



Acceptability of banana stem as an alternative in producing dietary Korean Kimchi

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Abstract

This study aims to investigate the acceptability of using banana stem as an alternative ingredient in producing Korean dietary kimchi. The researchers utilized an experimental research design, and a purposive sampling technique was used to select 50 respondents for the study. The study found that the use of banana stem in kimchi production is acceptable, and it presents a new flavor to Asian cuisine. The Kruskal Wallis Test was used to compare the three samples of kimchi made from banana stem, and the results showed no significant difference between the three samples based on the evaluation of the respondents. The study suggests that banana stem can be a viable alternative ingredient in making Korean dietary kimchi without compromising its acceptability in terms of sensory qualities. The study can benefit various stakeholders, such as farmers, entrepreneurs, and consumers, by providing an opportunity to innovate and introduce new products using less popular plant materials, creating a niche in the food industry, and increasing the overall income of the community. The study concluded that the majority of potential consumers for the product belong to Generation Z, or the post-millennial group, and have an interest in Korean trends. Several recommendations were made to maintain the product's acceptability among future consumers. These include improving the production process, endorsing the product across different generations, and innovating other samples by catering to the sensory attributes of future consumers.

Keywords: Banana stem; Kimchi; Acceptability; Alternative ingredient; Sensory qualities; Food innovation

1. Introduction

In this modern day of the 21st century, Korean cuisine is rising and continues to capture countries' palates across all continents. Due to its expanding presence, empowered by the growing popularity of Korean media content such as K-pop, films, and dramas, along with years-long efforts from food companies, Korean cuisine is now rising as a new Asian taste in the global food scene [1]. The emerging exposure of Korean foods in different media serves as a way to present dishes that are unique in the eyes of the public. In relation, kimchi, as the traditional Korean side dish, and fermented vegetables such as cabbage and Korean radish, including spring onions, garlic, ginger, and gochugaru, have happened to become highly popular for the last fifteen years.

The concept is devised to accept a kimchi product using banana stem as the main ingredient. [2] it is believed that the use of banana stem will be cheaper and more accessible for all and meet the escalating demand of raw materials supplies. In fact, the Philippines are the country of the highest diversity of Musa species, and banana is one of the country's most significant fruit crops where there are more than 400,000 hectares of land are dedicated to banana growing, with an annual fruit yield of more than nine (9) million metric tons [3]. With the willingness of consumers to try Korean dishes and experience unique taste, banana stem serves as the best supplement and alternative to change to style of traditional kimchi. Furthermore, the nutrient content of banana stems varies, as dry matter content ranges from 3.60-9.80%, crude protein ranges from 2.40-8.30%, crude fat ranges from 3.20-8.10%, extract material without

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nitrogen ranges from 31.60-53.00%, ash ranges from 18.4-24.70%, crude fiber ranges from 13.40-31.70%, neutral detergent fiber ranges from 40.50-64.10%, acid detergent fiber ranges from 35.60-45.50%, cellulose ranges from 19.70-35.20%, hemicellulose ranges from 4.90-18.70%, and lignin ranges from 1.3-9.20%. 3 [4].

[5] banana stems are high in fiber and aid in weight loss. Its high fiber content causes a sensation of satiation, which minimizes food intake. It also aids with constipation relief. Banana stems, like the fruit, are high in potassium and vitamin B6. Vitamin B6 aids in the synthesis of hemoglobin and insulin. Banana stem boosts the body's ability to fight illness. Potassium is essential for the efficient functioning of muscles, notably the heart muscles. It also aids in the prevention of excessive blood pressure and the maintenance of fluid balance inside the body. Banana stem is a diuretic that aids in detoxification. This basis strengthens the acceptability of banana stems to be used in various processes and innovations. That's why the researchers saw its benefits in using banana stems in producing Korean kimchi.

