

PRODUCT FORMULATION, ANALYSIS, AND SHELF-LIFE OF ROOT CROP BISCUITS WITH GREEN LEAFY VEGETABLES

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Abstract: Biscuits are often branded as a nutritious and convenient way to consume a staple food or cereal grain. The products of this study were evaluated as to sensory qualities and acceptability in terms of appearance, aroma, taste, texture, and crispness. Significant differences in the sensory qualities and acceptability were also determined. Proximate and microbial analysis of the best treatment was submitted and the shelf-life and temperature were also studied.

The study was an Experimental-Developmental research with the used of Completely Randomized Design (CRD). The study was conducted in three trials and one (1) final process for consumers' evaluation by the sixty (60) tasters. Scorecards with the Nine (9) Point Hedonic Scale were used to obtain the data. The Arithmetic mean and Analysis of variance (ANOVA) were used to analyze the data into alpha level set at 0.01. Findings on the sensory evaluation of root crop biscuits with green leafy vegetables showed that cassava flour with kulitis was the best in all five quality attributes. The acceptability of root crops biscuits with green leafy vegetables among the three products was in favor in cassava flour with kulitis which was "Liked Extremely" by the consumers across all qualities. There were no significant differences in the sensory qualities of the root crop biscuits considering the three products. There was a significant difference in five quality attributes the appearance, aroma, taste, texture and crispiness in favor of Cassava with Kulitis. The maximum shelf-life of root crop biscuits with green leafy vegetables at room temperature was fifteen (15) days and thirty (30) at chilling temperature. Therefore, the root crop biscuits with green leafy vegetables was safe for human consumption as the results of microbial analysis of the product and based on the BFAD standard for microorganism test for products belonging to the baked goods category.

Keywords: Product Formulation, Analysis, Shelf-life, Biscuits, Root Crops and Green Leafy Vegetables

I. INTRODUCTION

Filipinos enjoy snacks to satisfy their cravings for nutritious and tasty treats, such as crackers with green leafy vegetables, as one of their meals given the current state of our way of life. Due to their hectic schedules, parents are unable to prepare a substantial meal because they are too busy preparing for their children's bright future. With the presence of root crop biscuits with leafy vegetables, it is easy and convenient for them to prepare a nutritious and delicious meal. A biscuit is a bland, dry baked food typically made with flour. Flavorings or seasonings, such as salt, herbs, seeds, or cheese, may be added to the dough or sprinkled on top before baking. Biscuits are often branded as a nutritious and convenient way to consume a staple food or cereal grain.

The Philippines produces relatively abundant quantities of root crops, cassava, sweet potato, yam, and others, mostly grown as a substitute for rice and other cereals. They have a short storage life, and the supply in the local markets is therefore seasonal, as they are generally consumed in their fresh and unprocessed state. Still, during peak periods of production, tubers have to be stored for some days and sometimes longer during the rainy season. How that is done is described here, following a fact-finding survey in different provinces. Some experiments done by the PRCRTC are mentioned. In some cases, differences in storage behavior were found between varieties (Quevedo & Diamante, n.d.).

Snack biscuits are prepared using a single-stage mixing process in which all of the ingredients are mixed together at once to make the dough, which then may or may not be rested. The dough is then sheeted, laminated, cut, docked, and baked. Most snack crackers are sprayed with oil as they leave the oven. The oil gives the cracker a shiny appearance, imparts flavor, and helps any applied toppings adhere to the surface (Miller, 2016).

Flour is the main product of soft wheat milling, the primary objective of which is to produce a product with a high degree of purity (sifted). It consists of the starchy, innermost portions of the caryopsis (endosperm) after separation from the outermost portions (the bran, which makes up about 15% of the total content of the caryopsis, and the germ, which makes up about 3%), and is traditionally used as animal feed (Arlotti et al., 2011).

