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BREAD-ENRICHED WITH *BASELLA ALBA*: TECHNO-GUIDE FOR SCHOOL-BASED FEEDING PROGRAM

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ABSTRACT

Malabar spinach multifunctional goods addresses the needs of everyone who wants to continue their journey to health beyond COVID 19. Due to its abundant supply, a lot of the crop is either wasted or goes unused. This study sought to transform the excess produce into an innovative food product. It aimed to utilize Malabar spinach into a powder and incorporate into a bread to produce a nutrient-rich product. A quantitative experimental research design was utilized in the analysis of the study. Four treatments of enriched bread were prepared. A microbial analysis was conducted prior to product evaluation and the sample's microbial load count was within the safe limits for food consumption. Research showed that the four treatments of the enriched breads were acceptable and has significant differences in terms of its characteristics. T1 and T2 with a computed value of 6.642 and 8.162 with descriptive equivalent of like very much and like extremely and as the most acceptable treatment to be analyzed for total crude fiber properties. T1 had 1.39 grams of total crude fiber while T2 had 1.78 grams. The total crude fiber content has significantly increased from T1 to T2. To obtain the ideal result, control recipe plus the addition of 10 grams Malabar spinach powder was done. Techno-guide on Bread Enriched with Malabar Spinach was created, highlighting its complete crude fiber qualities, recipe, and cost.

Keywords: Malabar spinach, enriched-bread, microbial analysis, total crude fiber analysis, techno-guide

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INTRODUCTION

Rationale

The public popularity over other foods, bread and biscuits can serve as good sources of fiber, calcium, iron and zinc. It is strongly suggested that there is an increase of quantity in terms of food-to-food fortification with sufficient nutritional value. Baking contributes to the addition of fiber, calcium, iron, and zinc in the enrichment of the bread (Agrahar, 2020). According to Alsuhaibani, A. (2018), food enrichment to bread improved its rheological qualities, nutritional value, and quality in comparison to the control bread. However, compared to the control bread, food enrichment dramatically increases popular acceptance. Thus, it is advised to fortify bread with fiber from natural sources.

Basella alba, also known as "Alugbati" in the Philippines, is an underutilized crop with health advantages (Tongco et al., 2015). Malabar spinach is unique compared to other leafy green plants as it is able to survive in both temperate and very hot environments. Malabar spinach can be treated like regular spinach, you can eat it baked, boiled, fried, sautéed or steamed. *Basella alba* is high in crude fiber content because it absorbs water and is advantageous in improving gastrointestinal function, preventing constipation, and lowering the risk of metabolic disorders (Tongco, 2015).

A child who is wasting, according to the World Health Organization, is "too thin for his height and is the result of recent rapid weight loss or failure to gain weight." Operational parameters for the School-Based Feeding Program's implementation for the academic 2017-2022 were provided by DepEd Order 39, series of 2017. The Masustansyang Pagkain para sa Batang Pilipino Act, also known as Republic Act 11037, aims to combat hunger, encourage students to enroll, improve their nutritional status, give them food for growth and development, and improve health and nutrition use.

Realizing the benefits of Malabar spinach and knowing the various local and global issues, this paper seeks to produce bread-enriched with Malabar spinach with the use Malabar spinach powder as an ingredient in making nutrient-rich product. This supports the promotion of good eating habits. This will be beneficial to school-aged children because they will be able

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to eat a nutritious snack while also getting the nutrients provided by the Malabar spinach. This will help the community in reducing food waste by effectively utilizing food resources, as the Malabar spinach stem is frequently discarded and thrown away.

Theoretical-Conceptual Background of the Study

The framework presented on the next page shows the theories and goals that serve as anchors of this study. The study is supported with the theory of innovation by Joseph A. Schumpeter (2003) that expounds how an idea or a product obtains, boosts, and spreads or diffuses through a certain social system. The expected outcome of this diffusion is when people embrace a new concept and ideas or a product. While the theory of food waste reduction by Papargyropoulou et al. (2014) suggested that in order to have more sustainable resolution of the increasing food waste issues the first move is to embrace a sustainable production and utilize strategy in consumption and as well as discuss food surplus and waste all over the global food surplus chain.

Utilizing the Malabar spinach leaves, its stem and incorporating it to the production of bread is one way to control and reduce the increasing food waste today as Malabar spinach leaves and stem is frequently discarded and thrown away and they consider Malabar spinach leaves as the only useful and beneficial part. With these underlying connections, this study in which Malabar spinach stem and leaves are incorporated to the production of bread were the step in reducing and controlling food waste and to obtain new product or innovation. In the midst of the COVID-19 pandemic, the Department of Education's Bureau of Learner Support Services-School Health Division (BLSS-SHD) is committed to providing students with nutritious food. The program gave beneficiaries nutritious food products and pasteurized milk for SY 2021–2022, only 33 days for pasteurized or sterilized milk and only 60 feeding days nutritious food products.

The researcher incorporated Malabar spinach powder in the production of bread. According to Chef Rose Marie Lim's recipe the ingredients in making bread are 12g yeast, 240g water, 40g egg, 4g salt, 56g sugar, 120g butter, and 500 grams all-purpose flour.