Banana stem is also edible and tasty. However, its value in eating and the use of it as an exchange ingredient for any cuisine, especially in kimchi, are hardly seen by many. Moreover, most of the entire population only knows that the banana fruit, heart, and leaf are only the edible parts, but banana stem is considered as equally important in terms of their nutritional and nutraceutical contents and use as medicines to cure both infectious and degenerative diseases [6]. Also, the banana stem is edible and applicable for use as an ingredient in other types of cuisines. In comparison to Korean cabbage, which is the usual ingredient in making kimchi, it has a mild sweet-tart flavor similar to cabbage and other vegetables. In addition, it can be eaten as raw or cooked. Furthermore, for harvesting, when the plants are 18–24 months old, it can be harvested because the outer pseudo is matured during this approximate month. For storability, banana stem can be fermented and prolonged using appropriate packaging and materials in a moderate temperature.

Prior to the early 2000s, Korean culture was virtually unknown in Western and Asian countries except for the "Korean War" and "North Korea," which were the only aspects of Korean culture that the western world was aware of. During this era, Korean Kimchi was hardly seen by many countries. In fact, the tradition of making kimchi started as a way to ferment and store vegetables during the cold winter when many Koreans died of starvation [7]. However, due to the extended stays, work, and education of Korean people in other countries, as well as the rise of media content, Korean culture began to emerge. Korean cuisine has continued to gain worldwide popularity since 2010 [8]. Moreover, consumers have started to perceive more about their cuisine and expect to add unusual ingredients that are new and different, especially in the most popular fermented Korean Kimchi. In connection, the increasing plantation of bananas, members of *Musa acuminates*, in India, Indonesia, Brazil, Ecuador, and the Philippines has useful benefits to bring kimchi in the next level.

Fermentation procedures used in the creation of indigenous fermented foods frequently rely on the raw material's natural microflora and the surrounding environment [9]. With the help of nature, Filipinos can conveniently get raw ingredients. For that reason, the use of banana stems as the main ingredients in making kimchi can create a new version of a taste that is not familiar yet expected to be satisfying. Besides, banana stems in Philippines mostly used as diuretics and fertilizers and not as a form of fermentation ingredient supply. According to [10] about 55% of the overall cost of producing bananas was spent on pesticides and fertilizer. According to soil experts, extensive land usage and excessive chemical use severely harmed the land of banana growers in Davao, Philippines. To innovate this, with the growing adoption of Korean products in the Philippines due to their media contents, the use of banana stem in kimchi products believe as one of the sources of getting high GDP and resolving environmental waste. Also, using banana stem and considering its benefits create a wide support to increase economy.

The status of banana plantation is way bigger and accessible rather than cabbage which is the primary ingredients of kimchi. However, it was hardly apply as an alternative in any fermented product. With its bizarre identity in the local community, the production of banana generates a large amount of banana stem waste and therefore creates a major biomass-waste problem and an environmental nuisance [11]. Furthermore, the cycle of banana fruit production has a four times of biomass waste produced. It can be estimated that one hectare of banana farm could produce approximately 220 tons of biomass wastes. These wastes are usually disposed of by the farmer into lakes and rivers or simply burned. [22] with the volume of banana that is being harvested means that there is a huge amount of banana stem waste left to decompose emitting more carbon dioxide where it fact it banana stem can be used to produce product. Hence, a better way to solve the problem of banana stem is worth pursuing especially that Korean is facing hard times producing cabbage considering that this vegetable is sensitive in climate change [13]. That's why the researcher saw its worth to use the banana stem in producing Korean Kimchi by considering that fact that Korean enterprises are increasing. The acceptability of the experimented Korean kimchi will support the local plantation for supplementation of supplies. Moreover, the application of banana stem to use in fermenting kimchi delivers a solid help for the environment and for human's health. The purpose of this study was to develop Korean Kimchi using banana stem. This paper also used as a guide for future researchers on accepting and applying banana stem as a material to innovate a product.

1.1. Theoretical Framework

The study is anchored on the theoretical support of the Theory of Food as a Neurocognitive Adaptation by [14]. This outlines the human behavior of mastering a number of cognitive abilities that integrate through multiple senses: color, aroma, texture, flavor, and general appearance. The theory suggests the process of cognitively unified perspectives and synthesizes mental processes including homeostasis, monitoring the senses, memory, emotion, and categorization. The study is supported by the Theory of Food Choice by [15]. This presents the three approaches such as the product, person and environment where all these categories are listed as determinants of food preferences. The study also highlights the sensory appeal, nutritional quality, safety, and health determinants model of [16]. The model used is believed to support the theory applied in the study. This presents the sensory characteristics as essential motivating factors driving consumers towards consumption and convenience of food products. Moreover, the model shows how sensory appeals undoubtedly influence consumer perception and satisfaction.