Fruits and vegetables are universally promoted as healthy. The Dietary Guidelines for Americans 2010 recommend you make one-half of your plate fruits and vegetables. Myplate.gov also supports the idea that one-half the plate should be fruits and vegetables. Fruits and vegetables are a diverse group of plant foods with widely varying energy and nutrient content. Moreover, fruits and vegetables provide dietary fiber, which is associated with a reduced risk of cardiovascular disease and obesity. In addition to vitamins and minerals, fruits and vegetables provide phytochemicals that function as antioxidants, phytoestrogens, and anti-inflammatory agents, among other protective mechanisms.

II. STATEMENT OF THE PROBLEM & LITERATURE REVIEW

This study aimed to utilize root crops such as cassava, sweet potato, and ube in making biscuit with green leafy vegetables. Specifically, it has six objectives and two (2) hypotheses. These are (1) determining the sensory qualities of formulated product among three treatments in terms of appearance, aroma, taste, texture, and crispiness; (2) determining the acceptability of root crop biscuits with green leafy vegetables in terms of sensory qualities among three treatments; (3) finding out if there is a significant difference in the sensory qualities of root crop biscuits with green leafy vegetables among three treatments in terms of appearance, aroma, taste, texture, and crispiness; (4) finding out if there is a significant difference in the general acceptability of the product in terms of sensory qualities among the three treatments; (5) determining the proximate and microbial analysis of the best product; and (6) determining the shelf-life of the product in terms of room temperature.

The two (2) hypotheses were:

1. There is no significant difference in the sensory qualities of root crop biscuits with green leafy vegetables among the three (3) treatment products each in terms of appearance, aroma, taste, texture, and crispiness.
2. There is no significant difference in the acceptability of root crop biscuits with green leafy vegetables among the three (3) treatment products each in terms of sensory qualities.

Cassava, sweet potato, and ube were the main ingredient in making the biscuits with added vegetables like kulitis, kangkong, and lupu which gives essential nutrients. Brown sugar, salt, butter, skimmed milk, and water were the additional ingredients in making the biscuits become more delicious and crispier in texture.

The biscuits were using root crops flour instead of commercial flour which was healthier due to its natural process of drying and no added preservatives to maintain the quality of the flour. Biscuits are prepared using a single-stage mixing process in which all of the ingredients are mixed together at once to make a dough, which then may or may not be rested. The dough is then sheeted, laminated, cut, docked, and baked. Most snack biscuits are sprayed with oil as they leave the oven. The oil gives the cracker a shiny appearance, imparts flavor, and helps any applied toppings adhere to the surface (Miller, 2016).

The recipe for the biscuits came from the standard recipe from How to Make Crackers at Home by Emma Christensen. She was a former editor for The Kitchn and a graduate of the Cambridge School for Culinary Arts (thekitchn,2019).

III. MATERIAL SELECTION AND EXPERIMENTAL WORK

This study employed the experimental-developmental method of research. The experimental approach focused on the study of the future (what will be), when the study's variables were carefully managed or controlled (Calmorin, 2010). An experimental method is used to investigate the right proportion of Root Crop Biscuits with Leafy Vegetables. Developmental method is used for the formulation of root crops using different kind of green leafy vegetables, kangkong kulitis, lupu, and for potential Root Crop Biscuits with Green Leafy Vegetables for product development and commercialization.

Experimental Design

The experimental design used in the study was the Completely Randomized Design (CRD) (Stone et al., 2012) to generate the data. Samples for evaluation were coded, and scores were utilized for randomization. Product formulations were done before the conduct of the product for evaluation in three trials which were replicated three (3) times.

Tools and Equipment

The tools and equipment used in making root crops biscuit crackers with green leafy vegetables. were the following: one (1) piece working table, two (2) pieces strainer, one (1) piece wire whisk, one (1) piece white cloth, one (1) set measuring cup, one (1) set measuring spoon, two (2) pieces utility tray, two (2) pieces wooden spoon, three (3) pieces plates, two (2) pieces mixing bowl, one (1) piece food tong, (9) disposable containers, one (1) piece weighing scale, one (1) piece electric blender, six (7) pieces utility bowls, one (1) piece pastry brush, one (1) piece pizza cutter, one (1) dinner fork, one (1) piece spatula, three (3) piece baking sheet, and one (1) piece oven, and (3) pieces cookie shaper.