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However, for the treatments the amount of Malabar spinach powder will vary by grams. The researcher came up with four treatments having the first treatment as the control, the second, third, and fourth as the control plus the varying grams of Malabar spinach powder. Microbial Analysis was made to the four treatments to make sure that the food is safe for product testing. To examine the difference of the treatments, sensory attributes were tested through the different senses. The breads were examined by its color, odor, hand texture, mouth texture, and taste. Hedonic rating scale were utilized in determining the preference of the trained panelist with bread enriched with Malabar spinach. Kurek, M., & Wyrwisz, J. (2015), stated that there were numerous health advantages of fiber that have been studied, such as improved intestinal function, reduced levels of blood cholesterol, and better blood sugar regulation. Total Crude Fiber analysis were made to determine the fiber properties, and various nutrients that might be present in the formulated bread.

Lastly, a Techno-guide was made in order to provide and display new ideas and products to the people that aid them incase if they have plan to make such product in the future.

Statement of the Problem

This study sought to develop bread enriched with *Basella alba* as basis for designing a techno-guide for school-based feeding program. Specifically, it aimed to answer the following questions:

1. What is the microbial analysis of the four treatments?
2. What are the descriptive attributes of the treatments in terms of:
    2.1 appearance,
    2.2 odor,
    2.3 hand texture,
    2.4 mouth texture, and
    2.5 taste?

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3. What is the hedonic acceptability of the treatments in terms of:
    2.1 appearance,
    2.2 odor,
    2.3 hand texture,
    2.4 mouth texture, and
    2.5 taste?
4. What is the total crude fiber analysis of the most preferred treatment and the control?
5. Is there any significant difference among the four treatments in terms of the level of Hedonic Acceptability?
6. What Techno-guide for school-based feeding program may be designed?

Significance of the Study

Malabar spinach's multifunctional goods address the needs of everyone who wants to continue their journey to health beyond COVID-19. This study is significant to the teenagers on learning to eat and enjoying healthy snacks to develop healthy eating habits. To the parents, this study may help them in encouraging their children for healthy eating habits by providing alternatives for healthier snacks to their children. For the government officials, this study is significant in taking-action of the issues in food waste management and food shortage. This is also beneficial to Don Vicente Rama Memorial National High School in the provision of the nutritious food products to the identified primary school children. Finally, the findings of this study may be used as a different prospective area of concern to develop another intervention by future researchers.

Scope and Limitation of the Study

This study of bread enriched with Malabar spinach may help promote a healthier life and a better community. This study aimed to utilize Malabar spinach's leaf and stem effectively to lessen food waste. To ensure food safety, prior product testing and microbial analysis were done for the four treatments. Also, identifying pathogens that might be present in the product

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that causes spoilage was done. Total crude fiber analysis was conducted to the controlled and most preferred treatment.

Operational Definition of Terms

Terms are defined in this study in accordance with the concepts they are used for clarity:

Basella alba. It is known as the Malabar spinach. It is the plant used in making alugbati-enriched bread in this study. It is famous in the Philippines and in Asia due to its medicinal properties.

Breads. This refers to experimental baked snacks made by researchers.

Microbial Analysis. This is the process of identifying pathogens causing risk to human health in food products.

Total Crude Fiber Analysis. This determines the fiber content behavior of the food product during production, consumption, and storage.

Sensory Analysis. It is the utilization of human senses for the purpose of evaluation a certain food product.

Techno-guide. It is the crafted guide in the reproduction of the developed product.

MATERIALS and METHODS

The section of the study embodied the research methodology and its procedures. This section provides the methods and processes that had been undertaken that carry through the objectives of the study. The researcher considered the following in making the methodology: research design, research environment, sample design, research instrument, collection of data, data analysis, and ethical consideration.

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Research Design

This research utilized the quantitative design of research in which it uses data collection to explain things that are to be analyzed with the use of mathematically based methods specifically the statistics (Creswell, 1994). Moreover, an experimental research design was utilized that determined the most acceptable treatment of Malabar spinach enriched bread. The four treatments underwent microbial analysis to ensure food safety prior to product testing to identify the various pathogens that might be present in food that cause quick food spoilage, and identify microorganism that will cause risk and issues concerning the health of the people consuming the food product. Sensory attributes were tested through the different senses that examined the difference of the treatments. The breads were examined by its color, odor, hand texture, mouth texture, and taste. A 9-point hedonic evaluation was conducted to identify the most preferred treatment. The most preferred treatment underwent total crude fiber analysis to identify the fiber content helpful in proving the nutritional content of the formulated bread enriched with Malabar spinach. This type of research design, according to Cook (2015), was used to discover the reason of a certain treatment.

Research Environment

The location of the study was in one of the schools in Cebu City, Philippines. The researcher chose the locale where there were an abundance of Malabar spinach and due to its excessive supplies, great amount of Malabar spinach produced were unused, and worse were put into waste. The location was convenient for the researcher to conduct the study because of the complete and well-ventilated facility. Thus, this was where the researcher got the supplies and needed materials.

Research Respondents

Cebu City was the target population of this study, the researcher selected 15 trained panelists that are holders of National Certification Level II in Bread and Pastry Production. This study utilized the purposive sampling for 15 adult experts with ages that ranged from 25

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years old- 50 years old. Purposive sampling as defined by Black (2010) is a method of non-probability sampling that takes place when the judgement of the researcher is the basis in choosing the population for the sample. The researcher repeatedly acknowledged that they can obtain a representative sample by using sound judgment, which could result in saving time and money. The respondents were chosen since they were involved on health matters through this new pandemic world. Furthermore, it is assumed that the respondents provided adequate data.