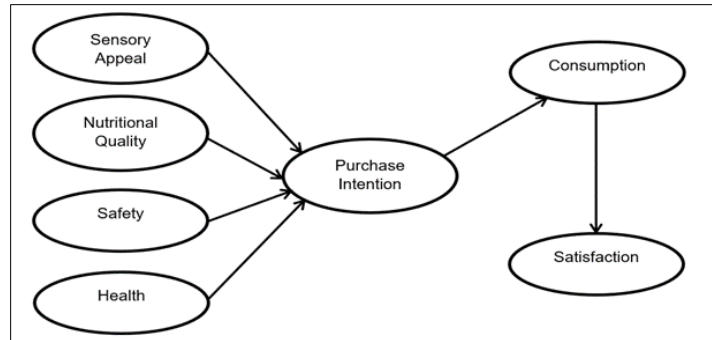


Figure 1 Sensory Appeal Model sensory appeal, Nutritional Quality, Safety, and Health Determinants Model

1.2. Conceptual Framework

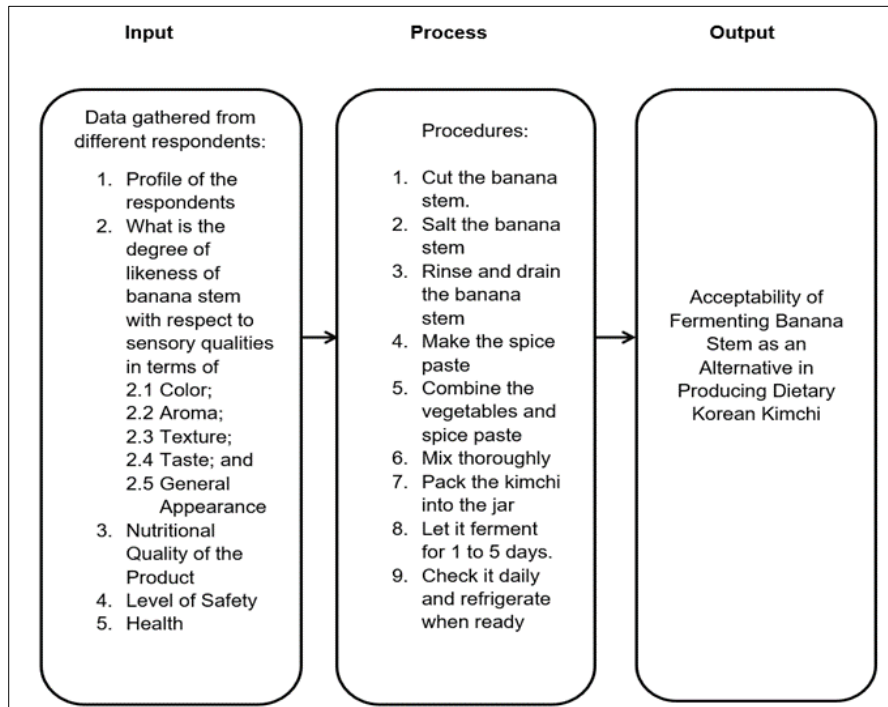


Figure 2 Conceptual Model of the Study

The Study is composed of three models presented in the figure below, it is made up of three boxes and those are the Input that includes the materials needed in the development and acceptability of fermenting banana stem as an alternative in making dietary kimchi. Second is the Process that has been done by the Researchers, and lastly is the Output which includes the finished product.