Experimental Treatments

The experiment was carried out in three (3) product formulations namely: Product 1 (cassava flour with lupu, kulitis, and kangkong) Product 2 (sweet potato flour with lupu, kulitis, and kangkong), Product 3 (ube flour with lupu, kulitis, and kangkong).

In this study, the product developed was root crop biscuits with different green leafy vegetables. The proportions were the same and vary with the different kinds of flour and vegetables used in the study.

Table 1 shows the ingredients and proportion used in making root crop biscuits with green leafy vegetables such as the lupu, kulitis, and kangkong, brown sugar, salt, olive oil, and water during the product formulation in three replications as evaluated by the semi-trained panelists as to the sensory evaluation of the product.

INGREDIENTS	TREATMENTS								
	TREATMENT A LUPO			TREATMENT B KULITIS			TREATMENT C KANGKONG		
Cassava Flour	200g	-	-	200g	-	-	200g	-	-
Sweet Potato Flour	-	200g	-	-	200g	-	-	200g	-
Ube Flour	-	-	200g	-	-	200g	-	-	200g
Vegetables	15g	15g	15g	15g	15g	15g	15g	15g	15g
Brown Sugar	30g	30g	30g	30g	30g	30g	30g	30g	30g
Butter	30g	30g	30g	30g	30g	30g	30g	30g	30g
Skim Milk	40g	40g	40g	40g	40g	40g	40g	40g	40g
Iodized Salt	5g	5g	5g	5g	5g	5g	5g	5g	5g
Water	110ml	110ml	110ml	110ml	110ml	110ml	110ml	110ml	110ml

Table 1. Proportion of ingredients in the Root Crop Biscuits with Green Leafy Vegetables.

Experimental Procedures

Step 1. Preparation of Raw Materials

The preparation of raw materials in the study were the following: preparation of cassava flour, sweet potato, ube flour and the vegetables (lupu, kulitis, and kangkong).

A. Preparation of Cassava, Sweet Potato, and Ube Flour

One (1) kilo of cassava, sweet potato, and ube is bought from a well-known root crop dealer at the Bagong Lipunan Trade Center to ensure quality and food safety. The cassava is washed thoroughly and pared. Then, it was thoroughly soaked in water with one (1) tablespoon of baking soda for 30 minutes, drained the cassava and it is grated. Using a clean cloth, the grated cassava will be squeezed to remove the extract and dried under the heat of the sun for three (3) hours. The dried cassava is grinded using a rice grinder into a fine flour texture. The prepared cassava flour is then placed in a clean container and set aside. While, the sweet potato and ube were washed thoroughly and pared. Then, washed again and drained the sweet potato and dioscorea alata and it is grated. And dried under the heat of the sun for three (3) hours. The dried sweet potato and ube were grinded using a rice grinder into a fine flour texture. The prepared sweet potato and ube flour were placed in a clean container and set aside for later use.

B. Preparation of vegetables (lupu, kulitis, kankong)

The three kinds of vegetables were bought from a well-known vegetable dealer to ensure quality and food safety. One (1/4) kilo of each kind of vegetable was washed thoroughly with running water. Then each vegetable was blended using an electric blender to achieve its fine texture and then set aside for later use.

Step 2. Procedure in Making Root Crop Biscuits with Green Leafy vegetables

The tools and equipment needed were prepared. All ingredients were measured and weighed using a digital weighing scale. Heat the oven to 450 °F. Sprinkle the mixture in a baking pan and set it aside. In a mixing bowl, mix together the dry ingredients. Whisk the flour, salt, and sugar together.