Research Instrument

To gather an ample data, a descriptive type of method was used. This method included the use of a scale. The 9-point Hedonic scale, created by David Peryam and colleagues, was used in this study to measure participants' food preferences. This 9- point hedonic scale shows longer scales, up to nine intervals, which tends to be more discriminating the other shorter scale (Peryam, 2008). Specifically, the researcher modified the scale utilized in the study of Gabrie et al., (2005) titled "Consumer Acceptance of Philippine Orange Drink as an Iron-fortified Beverage for Filipino Women". Moreover, sensory evaluation of the bread was conducted that determined the acceptability of the enriched-bread in terms of sensory attributes and the researcher adapted the tool used by Bornare, D. T., (2015) on their study "Physical and sensory Evaluation of Cookies Incorporated with Oats and Honey" which the respondents evaluated the product according to its color, appearance, texture, mouthfeel, taste and the overall acceptability.

Research Procedure and Treatment of Data

a. Procedure

Development of the product, procurement stage, product testing, and product assessment are the three phases in the research process for this study. This model is adapted to the study of Zabala & Goles (2021) titled Watermelon Rind-Ponkan Marmalade: A Physico-chemical Analysis.

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Figure 2 above shows the process in developing the Malabar spinach enriched breads from the generation of ideas, product testing including Pre-Experimental period, Experimental period, four treatment preparation and the four treatments final recipe. These different treatments were evaluated through sensory attributes including the product's color, odor, mouth texture, hand texture, and taste with scoring preference test were utilized, as well as the Hedonic scale in determining its acceptability, microbial analysis and total crude fiber analysis were made to check the product's composition. Lastly, a Techno guide was designed after all the process.

Idea Conceptualization

The Malabar spinach is rich in moisture and are fibrous to consume, that is why most of the people throw away the stem of the Malabar spinach or discard them. However, when processed properly, stems may be used in bread production specifically in incorporating it into the production of bread. The researcher adapted and modified the bread procedure of Chef Rose Marie Lim, an award winning and seasoned chef, food lecturer, and the Founder of Caro & Marie in Cebu City. With the different studies on Malabar spinach, the researcher proposed utilizing its stem and leaves into powder and incorporate in bread, which is considered to be a healthy snack for children as they grow with enough nutrients and as well as they will practice the healthy eating habits for a healthier and active life.

Formulation stage

The researcher got the ingredient, which is the freshly picked Malabar spinach in Tabunan, Cebu City. The researcher located where and procured Malabar spinach supplies that were utilized. In addition, the researcher gathered the necessary materials and ingredients needed for the experiment. Based on Chef Rose Marie Lim's recipe, the researcher utilized the same recipe for making the breads, the ingredients are 12g yeast, 240g water, 40 grams egg, 4g salt, 56g sugar, 120g butter, 500g all-purpose flour, and for the additional ingredient, the researcher used freshly picked Malabar spinach processed into a powder.

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Lastly, the materials that were used in making breads are food processor, baking sheet, measuring cup and spoon, rubber scraper, weighing scale, baking mat/parchment paper, bowl, mixer, spatula, wire whisk, and oven.

Product Testing

In this section, the proposed bread enriched with Malabar spinach went four periods in testing product. These periods were Pre-Experimental period, Experimental period, Four treatments preparation, lastly Four treatments final recipe.

Pre-Experimental Period

The Malabar spinach was prepared first. The stems were separated from the leaves, and then thoroughly washed. Using a strainer, the spinach was drained well and cut with a sharp knife on a cutting board. Next, other ingredients were prepared, the flour was sifted using a sifter, and the mise en place was performed. After the ingredients were prepared, the process of making bread enriched with Malabar spinach began. Yeast was dissolved in water. In a bowl, 40 grams of egg, 4 grams of salt, 56 grams of sugar, 120 grams of butter, 500 grams of all-purpose flour, and the Malabar spinach powder were added. The dough was made smooth and elastic by kneading. It was then placed in a greased bowl, allowing the dough to rise until it had doubled in size, which took 45 to 60 minutes. The dough was punched down, divided into 50-gram portions, formed into smooth balls, and placed on baking sheets. They were allowed to rise for 45 minutes or until doubled in bulk. Finally, the dough was baked at 350 degrees Fahrenheit for 12 minutes or until done.

Experimental Period

The researcher thoroughly washed the Malabar spinach, separated the stems and leaves, placing them in two different lined baking pans, and then dried them in the oven for about 30 minutes at 200 degrees Celsius or 400 degrees Fahrenheit, constantly checking the oven temperature. The dried Malabar spinach was processed using a food processor, resulting

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in Malabar spinach powder. The produced powder was sifted to prevent the bread from having a lumpy texture. Nevertheless, the process of combining the ingredients remained the same as in the pre-experimental period.

The researcher used the following amount in grams of bread enriched with Malabar spinach:

Treatment 1 – control

Treatment 2 – bread enriched with 10 grams of Malabar spinach powder

Treatment 3 – bread enriched with 30 grams of Malabar spinach powder

Treatment 4 – bread enriched with 50 grams of Malabar spinach powder

Process of Making Bread Enriched with Malabar Spinach

Ingredients:

The exact ingredients were utilized in producing the Bread Enriched with Malabar spinach are Malabar spinach powder, yeast, water, egg, salt, sugar, butter and all-purpose flour.

Materials:

The various materials used in the preparation of the product are oven, mixing bowl, spatula, measuring cup, measuring spoons, weighing scale, food processor, baking sheets, pastry brush, strainer, and heavy-duty mixer.