Figure 2 presents the conceptual model of the study showing the input, process and output of the Development and Acceptability of Fermenting Banana Stem as an Alternative in Producing Dietary Korean Kimchi. The first frame shows input of the study that includes the profile of the respondents, the degree of an acceptability of banana stem with respect to sensory qualities in terms of color, aroma, texture, flavor and general appearance also the nutritional quality of the product, level of safety and health. The second frame commemorate the process of the study that involves the procedures on making the kimchi that involves: cut the banana stem, salt the banana stem, rinse and drain the banana stem, make the spice paste, combine the vegetables and spice paste, mix thoroughly, pack the kimchi into the jar, let it ferment for 1 to 5 days, and check it daily and refrigerate For the third frame, it presents the output of the study which includes the assessed project of the Acceptability of Fermenting Banana Stem as an Alternative in Producing Dietary Korean Kimchi. The arrows from the input to the process and to the output present the connection and transformation of the profiles, and aspects with the actions taken into results that are considered as output.

[17] there are many types of fermented foods worldwide. Generally, traditional fermented foods have nutritive and functional properties. Moreover, they are considered safe foods because they have a long history of being consumed in their local communities. Most traditional fermented foods are fermented by spontaneous fermenting processes conducted by various microorganisms. However, spontaneous fermentation results in inconsistent quality from batch to batch. The food industry must practice ethics starting from higher positions down to lower positions to ensure food security and standardization with high sensory qualities [18]. This is particularly important as traditional fermented foods are now produced in massive amounts by the industry, which requires much stricter demands for safety and standardization. However, these traditional fermented foods are good resources for the isolation of useful microorganisms harboring antimicrobial activities to be used as starter cultures. Adapting proper regulations and starter system safeguards during the manufacture of kimchi and chongkukjang, which are popularly consumed Korean traditional fermented foods, is helping to ensure that these foods are acceptably safe as well as healthy.

Furthermore, Kimchi is a fermented cuisine made from raw materials by spontaneous fermentation by lactic acid bacteria. To explore the influence of these substances on food fermentation, four different varieties of food (kimchi cabbage, green onion, leaf mustard, and young radish) were analyzed. The *Leuconostoc gelidum*, *Weissella kandleri*, and *Lactobacillus sakei* families were the dominant bacteria. The distribution of these species varied according on the sample type. All three species were found largely in foods made from kimchi cabbage and young radish; however, the *Lac. The sakei* group was rare in foods made with green onion and leaf mustard [19].

The study by [20] shows that many farmers recognize the importance of modern technology in agriculture. This is particularly relevant to the process of fermentation, which involves breaking down organic compounds into simpler compounds using microorganisms. Fermentation technology can be used to improve the quality of feed ingredients, such as corn stalks, as shown in the research by [21]. [22] defines product quality as the "superiority or excellence" of a product. This concept is crucial in the food industry, where the quality of fermented foods, such as kimchi and chongkukjang, must be strictly monitored to ensure safety and standardization. In addition, traditional fermented foods can serve as sources of useful microorganisms with antimicrobial activities that can be used as starter cultures. One example of a fermenter that can be used in the process is Eco Enzyme, which is produced by fermenting organic wastes from kitchen waste, sugar, and non-chlorinated water using certain microorganisms like yeast and bacteria. Through this process, the nutritional quality of feed ingredients can be increased. Similarly, the banana stem, which is often overlooked as an edible and tasty part of the plant, can be fermented and used as an alternative ingredient in producing dietary Korean Kimchi. This highlights the potential of modern technology in agriculture to unlock the value of underutilized resources and promote sustainability.

On the other hand, the banana stem is commonly eaten in many parts of India because it is known to prevent the formation of kidney stones. The juice is made from the stem with a few drops of lemon in it. Banana stem is rich in potassium and the citric acid in the lemon juice, both do not allow the formation of stones because excess calcium is flushed out of the urinary system. Cardamom can also be added to the juice [23]. In the earlier days, natural fibres served a crucial role to mitigate the everyday needs for a wide range of uses. Dietary fibre is made up of carbohydrate polymers derived from plants and consists of more monomeric units that are resistant to hydrolysis by the endogenous enzymes in the small intestine of humans with complete fermentation in the colon where it can promote beneficial microfauna growth. [24] banana is packed with nutrition and health benefits. Eating off the banana stem has great digestive properties (not to mention, it is great for the environment!), the fruit is a source of potassium and vitamins, and the flower is good for diabetes and anti-aging. Consumed with fibre, banana stem slowly down the release of sugar and fats stored in the body's cells. It also improves metabolism and contains very few calories – meaning that it can be consumed without guilt pangs. In addition, it is rich in Vitamin B6 and has a lot of iron, and increases the hemoglobin count. It is enriched with potassium as well, and is effective to treat cholesterol and high blood pressure. The "Saba" or "Cardaba"

is one of the locally grown species of banana in the Philippines. It is frequently used in making desserts such as cakes, chips, banana cues, and turn. Oftentimes after using, the saba's peel serves no other purpose and is just thrown away.