Add vegetable puree, oil, and water to the flour mixture. Stir the ingredients until a soft, sticky dough forms. The dough was divided in half and one half was set aside. Lightly dust the work surface with flour and place the other half of the dough on top. Hand-pat it into a thick square shape. Working from the center of the dough, roll it out into a rectangle approximately 1/8 inch thick or thinner. If the dough shrinks as you roll it, allow it to rest, uncovered, for 5 minutes, and then continue rolling. Flattened the dough and shaped it. Baked the biscuit dough until 10 minutes or until done. Removed the cooked biscuits from the baking sheets and let them cool. Packed the biscuits in clean plastic and sealed.

Collection of Data

For sensory evaluation, the instrument used was a score card. It looked into the quality attributes of the product such as appearance, aroma, taste, texture, and crispiness. The evaluators were invited and were given an instruction on how to evaluate the product. The evaluation sheet was given to the ten (10) semi-trained panelists from Capiz State University, Main Campus with their honest opinions solicited. The evaluators were instructed to evaluate the product using a Nine (9) - Point Hedonic Scale as to appearance, aroma, taste, texture, and crispiness. The evaluators evaluated the sensory qualities of Root Crop Biscuits with Green Leafy Vegetables prepared in three (3) treatments in three replications.

The 60 evaluators of the study were composed of twenty (20) cookery students from Panitan National High School and Capiz State University, Main Campus, ten (10) Food vendors in Roxas Capiz, ten (10) Children, at Panitan Capiz and Pilar, Capiz, ten (10) senior citizen, and ten (10) Consumers includes parents of Cogon Panitan, Capiz. After the evaluation of the finished products, the evaluation sheets were gathered, tallied, summarized, and prepared for computation.

The mean is used to determine the level of acceptability of root crops biscuit crackers with leafy vegetables in terms of appearance, aroma, taste, texture, and crispiness. Likewise, the mean is also used to determine the general acceptability of the product as a whole. To determine whether significant differences existed among the nine treatments, the One-Way Analysis of Variance and Independent T-Test is computed at 0.01 levels of significance.

Detailed processes on how the data were gathered through the following steps: In experimental, developmental research, product formulation was the first step established by the researchers. After several trials and errors discovery, one final product can be established.

Starting with Trial 1, the product produced was made and presented to ten (10) semi-trained panelists for sensory evaluation using the Nine-Point Hedonic Rating Scale.

Trial 2 of product formulation was conducted based on the comments, suggestions, and recommendations of the panel of evaluators during the trial 1 evaluation. Results of the evaluation were carried out on the third trial for finalization of the product before it will undergo consumer evaluation for the acceptability level.

The consumer's evaluation of the acceptability of the product was based on the final product formulation during the sensory evaluation of the semi-trained panelist in the three trials or replications. The consumers were composed of sixty (60) evaluators which were classified as; students, food vendors, children, parents, and senior citizens.

Scoring of Variables

The researcher used the Hedonic Nine-Point Rating Scale to score the variables and evaluate the product. The researcher also provides the equivalent interpretation for each scale that corresponds to the Nine Point Hedonic Rating Scale in order to enhance comprehension of the results. In determining the level of acceptability of the product the following scale was used.

The categorizations of each variation were as follows:

1. Appearance of the product

Score	Mean Score	Adjectival Description
9	8.12 – 9.00	Extremely Appealing
8	7.23 – 8.11	Very Much Appealing
7	6.34 – 7.22	Moderately Appealing

6	5.45 – 6.33	Slightly Appealing
5	4.56 – 5.44	Neither appealing nor unappealing
4	3.67 – 4.55	Slightly Unappealing
3	2.78 – 3.66	Moderately Unappealing
2	1.89 – 2.77	Very Much Unappealing
1	1.00 – 1.88	Extremely Unappealing

2. Aroma of the product

Score	Mean Score	Adjectival Description
9	8.12 – 9.00	Extremely Pleasant
8	7.23 – 8.11	Very Much Pleasant
7	6.34 – 7.22	Moderately Pleasant
6	5.45 – 6.33	Slightly Pleasant
5	4.56 – 5.44	Neither Pleasant nor Unpleasant
4	3.67 – 4.55	Slightly Unpleasant
3	2.78 – 3.66	Moderately Unpleasant
2	1.89 – 2.77	Very Much Unpleasant
1	1.00 – 1.88	Extremely Unpleasant

