers in different age groups and gender identified by using the

95% confidence level and +5% precision and selected through the quota sampling technique described by [29]. These participants rated the sensory properties of the formulated products based on descriptive and acceptability.

The formulations of brownies containing banana pseudostem flour were experimental, and the formulation with 100% all-purpose flour served as the control. The testing of the products was done after a day of the formulation of brownies. After tasting every treatment of the products, the participants need to drink water to remove the effect of every treatment and cannot influence the rating.

A survey questionnaire was used to measure the sensory properties and acceptance of the formulated products. The descriptive analysis comprises a 5- point scale describing the color, odor, flavor, and texture of the products. The acceptability analysis used the 9-point hedonic scale with 1- described as extremely dislike and 9-extreme like to assess the same attributes of the products as described by [30].

2.7. Statistical Analysis

Data obtained were consolidated and transferred to MS Excel to tabulate significant differences among treatments were analyzed through one-way ANOVA with repeated measures.

3. Results and Discussions

3.1. Effects of Incorporating BPSF on Brownies' Descriptive Sensory Properties

In this study, the flavor is described based on how noticeable is the banana in the baked brownies. As seen in table 2, all treatments with BPSF (T1-T4) obtained a range of mean scores from 3.40 to 3.93, described as noticeable banana flavor, the least mean score (1.67) equivalent to not noticeable was obtained by the control formulation. The results showed that incorporating BPSF with 15% - 60% (T1 to T4) provides a distinct banana flavor compared to the control. The raters probably identified such flavors among the five treatments since, at the onset, they were aware of the aroma of the BPSF that contributed to their perception of the brownies' flavor.

Color is an important sensory attribute that influences the impression of quality by consumers [31]. The results show that the highest mean (4.74) was observed in the control formulation, and the least was seen in T3 (45% BPSF). A trend was also noted that as the BPSF concentration increased, the color's mean scores decreased, indicating the difference in color among formulations. Further, the formulations with 15% to 30% BPSF were observed to have the same color as the control formulation

described as dark brown. The formulations (T3 & T4 with 45% & 60% BPSF) obtained a brown color description. The result implies that incorporating BPSF from 45% may decrease the color intensity of the product. Harahap [32] pointed out that dark chocolate is an essential component in making brownies, increasing *the color and giving the sweet taste besides sugar*.

Odor is suspected that chemical reactions produced a particular aroma of the banana pseudostem flour [33]. The highest mean (4.10) was observed in T1 (15% BPSF; 85% APF), followed by T0, control. It was also noted that there is a decrease in mean values as the amount of BPSF increases, though all treatments have the same descriptive rating of slightly noticeable BPS odor. The results appeared to be contrasting since even in the control treatment, without BPSF, the raters slightly perceived the banana pseudostem odor, similar to the other treatment with BPSF. This means that incorporating BPSF with other ingredients in brownies formulations resulted in the difficulty of perceiving the distinct BPS odor among the treatments; thus, they perceived all treatments to have a similar odor.

Textural characteristics of baked products that are pleasing to consumers are essential to succeed in the marketplace. Quality control and product development can both benefit from assessing the tactile qualities of baked items. The results show that the highest mean (3.39) was observed in the control formulation, and the least was seen in T3 (45% BPSF). A similar result was obtained by other formulations T1 (15% BPSF), T2 (30% BPSF), and T4 (60% BPSF). The different treatments of brownies showed a slightly fine texture, the same with the control formulation except for T3 described as slightly coarse. In addition, a trend was observed that generally, as the amount of BPSF increases, the rating mean scores of the formulations decrease.

3.2. Effects of BPSF on the Acceptability of Brownies Formulations Based on Sensory Attributes

The mean scores of the sensory properties' acceptability in five brownies' treatments based on color, odor, texture, and flavor are presented in Table 3, including the differences among treatments per attribute using the ANOVA test. The results revealed that the five treatments significantly ($p < 0.05$) differ in the brownies' flavor, color, odor, and texture attributes.

As shown in Table 3, the flavor of the control formulation, without BPSF, got significantly ($p < 0.05$) the lowest score described as moderately acceptable while the other treatments (T1 to T4) obtained mean scores equivalent to Like very much. Significant differences existed among treatments. T4 obtained the highest mean, followed by T3. Results appeared that those treatments containing BPSF got significantly ($p < 0.05$) higher scores and were more acceptable than the control formulation. It implies further that the inclusion of BPSF in brownies from 15% to 60%, which provided a prominent banana-like flavor of brownies, has probably enhanced the flavor of baked brownies and hence, got significantly higher scores than the control one.