Procedure:

Perform mise en place. Wash the Malabar spinach thoroughly, then dry the leaves and stems in the oven. Process the dried Malabar spinach using a food processor to create Malabar spinach powder. Preheat the oven to 400 degrees Fahrenheit. Dissolve the yeast in water and add egg, salt, sugar, butter, all-purpose flour, and Malabar spinach powder. Knead the dough until it becomes smooth and elastic. Allow the dough to rise for 45-60 minutes, then punch it

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down. Scale the rested dough into 50-gram portions, shaping them into smooth balls and placing them on a greased baking sheet. Proof for 45 minutes or until doubled in bulk, then bake for 12 minutes at 400 degrees Fahrenheit.

Preparation of the four treatments

The Malabar spinach was washed, strained, and dried in an oven for about 30 minutes. It was then processed with a food processor to produce the Malabar spinach powder. The yeast was dissolved in water. In a bowl, 40 grams of egg, 4 grams of salt, 56 grams of sugar, 120 grams of butter, 500 grams of all-purpose flour, and the Malabar spinach powder were added for each treatment (Treatment 1-control, Treatment 2- 10 grams of Malabar spinach powder, Treatment 3- 30 grams of Malabar spinach powder, and Treatment 4- 50 grams of Malabar spinach powder), ensuring uniform incorporation. The dough was kneaded until stretchy. It was then placed in an oiled bowl and allowed to double in bulk for 45 to 60 minutes. The dough was punched down and divided into 50-gram portions, which were formed into smooth balls and placed on baking sheets. They were allowed to rise for 45 minutes or until doubled in bulk. Finally, they were baked at 400 degrees Fahrenheit for 12 minutes or until done.

Final Recipe of the Four Treatments.

Table 1

Bread Enriched with Alugbati Formulation

Treatment 1 (Control)	**Treatment 2** 10g alugbati powder	**Treatment 3** 30g alugbati powder	**Treatment 4** 50g alugbati powder
12 grams Yeast 240 grams Water	12 grams Yeast 240 grams Water	12 grams Yeast 240 grams Water	12 grams Yeast 240 grams Water

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40 grams Egg 4 grams Salt 56 grams Sugar 120 grams Butter 500 grams All-purpose flour	40 grams Egg 4 grams Salt 56 grams Sugar 120 grams Butter 500 grams All-purpose flour	40 grams Egg 4 grams Salt 56 grams Sugar 120 grams Butter 500 grams All-purpose flour	40 grams Egg 4 grams Salt 56 grams Sugar 120 grams Butter 500 grams All-purpose flour

Product Testing

Sensory evaluation of the samples was conducted using 15 expert panelists. Four coded bread samples were presented to each panelist. They evaluated the bread enriched with Malabar spinach based on its color, appearance, texture, mouth feel, hand texture, and taste using Hedonic rating scale. The evaluation ran for a maximum of 15 minutes per participant.

Microbial Analysis and Total Crude Fiber Analysis

The most acceptable sample was then subjected to total crude fiber analysis in a certified food chemical analysis laboratory facility of FAST Laboratory in Mandaue, City. In order to assure food safety prior to consumption, the Department of Science and Technology (DOST) Region VII laboratory conducted a microbiological aerobic plate count on the four treatments.

In determining the computed values, the following scales were used:

1. For the characteristics of the four treatments of Bread-Enriched with Malabar Spinach

Appearance

5.00-4.21 - Golden Brown
4.20-3.41 - Light Brown
3.40-2.61 - Pale Brown
2.60-1.81 - Dark Brown
1.80-1.00 - Yellowish

Odor

5.00-4.21 - Commercial Yeast

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4.20-3.41	-	Absence
3.40-2.61	-	Sour Odor
2.60-1.81	-	Strong Alcohol Odor
1.80-1.00	-	Balsamic Odor
Hand Texture		
5.00-4.21	-	Uniform
4.20-3.41	-	Thin Walled
3.40-2.61	-	Thick Walled
2.60-1.81	-	Coarse Distribution
1.80-1.00	-	Not Uniform
Crumb Texture		
5.00-4.21	-	Tasty
4.20-3.41	-	Flaky
3.40-2.61	-	Coarsely
2.60-1.81	-	Tough
1.80-1.00	-	Curdy
Taste		
5.00-4.21-	Tasty	
4.20-3.41-	Salty	
3.40-2.61-	Bland	
2.60-1.81-	Burnt	
1.80-1.00	-	Underbaked

For the hedonic acceptability of the four treatments of Bread-Enriched with Malabar Spinach

9.00-8.112	-	Liked Extremely
8.112-7.223	-	Liked Very Much
7.223-6.334-		Liked Moderately
6.334-5.445		Liked Slightly

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5.445-4.556	Neither liked nor dislike
4.556-3.667-	Disliked Slightly
3.667-2.778	Disliked Moderately
2.778-1.889-	Disliked Very Much
1.889-1.00-	Disliked Extremely

Data Treatment

The study utilized quantitative data analysis, employing tables to present the summary of data and implementing the Brown-Forsythe Test for non-normally distributed data. Brown, R. and Forsythe, L. (1974) provided alternatives to Levene's test, utilizing deviations instead of the median or trimmed mean, as discussed by Derrick et al. (2018, pp. 36-47). Dag & Konar (2018, p. 10) stated that the most popular statistical techniques used in investigations across various fields—such as medicine, pharmaceutical research, agriculture, biology, engineering, social sciences, and food research—are applicable to one-way tests in independent group designs.

RESULTS AND DISCUSSIONS

This chapter presented the results and discussion of the findings derived from the responses in the questionnaires and the total crude fiber analysis, and Microbial Analysis conducted at the laboratory facilities of the FAST Laboratory in Mandaue, City and Department of Science and Technology- Region VII. The presentation of the data follows the statement of the problems.