3. Taste of the product

Score	Mean Score	Adjectival Description
9	8.12 – 9.00	Extremely Delicious
8	7.23 – 8.11	Very Much Delicious
7	6.34 – 7.22	Moderately Delicious
6	5.45 – 6.33	Slightly Delicious
5	4.56 – 5.44	Neither Delicious nor Not Delicious
4	3.67 – 4.55	Slightly Not Delicious
3	2.78 – 3.66	Moderately Not Delicious
2	1.89 – 2.77	Very Much Not Delicious
1	1.00 – 1.88	Extremely Not Delicious

4. Texture of the product

Score	Mean Score	Adjectival Description
9	8.12 – 9.00	Extremely Fine
8	7.23 – 8.11	Very Much Fine
7	6.34 – 7.22	Moderately Fine
6	5.45 – 6.33	Slightly Fine
5	4.56 – 5.44	Neither Fine and Not Fine
4	3.67 – 4.55	Slightly Not Fine
3	2.78 – 3.66	Moderately Not Fine
2	1.89 – 2.77	Very Much Not Fine
1	1.00 – 1.88	Extremely Not Fine

5. Crispiness of the product

Score	Mean Score	Adjectival Description
9	8.12 – 9.00	Extremely Crispy
8	7.23 – 8.11	Very Much Crispy
7	6.34 – 7.22	Moderately Crispy
6	5.45 – 6.33	Slightly Crispy
5	4.56 – 5.44	Neither Crispy and Not Crispy
4	3.67 – 4.55	Slightly Not Crispy
3	2.78 – 3.66	Moderately Not Crispy
2	1.89 – 2.77	Very Much Not Crispy
1	1.00 – 1.88	Extremely Not Crispy

6. Acceptability of the Product

Score	Mean Score	Qualitative Description
9	8.12 – 9.00	Liked Extremely
8	7.23 – 8.11	Liked Very Much
7	6.34 – 7.22	Liked Moderately
6	5.45 – 6.33	Liked Slightly
5	4.56 – 5.44	Neither Liked nor Disliked
4	3.67 – 4.55	Disliked Slightly
3	2.78 – 3.66	Disliked Moderately
2	1.89 – 2.77	Disliked Very Much
1	1.00 – 1.88	Disliked Extremely

Statistical Tools and Analysis

The data were tabulated and statistically analyzed by SPSS software using the Arithmetic Mean and the Analysis of Variance (ANOVA).

The Analysis of Variance (ANOVA) was used to determine the significant difference in the sensory qualities of the product in terms of appearance, aroma, taste, texture, and crispiness as well as the differences among the three treatments (Larson, 2008) level of significance was set at a 0.01 alpha.

Cost Analysis

Table 2 shows the product cost and analysis of the ingredients used in making the Root Crop Biscuits with Green Leafy Vegetables.

Ingredient	Quantity	Total
Cassava Flour	50grams	10.00
Butter	50grams	7.00
Skim Milk	45 grams	9.60
Brown Sugar	3 grams	3.00
Iodized Salt	40 grams	1.00
Water	20 grams	
ulitis vegetable	20 grams	2.00

Table 2. Product Cost and Analysis of Product 1.

A. Labor

Labor is equal to 40% of the cost of materials
 Labor = Php 31.60.00 (cost of materials)
 = .40 x Php 31.60
 = 12.64

If the labor consists of 40% of the cost of materials, the total project cost of Product 1 therefore was:

Labor = Php 12.64
 Cost of Materials = 31.60
 Product Cost = 44.24

B. Summary of Expenses of Product 1

The above data shows the cost of all the materials used in making Product 1, Hence, if the 40% is labor and it is added to the cost of materials for treatment, and the project cost of the product therefore was:

Labor = 12.64
 Cost of Materials = 31.60
 Product Cost = 44.24 / 60 pieces of Root Crop Biscuits with Leafy Vegetables
 Cost per biscuit = 0.73

IV. DISCUSSION OF THE RESULTS**Sensory Qualities of Root Crop Biscuits with Green Leafy Vegetables**

The sensory qualities of Root Crops Biscuits with Green Leafy Vegetables were evaluated by the panel of experts with three different kinds of flour with three treatments in terms of appearance, aroma, taste, texture, and crispiness.