Concerning color, the lowest score was observed in T2, which was significantly ($p < 0.05$) different from the other four treatments. Similarly, T0, the control, got the second-lowest score and was significantly ($p < .05$) different from the rest of the treatments, while T4 (8.52) was not comparable with T3 (8.46) and T5 (8.54). Also, a trend can be observed that generally, as the amount of BPSF increases, the ratings of color acceptability significantly increase as well. The dark brown color of the formulations (T3, T4, & T5), with BPS flour, may be attributed to the light brown color of BPS flour compared to the control with white flour described as brown was significantly liked by the participants.

Table 2. Descriptive properties of brownies incorporated with BPSF in different proportions

	Flavor		Color		Odor		Texture	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
T0	4.15	1.1	4.74	0.85	4.09	1.13	3.39	1.31
T1	3.93	1.3	4.45	0.81	4.1	1.15	3.24	1.28
T2	3.47	1.66	4.26	0.67	3.87	1.4	2.74	1.24
T3	3.4	1.72	3.92	0.76	3.73	1.47	2.55	1.23
T4	3.8	1.47	3.97	0.73	3.86	1.36	2.74	1.16
Legend: Scale		Flavor and Odor (Banana-like)		Color	Texture			
4.2 – 5.00		Very Noticeable		Dark brown	Very fine			
3.4 – 4.19		Noticeable		Brown	Moderately fine			
2.60 – 3.39		Moderately Noticeable		Light brown	Slightly fine			
1.80 – 2.59		Slightly Noticeable		Natural brown	Slightly coarse			
1.00 – 1.79		Not Noticeable		Cream	Coarse			

Table 3. Results of acceptability differences on the five brownies formulations using ANOVA

Treatment	Flavor		Color		Odor		Texture		General Acceptability		P-Value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
T0	7.97 ^a	0.87	8.30 ^a	0.76	8.02 ^a	0.91	8.19 ^a	0.83	8.3 ^a	0.77	0.000*
T1	8.18 ^b	0.84	8.25 ^b	0.79	8.11 ^a	0.98	8.21 ^a	0.82	8.45 ^b	0.75	
T2	8.43 ^c	0.76	8.46 ^c	0.77	8.34 ^b	0.84	8.30 ^{bc}	0.88	8.42 ^c	0.71	
T3	8.55 ^d	0.77	8.52 ^{cd}	0.78	8.40 ^b	0.94	8.45 ^b	0.86	8.2 ^d	0.80	
T4	8.45 ^c	0.80	8.54 ^d	0.79	8.42 ^b	0.95	8.45 ^{bc}	0.87	8.19 ^c	0.77	
Legend :	Scale 8.5 – 9.0 7.5 – 8.49 6.5 – 7.49 5.5 – 6.49 4.5 – 5.49		Description Like extremely Like very much Like moderately Like slightly Neither like nor dislike		Scale 3.5 – 4.49 2.5 – 3.49 1.5 – 2.49 1.0 – 1.49		Description Dislike Slightly Dislike moderately Dislike very much Dislike extremely				

*Mean values in the same column having the same superscripts are not significantly different ($p \leq 0.05$)

Regarding odor acceptability, the least mean result (8.02) was observed in the control (T0), which is significantly ($p < 0.05$) different from all other treatments with BPSF. Treatments blended with BPSF from 15% to 60% which were described having a banana-like odor did not significantly differ ($p < 0.05$). Hence, it connotes that the participants liked more those brownies treatments containing BPSF than the control one.

For texture acceptability, T0, control got the least mean value (8.19) and not comparable to T1 & T2. It means no significant differences existed in the flavor acceptability rating of those 3 formulations. However, T3 (45% BPSF) and T4 (60% BPSF) obtained means significantly higher than the control treatment. Results indicate that though all treatments were perceived as liked very much, as shown above, the participants still prefer BPSF over the control one. The result of this study did not conform to the banana pseudostem-based- biscuits of Sangroula [23] that as the amount of pseudostem flour increases, the texture score decreased, which may be due to tougher texture and cracks on the crust.

Relating to general acceptability, all treatments were significantly ($p < 0.05$) different from each other, the highest score was seen in T1 (15% BPSF), which is significantly different from the rest of the treatments, followed by T2 (30% BPSF), and the least was in T4 (60% BPSF). Hence, the most acceptable formulation is T1 with 15% BPSF, having the highest scores in different sensory attributes. However, all brownies treatments are acceptable to the participants until 60% of BPSF inclusion.