Microbial Analysis of the Four Treatments

There were four coded treatments with varying amounts of Malabar spinach powder that were subjected for microbial analysis in the DOST VII- regional laboratory facility. Table 1 below shows the total plate count results of the four treatments as per examined in the Department of Science and Technology VII.

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Table 2

Microbial Analysis Results of the Four Treatments

Treatments	Microbial Analysis Result	Remarks
1	2.7x 10^2 cfu/g	Acceptable Limit
2	<25 x 10 eapc*/g	Acceptable Limit
3	<25x10 eapc*g	Acceptable Limit
4	<1.0 x 10 eapc*/g	Acceptable Limit

Legend: CFU- Colony Forming Unit, EAPC- Estimated Aerobic Plate Count

Saddozai, A. *et al.* (2009), emphasized that the maximum acceptable limits for baked products like bread, biscuit, and cake for the total plate count (TPC) is 2.0 x 10^5 cfu g^1, World Health Organization standard (1994).

The allowed limit for Aerobic Plate Count is stated in Food and Drug Administration Circular No. 2013-010, or "Revised Guidelines for the Assessment of Microbiological Quality of Processed Food" is:

n= (5) number of sample units selected from a lot of food to be examined

c= (2) maximum allowable number of marginally acceptable samples

m= (10^4) acceptable level of microorganism determined by a specified method; the values are typically based on the highest levels that can be achieved under GMP.

M=(10^6) level that if exceeded in one or more samples would result in the lot being rejected as this could signal potential health risks or impending spoiling. It can be gleaned from Table 1 that the results of the microbial analysis that the product was within the safe limits and was safe for consumption.

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Descriptive Attributes of the Four Treatments

There were four treatments of bread enriched with Malabar spinach with varying proportion of Malabar spinach powder. Each treatment of bread enriched with Malabar spinach was given a number code. Treatment 1 was the control treatment, treatment 2 was the control treatment added with 10 grams of Malabar spinach powder, treatment 3 was added with 30 grams of Malabar spinach powder, and treatment 4 was added with 50 grams of Malabar spinach powder. Table 2 below shows the characteristics of treatment as assessed by the research participants.

Table 2

Descriptive attributes of the four treatments

Attributes	Treatments	Mean ± SD	Adjectival Rating
Appearance	Treatment 1	4.27 ± 0.704	Golden Brown
	Treatment 2	4.80 ± 0.414	Golden Brown
	Treatment 3	4.33 ± 1.234	Golden Brown
	Treatment 4	4.00 ± 1.414	Light Brown
Odor	Treatment 1	4.73 ± 0.458	Commercial Yeast
	Treatment 2	4.80 ± 0.414	Commercial Yeast
	Treatment 3	4.07 ± 1.387	Absence
	Treatment 4	3.47 ± 1.302	Absence
Hand Texture	Treatment 1	4.67 ± 0.488	Uniform
	Treatment 2	4.80 ± 0.561	Uniform
	Treatment 3	4.73 ± 0.458	Uniform
	Treatment 4	4.47 ± 0.915	Uniform
Crumb Texture	Treatment 1	4.87 ± 0.352	Spongy
	Treatment 2	4.80 ± 0.414	Spongy
	Treatment 3	4.60 ± 0.632	Spongy
	Treatment 4	4.53 ± 0.990	Spongy

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Taste	Treatment 1	4.93 ± 0.258	Tasty
	Treatment 2	4.93 ± 0.258	Tasty
	Treatment 3	4.53 ± 0.743	Tasty
	Treatment 4	4.20 ± 1.146	Salty

Table 2 displays the descriptive attributes of the four treatments of bread enriched with Malabar spinach as rated by the panel.

Purlis, E. *et al*. (2010) expected that color intensity of the samples got brighter as the baking time increased. However, browning was only visible after 10 minutes of baking in an oven set to 200 or 220 C. In addition to the significant impact of oven temperature on color development, likely for the appearance, treatment number 1, treatment number 2 and number 3 had golden brown color while treatment number 4 had light brown in color as evaluated by the consumer panelist.

According to Sengev, A. *et al.* (2013) that bread's browning may be delayed by using more chlorophyll-rich ingredient in baking. Relatedly, it can be established that treatments 1, 2, and 3 that have less amount of Malabar spinach powder have similarity that is golden brown in color while the treatment 4 which has the highest amount of Malabar spinach powder had light brown in color. The Malabar spinach powder contains chlorophyll that delays the browning of the bread. The addition of Malabar spinach powder delays the browning of the bread. The more Malabar spinach powder is added, the longer baking time was needed for browning.

Birch, A.N. *et al.* (2014) asserted that yeast, fermentation temperature, and time significantly affected the odor of breads. Also, the odor of the treatment 1 and treatment 2 were evaluated as commercial yeast while treatment 3 and treatment 4 were evaluated as *absence*. The respondents' perceptions of the commercial yeast odor were identical, which may be explained by the influence of the odor of yeast fermentation, while the absence can be explained by the addition of Malabar spinach powder, which overpowered the odor. The

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increasing amount of Malabar spinach addition dominated the odor of the bread that impacted to be absence for both treatments 3 and 4.

The characteristics on hand texture of bread enriched with Malabar spinach received an even uniform rating to all treatments as evaluated by the consumer panelist. Hand texture of all the treatments are uniform due to the proper mixing, fermentation, proofing, ingredient ratio, kneading, shaping, and baking time and temperature being followed in producing the bread enriched with Malabar spinach.