Considering the cassava flour with three treatments, treatment A lupo, treatment B kulitis and treatment C kangkong with 15 grams of vegetables, results were obtained in terms of appearance. The cassava flour with kulitis was evaluated as “Extremely Appealing” which got the highest mean of 8.90, cassava flour with lupo got the mean of 8.60, and cassava flour with kangkong got the mean of 8.50 were evaluated as “Extremely Appealing”. Furthermore, the higher mean of the cassava flour with kulitis means that this vegetable was more attractive, based on the evaluation of the panel of experts. Similar results were obtained in terms of the aroma of root crops biscuit crackers with green leafy vegetables. The cassava flour with kulitis, cassava flour with lupo, and cassava flour with kangkong were evaluated as “Extremely Pleasant”. These results are shown by the mean of 8.60 for cassava flour with kulitis, 8.30 for cassava flour with lupo and 8.20 for cassava flour with kangkong. This indicates that the products have an appropriate aroma for biscuits.

In terms of taste, cassava flour with kulitis got the highest mean of 8.80 and were rated as “Extremely Delicious” cassava flour with lupo got the mean of 8.50, and cassava flour with kangkong got a mean of 8.30 were rated as “Extremely Delicious”. Comparing the means, it can be said that the cassava flour with kulitis have the best taste, considering that it got the highest mean. This result may be attributed to the natural good taste of cassava flour with kulitis.

Acceptability of Root Crop Biscuits with Green Leafy Vegetables

Results in the general acceptability of the root crop biscuits with green leafy vegetables of the three products in terms of sensory qualities as evaluated by a group of consumers using the best treatment of each product. Product 1 which is cassava flour with treatment A lupo vegetable got the highest average mean of 8.06 in terms of appearance, “Like Very Much” (M- 8.44) for aroma “Liked Extremely” (M-8.58) for taste “Liked Extremely”, (M-8.88) for texture “Liked Extremely” and (M-8.60) for crispiness “Liked Extremely”. Thus, the cassava flour with lupo was described as “Liked Extremely”.

The result of the study conforms to the study of Evelyn Mae Tecson-Mendoza (2007) Filipinos have traditionally recognized that some foods have benefits beyond nutrition although the term “functional foods” is new to them. Various studies show 9 the nutritional and medical benefits of common Philippine foods. This paper reviews the functional attributes of selected traditional Philippine foods such as rice (*Oryza sativa* L.), coconut (*Cocos nucifera* L.), legumes [mungbean [*Vigna radiata* L. Wilczek] and indigenous legumes], selected native vegetables (*Momordica charantia* and *Moringa olifeira*), root crops (sweet potato (*Ipomoea batatas*), greater yam (*Dioscorea alata*) and taro (*Colocasia esculenta*)] and fruits [mango (*Mangifera indica*), papaya (*Carica papaya*), banana (*Musa* sp.) and pineapple (*Ananas comosus*)]. Processed food products with functional attributes include nata de coco and achara or pickled grated papaya. Germination and fermentation processes have been shown to improve the health benefits of some foods. Increasingly becoming popular are food products promoted with health benefits such as fermented milk drinks, yoghurt with lactobacillus, spirulina cereal, ganoderma coffee, milk with Bifidobacteria, etc. Evaluation of food products that qualify as functional foods on a scientific basis is done under the existing regulations of the Bureau of Food and Drugs of the Philippines Department of Health. Concerned government agencies have been involved in technical consultation meetings in the Asian region aimed at harmonizing the standards for regulating functional foods in the region.