However, comparing these results to other pastry products made from banana flour blends, a contrasting result was found with the study of [24]. They described the characteristics of biscuits made using hot air-dried banana flour and freeze-dried banana flour. The sensory score for color, texture, and overall acceptability of biscuits decreased as banana flour in the formulation

increased. In addition, results obtained in the study of [29], that the Banana Pseudostem biscuits with the least banana flour content turn out to be the most acceptable compared to other formulations, which showed a significant difference from all other formulations, and the formulation with the greatest BPSF content showed the lowest score in overall acceptability.

3.3. Effects of incorporating BPSF on the Proximate Composition of Brownies Five Formulations

The proximate compositions of the formulated brownies in five treatments are shown in table 4, which were measured based on moisture, crude protein, crude fat, carbohydrates, crude ash, and dietary fiber.

The moisture content of the brownies ranged from 15.9 to 13.3, with the highest content observed in the control formulation, while T5 got the least moisture. As observed from the result, the higher the amount of the banana pseudostem flour in brownies treatment, the lower is the moisture content. The moisture content is responsible for the spoilage of the product; the result indicates that the inclusion of BPSF in brownies formulation may have longer shelf life than the control formulation. Such a result is similar to [21], in their study, the moisture content was 2.62% in control biscuits and 2.54% in banana pseudostem incorporated biscuits. However, it opposes the study of [34], who showed that the proximate compositions of the banana pseudostem revealed in the blended product had the highest moisture content (6.42%), while the least was in the control (3.33%) sample.

For protein and fat contents, the same trend as the moisture was observed in crude protein and crude fat, that as the BPSF content in the formulation increases, the amount of protein and fat decreases. T4 and T3 have a minimal difference (0.87) in protein content. The same result was obtained in fat content for T1 and T2 with 0.1 difference.

The current international Recommended Dietary Allowance (RDA) for protein is 0.8 g per kg of body weight regardless of age. These recommendations are based on the minimum level required to maintain nitrogen balance and are not optimized for physical activity levels [35]. Based on the RDA, the consumption of brownies may supply the required nutrients to the body.

The present result is parallel to the protein trend of banana pseudostem biscuits, which showed lower content in the banana pseudostem-based products (18.6%) than the control (16.26%). The banana pseudostem product has a low protein level because wheat flour's initial protein concentration (10.2 percent) is higher than banana pseudostem flour's, affecting the overall protein content of the product [4]. In addition, they also confirmed that the fat content of banana pseudostem incorporated biscuit (18.6%) was higher than the control (16.26%). However, an opposite trend was observed in the present study.

Regarding carbohydrates, results revealed that all treatments have significantly ($P < 0.05$) different carbs composition. A trend was noted that as the level of BPSF increases, the carb content also increases since the least value was seen in the control formulation (55.1%), and the highest is in T4 (60.8%). The Institute of Medicine (IOM) established a carbohydrate distribution range of 45–65 percent of total calories as an acceptable macronutrient distribution range. Hence, the formulated brownies are a good source of carbohydrates.

Table 4. Chemical Compositions of Brownies

Proximate Composition	T0	T1	T2	T3	T4
Moisture, g/100g	15.9	14.9	14.9	14.5	13.3
Crude Protein (Nx6.25), g/100g	7.9	6.85	5.98	5.62	5.76
Crude Fat, g/100g	19.8	18.5	18.6	17.8	17.1
Carbohydrates, g/100g	55.1	57.7	58.2	59.4	60.8
Crude Ash, g/100g	1.65	2.05	2.31	2.67	3.02
Total Dietary Fiber g/100g	3.92	6.05	6.14	6.54	7.17

For fiber content, the increasing values are notable in the result (Table 4). It indicates that the fiber contents of brownies with BPSF have higher values than the control formulation. The banana pseudostem as the best source of fiber [4],[10] has contributed such evident results. In addition, BPSF was reported to be rich in non-starch polysaccharides or dietary fibers, including cellulose, hemicellulose, and lignin [36]. Thus, BPS-based brownies are a good source of fiber which is beneficial to human health. Comparing the findings obtained in the study of [37], the Chemical characteristic of steamed pumpkin brownies premix flour showed similar results to the present study. The same trends were observed in moisture protein, fat, and carbohydrates contents.

3.4. Effects of Incorporating BPSF on Mineral Content of Brownies Five Formulations

The mineral composition of the brownies with the pseudostem flour and their different treatments are shown in Table 5, with the following parameters: sodium, calcium, potassium, and magnesium.