Abdullah, M. *et al.* (2021) stated that one of the crucial factors in the baking industry that impacts the sensory quality and therefore the consumer acceptability of bakery goods is the crumb softness. In terms of the crumb texture, all treatments were evaluated by the panelists as spongy. Trained panelist evaluated all treatments of enriched bread to be spongy due to the soft crumb and uniform texture of the enriched-bread. Fu Y. *et al.* (2021) claimed that the major indicator of bread textural qualities was softness, while hard behavior was regarded as acceptable. All four treatments considered the proper leavening, gluten development, moisture content, proper proofing, and cooling as essential factors in producing a spongy bread enriched with Malabar spinach.

Nur, M. *et al.* (2023), stated that the latest investigations offer new insights into the physicochemical properties and nutritional advantages of native and hybrid Malabar spinach fruit variants. According to studies that looked at both native and hybrid varieties of the vegetable, Malabar spinach provides a high source of fat, fiber, energy, protein, ß-carotene, numerous important minerals and fatty acids (Arachidic, linolenic, and linoleic acids). According to Pu, D. et al. (2020) claims that sour, tasty, and salty were identified by dynamic sensory analysis as the primary flavors experienced while eating bread. These flavors are effects of chewing and perceptions were all substantial. Similarly, the results on the evaluation of the taste for treatment 1, treatment 2, treatment 3 as perceived by trained panelist is tasty. Treatment 4 is perceived to be salty. Balance of flavors, quality ingredients, and flavorful addition of Malabar spinach powder contributed in the tasty and salty taste of bread enriched

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with Malabar spinach. The increasing amount of Malabar spinach powder addition resulted to the significant salty taste of the enriched-bread.

Level of Acceptability of Each Treatment of Bread Enriched with Malabar Spinach

The acceptability of each treatment of bread enriched with Malabar spinach was calculated using the conventional questionnaire-Hedonic Scale. Table 3 indicates the degree to which the four treatments are acceptable.

Table 3

Hedonic acceptability of the four treatments

Attributes	Treatments	Mean ± SD	Adjectival Rating
Appearance	Treatment 1	8.07 ± 0.594	Like Very Much
	Treatment 2	8.67 ± 0.488	Like Extremely
	Treatment 3	7.53 ± 1.506	Like Very Much
	Treatment 4	6.93 ± 1.751	Like Moderately
Odor	Treatment 1	8.13 ± 0.516	Like Extremely
	Treatment 2	8.60 ± 0.632	Like Extremely
	Treatment 3	7.00 ± 1.464	Like Moderately
	Treatment 4	6.40 ± 1.844	Like Moderately
Hand Texture	Treatment 1	8.07 ± 0.704	Like Very Much
	Treatment 2	8.67 ± 0.617	Like Extremely
	Treatment 3	7.20 ± 1.424	Like Moderately
	Treatment 4	6.87 ± 1.885	Like Moderately
Crumb Texture	Treatment 1	8.27 ± 0.704	Like Extremely
	Treatment 2	8.67 ± 0.617	Like Extremely
	Treatment 3	7.47 ± 1.552	Like Very Much
	Treatment 4	7.00 ± 1.732	Like Moderately
Taste	Treatment 1	8.27 ± 0.704	Like Extremely
	Treatment 2	8.60 ± 0.737	Like Extremely

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Treatment 3	6.87 ± 1.727	Like Moderately
Treatment 4	6.33 ± 2.193	Like Moderately

Note. 1.0 – 1.889– **; 1.889 – 2.778 – **; 2.778 – 3.667 – **; 3.667 – 4.556 – **; 4.556 – 5.445 – **; 5.445 – 6.334 - **; 6.334 – 7.223 - **; 7.223 – 8.112 - **; 8.112-9.00**

The trained panelists also assessed the acceptability of each sensory component of each treatment. Table 3 displays the calculated results and a qualitative evaluation of how well the characteristics of each treatment of bread enhanced with Malabar spinach performed.

According to Govender, L., & Siwela, M. (2020) that the prepared bread has a darker color. Maybe this is because brown bread naturally has a darker color due to the bran's chocolate color, which hides the darker color that white bread would otherwise have at identical level of moringa. These results corroborated Bourekoua et al.'s (2018) investigation, which found that when the moringa concentration rose, the bread crust and crumb's lightness decreased. Customers are more accustomed to bread being a golden-brown tone, therefore this dark color could negatively affect how popular bread supplemented with moringa is with shoppers.

Govender, L. *et al.* (2021) stated that Malabar spinach is naturally dark green in color which contains high percentage of chlorophyll that helps in the fast browning of breads when baked. Also, it can be gleaned that for the appearance, trained panelists liked extremely treatment 2 compared to treatment 3, and treatment 1 that had like very much acceptability, while treatment 4 had like moderately. The addition of Malabar spinach powder contributed to the golden-brown appearance of the enriched bread that most of the trained panelist liked extremely.

According to Esfanjani, F. *et al.* (2023) that odor interaction improved the sensory qualities of bread samples, such as increasing a pleasant aroma, bread flavor, and softness. Likewise, the odor of treatment 1 and treatment 2 were liked extremely by the trained panelist while treatment 3 and treatment 4 were like moderately. Commercial yeast odor and liked extremely prevails as evaluated by the trained panelist.