Difference in the Sensory Qualities of Root Crop Biscuits with Green Leafy Vegetables

The result of the study conforms to the study of Chandrasekara and Kumar (2016) nutritionally, roots and tubers have a great potential to provide economical sources of dietary energy, in the form of carbohydrates. The energy from tubers is about one-third of that of an equivalent weight of rice or wheat due to high moisture content of tubers. In general, the protein content of roots and tubers is low ranging from 1 to 2% on a dry weight basis. Potatoes and yams contain high amounts of proteins among other tubers. Sulphur-containing amino acids, namely, methionine and cystine, are the limiting ones in root crop proteins. Cassava, sweet potatoes, potatoes, and yam contain some vitamin C, and yellow varieties of sweet potatoes, yam, and cassava contain β -carotene. Taro is a good source of potassium. Roots and tubers are deficient in most other vitamins and minerals but contain significant amounts of dietary fiber. Similar to other crops, the nutritional value of roots and tubers varies with variety, location, soil type, and agricultural practices, among others.

Difference in the General Acceptability of Root Crop Biscuits in terms of Appearance, Aroma, Taste, Texture and Crispiness

The result of the study conforms to this study of Nantong Ohe Chemicals CO Ltd, the invention discloses a preservation method of rice crackers. A clay drying agent for food is adopted to preserve the rice crackers and contains iron oxide, alumina, and silicon dioxide.

According to the preservation method, the moisture absorption effect is good, foreign odor of hydrogen sulfide can be adsorbed selectively, and aroma or flavor of the rice crackers is preserved.

Results also revealed significant difference in taste among the treatments with the (F-value = 7.246, p value = .001). The formulated hypothesis that there is no significant difference in the products considering treatments is rejected. This means that the treatments were dissimilar in terms of taste. Furthermore, the variation may be due to the taste of different flour and vegetable.

The result of the study conforms to the study of Olaoye et al., (2007) biscuits are produced as nutritive snacks from unpalatable dough that is transformed into appetizing products through the application of heat in the oven.

In addition to the study of Chandrasekara and Kumar (2016) nutritionally, roots and tubers have a great potential to provide economical sources of dietary energy, in the form of carbohydrates. The energy from tubers is about one-third of that of an equivalent weight of rice or wheat due to high moisture content of tubers. However, high yields of roots and tubers give more energy per land unit per day compared to cereal grains.

In general, the protein content of roots and tubers is low ranging from 1 to 2% on a dry weight basis. Potatoes and yams contain high amounts of proteins among other tubers. Sulphur-containing amino acids, namely, methionine and cystine, are the limiting ones in root crop proteins. Cassava, sweet potatoes, potatoes, and yam contain some vitamin C and yellow varieties of sweet potatoes, yam, and cassava contain β -carotene. Taro is a good source of potassium. Roots and tubers are deficient in most other vitamins and minerals but contain significant amounts of dietary fiber. Similar to other crops, nutritional value of roots and tubers varies with variety, location, soil type, and agricultural practices, among others.

The outcomes of the test for no significant difference among the products in terms of texture accepted the null hypothesis (F-value = 9.303, p value = .000). The unevenness of the product in terms of texture may be due to the composition of the variants.

The study result conforms to the study of Eduardo & Svanberg & Oliveira & Ahrne (2013) there is a growing interest in using composite flour for bread making owing to some economic, social, and health reasons. However, the partial substitution of wheat flour by other flour types presents considerable technological difficulties because their proteins lack the ability to form the necessary gluten network for holding the gas produced during the fermentation. The dough formed is more difficult to handle, and the bread has poor loaf volume and crumb softness. Composite flour with cassava has been evaluated in bread making, and general observations are reduced loaf volume, crust color, and impaired sensory qualities as the level of substitution of wheat with other flours increased.

Shelf-life of Root Crop Biscuits with Green Leafy Vegetables

The shelf-life was determined in terms of room temperature and chilling temperature. Results revealed that when the products were stored at room temperature where the product was away from sunlight, with the free passage of air, dry, normally lighted room, and sealed with plastic for 30 days, the 7 days until 15 days, no changes occurred as to physical characteristics indicating that its nutrients were intact. But after 30 days, the product started to lose the crispiness, luster and an unpleasant smell developed. The freshness of the product in general was lost.