In relation to the study, more scientific studies have shown that the biological compounds of kimchi stimulate immune function and reduce pro-oxidants, free radicals, certain cancers, cardiovascular disease (CVD), metabolic syndrome risks, and aging, as reviewed. Several studies have evaluated the potential benefits to human health, and accumulating data on human kimchi consumption has shown that kimchi consumption lowers lipids and the atherogenic index in plasma; it also changes the composition as well as the count of intestinal microflora and increases iron levels [25]. Also [26] kimchi is prepared with healthy vegetables and condiments and fermented with probiotic LAB and has various health benefits along with tasting good. Based upon our research and that of others, the health functionality of kimchi includes anticancer, antioxidative, antiobesity, anti-constipation, serum cholesterol and lipid-controlling, antidiabetic, and immune-boosting. They can compensate for any negative effects of NaCl.

Moreover, [27] kimchi is a traditional fermented Korean food that has garnered international interest due to its various beneficial effects. This study hypothesized that the consumption of fermented kimchi would have more beneficial effects compared with that of fresh kimchi on metabolic parameters that are related to cardiovascular disease and metabolic syndrome risks in overweight and obese subjects.

The banana (*Musa*), which is grown on the largest amount of land and generates the greatest revenue through exports, is regarded as the most significant fruit crop in the nation. The Philippines is one of the top five exporters of bananas in the world due to the country's mild environment. However, a great deal of research has been done to increase the use of banana by-products in order to meet the rising demand for raw materials in a variety of industries. There is still a shortage of awareness and information transmission, particularly in the Philippines, despite the fact that these opened up new and alternative means of developing new products and applications with a value-added approach. In order to build a sustainable civilization, it is constantly necessary to produce new goods with added value from alternative bio-resources [28].

[29] one of the world's top banana producers in 2019 originated in the Philippines. Bananas are also the fourth-largest product produced in the Philippines after paddy rice, coconut, and native pig meat. Because so many bananas are being picked, there are a lot of stems that can be utilized to make banana fiber and support the livelihood of nearby banana growers. Banana fiber's chemical make-up includes cellulose (50–60%), hemicelluloses (25–30%), pectin (3–5%), lignin (12–18%), water-soluble compounds (2–3%), fat and wax (35%) and ash (1-1.5 percent). The precision of classification and grading of produced fibers is crucial to the natural fibers of the Philippines' ability to compete internationally. However, since the Philippines are one of the world's top producers of banana, Philippines also become one of the primary generators of banana fruit stem wastes. In Mindanao alone, some 1.35 billion kilos of these stem are produced every year and left in the fields to rot [30].

On the other hand, banana stems are considered safe and edible because they can be used as a medical alternative. Banana stems are high in fiber and can aid in the treatment of ulcers or other stomach acid. Like its fruit, the stems of banana are high in potassium and B6, which together serve as a dietary supplement that benefits the muscles and the body's production of hemoglobin and insulin [31]. Furthermore, Nanometric fibers commonly used in nanotechnology applications and silver nanoparticles useful in therapeutic cancer treatments can be produced from banana pseudostems. There are different studies on the processing of bananas and the application of their waste-loss in new production processes Pseudostems are the banana stem that supplies nutrients from the soil to the fruits. It is structured by two elements, the nodes and internodes, which make up the floral stem and support the inflorescence in the inner part [32].

In connection to the study, due to the rise of globalization most Filipinos learned to eat kimchi only with Korean food. The side dish such as kimchi is a cooking ingredient for Korean soups, stir-fries, and fried rice. This served as "pulutan" paired with makgeolli, a light, white rice wine, or soju, a distilled liquor made from rice, barley, or sweet potato [33]. This supports the idea of developing the traditional Korean kimchi into something different and extraordinary.