Table 5. Mineral Content of Brownies

Proximate Composition	T0	T1	T2	T3	T4
Magnesium mg/kg	55.1	215	209	236	252
Calcium mg/kg	14.2	17.8	19.5	36.4	43.3
Sodium g/100g	0.097	0.10	0.11	0.11	0.12
Potassium g/100g	19.8	0.54	0.59	0.71	0.77

As revealed in the results, the control formulation has the least magnesium content (55.1); such amount is almost four times lesser than those formulations containing BPSF with magnesium contents ranging from 209 mg/kg to 252 mg/kg. The highest amount was seen in treatment 4, with 100% BPSF. The recommended daily intake for magnesium is 170 mg [38]. Hence, consuming about 670 g per day of brownies with BPSF will reach the recommended intake.

Concerning calcium, a similar result was observed as that of magnesium, that the lowest content (14.2 mg) was in the control formulation and the highest was in T4 (43.3 mg), with pure BPSF. An increasing trend (17.8 - 43.3 mg) was also noted, that as the proportion of BPSF increased, the calcium content also increased. Hence, incorporating the BPSF in brownies formulations has improved the product's calcium value from treatment 1 to 4 about 25% to 300%, respectively.

The recommended daily intake of Ca is 450 mg; such a value is far from the obtained result of the formulated products. The amount of calcium found in the banana pseudostem flour in this study was higher than that found in banana pulp, peels, and unpeeled bananas [39-40]. Also, Ca was relatively high in the pseudostem due to its importance in the cell strength of the trunk that sustains the plant [41].

Regarding sodium, the result displayed the same as other elements: as the amount of BPSF increases, the sodium content has increased. The formulation without BPSF has the least sodium (0.097 g/100g) and the highest in T4 (0.12 g/100g). Hence, incorporating BPSF in food products may improve the sodium content. In the extracellular fluid of the body, sodium is the most abundant cation. It is a vital nutrient for maintaining plasma volume, acid-base balance, nerve impulse transmission, and appropriate cell function. Nearly all of the sodium consumed is absorbed during digestion in healthy people, and urine excretion is the primary method for maintaining sodium balance.

Table 6. Microbial Component of the brownies in five treatments

Proximate Composition	T0	T1	T2	T3	T4
Aerobic Plate Count (APC) (CFU/g)	300	300	<250 ^(Est)	350	<250 ^(Est)
E. coli	Negative	Negative	Negative	Negative	Negative
S.aureus Count (CFU/g)	<10 ^(Est)	<10 ^(Est)	<10 ^(Est)	<10 ^(Est)	<10 ^(Est)
Yeast and Mold Count (CFU/g)	20 ^(Est)	30 ^(Est)	<10 ^(Est)	40 ^(Est)	<10 ^(Est)

For the potassium, the results revealed that the highest content was in the control formulation (19.8 g/100g) while all the four treatments (T1-T4) with different amounts of BPSF had a very small amount of sodium as all contained <1 g/100g. Those with hypertension and those who have excessive potassium excretion through their body fluids could benefit from potassium. Because of their role in brain transmission and muscle contraction, macro-elements including Na, K, Ca, and Mg are vital in our daily diet [42].

3.5. Microbial Quality of Banana Pseudostem-Based Brownies in Five Treatments

The microbial quality of the brownies in five treatments are shown in Table 6, with the parameters aerobic plate count, E. coli, S. aureus count, and yeast and mold count. For aerobic plate count (CFU/g), it is intended to indicate a product's microorganism level. The range of values was <250 – 350 cfu/g, which conforms to the standard limit of 104 cfu/g, based on AO No. 184 s. 2004, FDA limits for formulated products.

Moreover, E. coli is negative with S. aureus count (CFU/g) <10(Est) in all formulations. Also, the range of yeast and mold count (CFU/g) in five formulations is (10-40 cfu/g). All microbial parameter results conform to the standard limit set by FDA for processed foods, negative for E.coli, and 103 for yeast and mold. Therefore, the formulated products are considered safe for consumption.

4. Conclusion

The brownies with BSF up 60% were highly acceptable to the consumers based on the 9-point hedonic scale. But, the most acceptable formulation based on the general acceptability score was T1 which is incorporated with 15% BPSF and 85% APF. The formulated brownies contain macro and micronutrients needed by the body and safe for consumption as all microbial parameters conformed to the standard limits. Hence, banana pseudostem is a potential ingredient for producing nutritious pastry products.

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