Microbial Analysis of Root Crop Biscuits with Green Leafy Vegetables

The Root Crop Biscuits with Green Leafy Vegetables with four (4) packs at 150grams per pack were subjected to Aerobic Plate Count using the Pour plate method, 35°C, 48 hrs., PCA, USFDA BAM Online (2001), Coliform Count using Multiple Tube Fermentation Technique, USFDA BAM Online (2001), and Mold and Yeast Count using Pour plate method, 25°C, 5-7 days., PCA, USFDA BAM Online (2001).

Proximate Analysis of Root Crop Biscuits with Green Leafy Vegetables

The proximate analysis of Root Crop Biscuits with Green Leafy Vegetables obtained the moisture content of 1.64 gram/100gram, ash content of 0.91 gram/ 100gram, crude protein of 4.52 gram/ 100gram, total fat of 9.17 gram/ 100gram, carbohydrate of 83.76 gram/ 100gram and total energy content of 438 kcal/100gram.

Table 3 shows the results for the proximate analysis.

Sample Description	Parameter	Result
Root Crop Biscuits with Green Leafy Vegetables (250g in plastic pack)	Moisture	1.64
	Ash	0.91
	Crude Protein	4.52
	Total Fat	9.17
	Carbohydrates	83.76
	Energy	438 kcal/100g

Table 3. Laboratory analysis for proximate analysis of Root Crop Biscuits with Green Leafy Vegetables.

The results given in this report were those obtained at the time of examination and refer only to the particular sample submitted.

V. CONCLUSION AND RECOMMENDATION

Cassava flour can be utilized as the main ingredient in making biscuits. And the three varieties of vegetables such as lupu, kulitis, and kangkong can be used as savory filling in a biscuit. Among the flour, cassava flour with kulitis has better quality attributes in appearance, aroma, taste, texture and crispiness. While sweet potato flour with lupu and ube flour with kangkong needs further formulation to get the best and can be more appealing, good smell, delicious, smoother/finer texture, and crispiness.

Cassava flour with kulitis, sweet potato flour with lupu, and ube flour with kangkong were liked extremely by the evaluators considering the sensory qualities. Cassava flour with kulitis is the most preferred and cassava flour with lupu is the second choice and cassava flour with kangkong was the third choice. There is a similarity in quality attributes of the three products as to sensory evaluation. There is a dissimilar variation in quality attributes based on consumer preference evaluation. The shelf-life of root crop biscuits with green leafy vegetables at room temperature was 15 days.

Therefore, the root crop biscuits with green leafy vegetables is safe for human consumption as the results of microbial analysis of the product and based on the BFAD standard for microorganism test for products belonging to the baked goods category

Further, it is recommended that cassava flour can be used as flour for biscuits. Biscuit has quality, nutritious and eye-catching style, and shape, and their mouth-watering flavor, pleasing appearance, and aromas can be a recognizable refinement of the formulation per variant and are proposed not only for an economic reason but as supplementary food for all regardless of status. Therefore, that cassava flour with kulitis for biscuits is recommended according to the panel of experts and consumers.

The product can be exhibited in the school during the food fair because of its originality and can be an example and basis for those researchers who will undergo research. Since the preference for biscuits among young and adults is undeniable, the inclusion of the product in the list of food stall vendors at, school, mall and small businesses to have a variety of biscuits with healthy flavors and to fight against malnutrition and nutrient deficiency might ease up the problem.

The method and process may be submitted to RDE to be among the food-matured technology for an extension. As the protection of the proponent, the process may be submitted for IPR protection. The shelf-life of the root crop biscuits with green leafy vegetables may seal in order to prolong the crispiness so that it can be brought/transported to other places or in food display centers.

Other researchers may try other variants/factors not covered in the current study

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