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According to Kumala, T. *et al.* (2020), increased protein in bread mixture makes the bread elastic. In terms of crumb texture, treatments 1 & 2 is preferred by the trained panelists as like extremely. Meanwhile, treatment 3 had like very much and treatment 4 had like moderately preferences from the trained panelists. The first two treatments were liked extremely due to the spongy texture of the bread sample.

Kumala, T. *et al.* (2020) stated that increased elasticity and cohesiveness of bread were caused by increasing protein in mixture, which also reduced hardness in bread. Similarly, for the hand texture, trained panelists liked extremely treatment 2. Treatment 1 had like very much while treatment 3 and treatment 4 had like moderately. The uniform texture of treatment 2 was liked extremely by the trained panelist.

According to Pu, D*. et al.* (2020) claimed that sour, tasty, and salty were identified by dynamic sensory analysis as the primary flavors experienced while eating bread. These flavors are effects of chewing and perceptions were all substantial. Similarly, treatments 1, 2 and 3 were evaluated as like extremely by the trained panelists, while for treatment 4 it was evaluated like moderately. Balance of flavors, quality ingredients, and flavorful addition of Malabar spinach powder contributed in the tasty and salty taste of bread enriched with Malabar spinach. The increasing amount of Malabar spinach powder addition resulted to the significant salty taste of the enriched-bread.

Total Crude Fiber Analysis of Bread Enriched with Malabar Spinach

The treatments numbered 1 and 2 were the two (2) that received the highest computed acceptability value. The two samples with the highest computed value are subjected to an analysis of total crude fiber.

According to the study of Estrella, D. *et al.* (2020) addition of quinoa to the enriched bread increases fiber content of the enriched bread. Similarly, it can be gleaned that treatment 1 (1A-1B, coded by FAST Laboratory) had an average of total crude fiber of 1.39g/100 grams of bread while treatment 2 (2A-2B, coded by FAST Laboratory) had an average of total crude

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fiber of 1.78 grams/ 100 grams of bread. Clearly, the addition of Malabar spinach powder increases the amount of total crude fiber content of the bread.

Table 4

Total Crude Fiber Analysis Result

Customer:	Luis C. Gerunda
Address:	556 J. P. del Rosario Extension Cebu City
Sample(s) Submitted:	FOOD (As declared)
Sample Code:	MC2305-2030-01 TO 02
Date/Time Received:	May 30, 2023- 01:36 PM
Date Analyzed:	May 30- June 7, 2023
Analyzed by:	R.B. BARANGIAN/ R.T. ONG
Date Reported:	June 8, 2023

Sample	Crude Fiber, g/100g	Test Method
Treatment 1- Original Recipe (Pan De Sal) (Controlled) MC2305-2030-01	**1.39**	**ANKOM Fiber Analyzer**
Treatment 2- (Original Recipe plus 10 grams of Malabar spinach powder) MC2305-2030-02	**1.78**	

Suárez-Estrella, D. *et al.* (2020) claimed that they were able to create enriched bread using sprouted quinoa at a 20:80 replacement level in wheat formulation. To increase the production and consumption of fiber-rich foods and highly biologically active proteins, it may be appropriate that the addition of seed be done to produce quinoa-enriched bread. Similarly, the addition of Malabar spinach powder is important in producing the crude fiber-enriched bread.

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Betoret, E., & Rosell, C. M. (2020) stated that successful enrichment methods can be carried out using bread with bioactive substances found in fruits and vegetables. Fruits and vegetables were substantially more frequently included in meals that is with antioxidant capacity of all phenolic chemicals combined richer breads. Correspondingly, the Malabar spinach powder enriched-bread is good in providing nutritious snacks in schools.

According to Osimani, A. *et al.* (2018), that the overall data showed cricket powder was a suitable fit for making enriched bread. The current study showed that to improve the nutritional value of leavened baked goods, especially in terms of protein content, edible insect powder can be added successfully. Doughs that appeared to be suitable for making bread were formed when 10% cricket powder was added. The nutritional profile of the experimental breads was superior to that of the controls in terms of nutrients because they contained cricket powder. Their fatty acid composition, protein content, and presence of the three crucial amino acids valine, methionine, and lysine. Notably, the bread loaves that contained crickets contained a significant number of spore-forming bacteria, which raised questions about the powder's safety for consumers.

Significant Difference of the Four Treatments in Terms of the Level of Hedonic Acceptability

Table 5

Significant Difference of the Four Treatments (Level of Hedonic Acceptability)

Dimension		Statistic[a]	df1	df2	Sig.
Appearance	Welch	7.582	3	28.846	.001
	Brown-Forsythe	5.552	3	33.368	.003
Odor	Welch	9.680	3	28.932	.000
	Brown-Forsythe	9.877	3	32.950	.000
Hand Texture	Welch	7.650	3	29.356	.001
	Brown-Forsythe	6.236	3	34.086	.002

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Crumb Texture	Welch	5.759	3	29.327	.003
	Brown-Forsythe	5.441	3	36.400	.003
Taste	Welch	7.767	3	29.251	.001
	Brown-Forsythe	8.062	3	33.516	.000

The Brown-Forsythe test results for appearance indicate that the variances are significantly different (W=5.552, p=0.003) among the groups. Hence, we fail to accept the null hypothesis (as p<0.05) that group variances are unequal. Treatment 2 is the highest in terms of appearance in the level of acceptability. With the mean value of 8.67 and standard deviation of 0.488 with adjectival rating of like extremely compared to other treatments. Govender, L. *et al.* (2021) stated that Malabar spinach is naturally dark green in color which contains high percentage of chlorophyll that helps in the fast browning of breads when baked. The appearance of treatment 2 that has an adjectival rating of like extremely by the trained panelist is due to the contribution of the added Malabar spinach powder to the bread recipe which has high chlorophyll content that helps in the fast browning of bread's crust.

The Brown-Forsythe test results for odor indicate that the variances are significantly different (W=9.877, p=0.000) among the groups. Hence, we fail to accept the null hypothesis (as p<0.05) that group variances are unequal. Treatment 2 is the highest in terms of odor in the level of acceptability. With the mean value of 8.60 and standard deviation of 0.632 with adjectival rating of like extremely compared to other treatments. The odor of treatment 2 that has an adjectival rating of like extremely by the trained panelist is due to minimal amount of addition of Malabar spinach powder which may block the yeast odor if added with much amount to the enriched-bread. According to Birch, A.N. *et al.* (2014) that asserted that yeast, fermentation temperature, and time significantly affected the odor of breads.

The Brown-Forsythe test results for hand texture indicate that the variances are significantly different (W=6.236, p=0.002) among the groups. Hence, we fail to accept the null hypothesis (as p<0.05) that group variances are unequal. Treatment 2 is the highest in terms of hand texture in the level of acceptability. With the mean value of 8.67 and standard

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deviation of 0.617 with adjectival rating of like extremely compared to other treatments. Abdullah, M. *et al.* (2021) stated that one of the crucial factors in the baking industry that impacts the sensory quality and therefore the consumer acceptability of bakery goods is the crumb softness. The hand texture of treatment 2 that has an adjectival rating of like extremely by the trained panelist is due to the proper mixing, fermentation, proofing, ingredient ratio, kneading, shaping, and baking time and temperature being followed in producing the bread enriched with Malabar spinach.

The Brown-Forsythe test results for crumb texture indicate that the variances are significantly different (W=5.441, p=0.003) among the groups. Hence, we fail to accept the null hypothesis (as p<0.05) that group variances are unequal. Treatment 2 is the highest in terms of crumb texture in the level of acceptability. With the mean value of 8.67 and standard deviation of 0.617 with adjectival rating of like extremely compared to other treatments. According to Kumala, T. *et al.* (2020) stated that increased elasticity and cohesiveness of bread were caused by increasing protein in mixture, which also reduced hardness in bread. The crumb texture of treatment 2 that has an adjectival rating of like extremely by the trained panelist is due to the elastic properties of the bread that causes it to be spongy and soft.

The Brown-Forsythe test results for taste indicate that the variances are significantly different (W=8.062, p=0.000) among the groups. Hence, we fail to accept the null hypothesis (as p<0.05) that group variances are unequal. Treatment 2 is the highest in terms of taste in the level of acceptability. With the mean value of 8.60 and standard deviation of 0.737 with adjectival rating of like extremely compared to other treatments. According to Pu, D. *et al.* (2020) claimed that sour, tasty, and salty were identified by dynamic sensory analysis as the primary flavors experienced while eating bread. These flavors are effects of chewing and perceptions were all substantial. The taste of treatment 2 that has an adjectival rating of like extremely by the trained panelist is due to the balance of flavors, quality ingredients, and flavorful addition of Malabar spinach powder contributed in the tasty taste of bread enriched with Malabar spinach.

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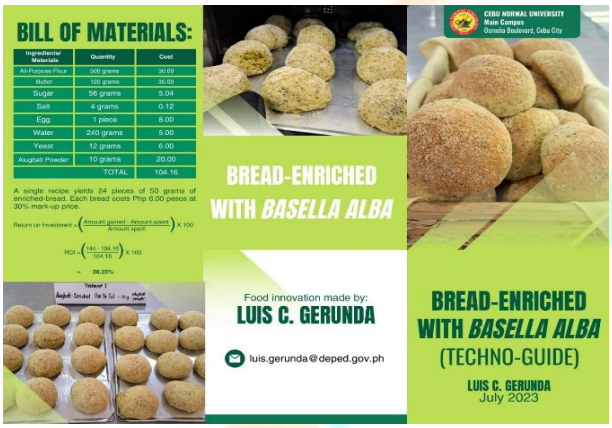
Techno-guide for Bread Enriched with Malabar Spinach

The researcher's techno-guide provides the foundation and outline of what Malabar spinach-enriched bread is, the ingredients used in producing the enriched bread and its nutritional benefits. Furthermore, the recipe of the enriched bread is featured, expenses and suggested price is also presented in the techno guide.

Figure 3

Techno-guide for Bread Enriched with Malabar Spinach



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CONCLUSIONS

This chapter presents conclusions from the research conducted.

Conclusion

The four treatments were subjected for microbial analysis for safety consumption purposes. Results of the microbial analysis is within acceptable safety limits. The findings of the study demonstrated the four treatments of enriched bread have achieved the desirable characteristics of bread and that each characteristic of each treatment were acceptable as evaluated by the trained panelists. Therefore, the product's appearance, smell, hand texture, crumb texture, and taste are all greatly impacted by the quantity of Malabar spinach powder used in each treatment. The second treatment had the best effects, according to the findings of the toral crude fiber analysis. The original bread recipe plus the addition of 10 grams of Malabar spinach powder should be the major component ratio to achieve the optimal result. Moreover, it can be said that the bread recipe, particularly the ingredient measurements, were found to be in good proportion for baking bread. Furthermore, a techno-guide was made specifying information about the product and its main ingredients in order to expansively introduce the product to future research studies and target markets if commercialization of the product is possible.

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