Furthermore, a lot of fermented food products in relation to Korean kimchi are considered to be safe for consumption without the need for reheating. Commonly used probiotic strains such as *Lactobacillus*, *Bifid bacterium*, and *Streptococcus*, Although there have been some testimonies of clinical-pathological conditions of bacteraemia and endocarditis that have been associated with the consumption of lactic acid bacteria (LAB) fermented products it is likely that these infections are opportunistic that occur in immune compromised individuals [34]. In the Philippines, there are various indigenous lactic acid-fermented foods that may differ in texture, flavor, and appearance depending on regional preferences, materials used, and manufacturing processes employed. The crucial role of LAB in lactic acid-fermented

foods involves inhibiting the growth of spoilage organisms and enhancing the end product's flavor, fragrance, and texture. While Philippine cuisine may have foreign influences, local techniques are adapted to local products and preferences, and fermentation is widely used to improve food's organoleptic properties and extend its shelf life across the many islands of the Philippines.

This study aims to investigate the potential of using banana stem as an alternative ingredient in producing Korean Kimchi. The study will assess the degree of likeness of banana stem in terms of sensory qualities and investigate significant differences between three samples, as well as the relationship between respondents' demographic profiles and the most acceptable formulation of fermented banana stem. The study will benefit various stakeholders, but its scope is limited to the acceptability of fermented banana stem as an alternative ingredient in producing dietary Korean Kimchi. The study will rely on survey questionnaires from 50 respondents to assess the fermented product based on color, aroma, texture, flavor, and general appearance. The research will test the null hypothesis that there is no significant difference between the three samples and that there is no significant relationship between the respondents' demographic profile and the most acceptable formulation of fermented banana stem. The continuous effort of the owners in making strategies that can help and improve their business like making the image of their products more appealing and healthier to their customers [35].

2. Material and methods

In this study, the researchers aimed to explore the development and acceptability of fermenting banana stems as an alternative ingredient in producing dietary Korean kimchi. They utilized an experimental research design to test the acceptability of banana stems in making Korean kimchi. By surveying respondents in the Laguna area, they gathered data on the performance and capabilities of this alternative ingredient.

The respondents were selected purposively from various groups within Laguna, ensuring diverse backgrounds and opinions. In total, 50 individuals who consume Korean products were chosen to participate in the study. A Likert Scale Questionnaire was used to collect data on the acceptability of banana stems in producing dietary Korean kimchi. The questionnaire was divided into three parts: demographic profile, assessment of banana stems, and respondent comments and suggestions.

The researchers documented the study using a camera and analyzed the data gathered using various statistical tools. A nine-point scale was used to rate respondent satisfaction and determine the level of acceptability. For data collection, the researchers designed and distributed questionnaires to the respondents, tabulated and computed the results, and interpreted the findings to reach a conclusion on the acceptability of the study.

The cost of production for the banana stem kimchi included ingredients, nutritional value analysis, and transportation, totaling PHP 13,190. The tools and equipment used in the study were jars, knives, chopping boards, casseroles, ladles, strainers, mixing bowls, stoves, and refrigerators. The method of extraction involved cutting and peeling banana stems, slicing and soaking them in saltwater, straining the cores, and mixing them with other ingredients. The packaging and labeling process involved placing the kimchi in jars and refrigerating them.

The production timeframe consisted of planning, buying ingredients and materials, producing the kimchi, fermenting it, conducting product and sensory evaluation testing, tabulating the results, and drawing conclusions. This methodology was designed to provide valuable insights into the potential of banana stems as a viable alternative ingredient in Korean kimchi production.

3. Results and discussion

The study aimed to determine the level of acceptability of using banana stem as an alternative ingredient in producing Korean dietary kimchi. The researchers employed a purposive sampling technique in selecting 50 respondents, and the data collected were analyzed to draw conclusions. The first aspect investigated was the age range of the respondents. The study found that the majority of the respondents (14 out of 50) were between the ages of 18 to 29 years old. This demographic group was the most represented in the study. The study also looked at the gender of the respondents and found that 56% (28 out of 50) were female, while 44% (22 out of 50) were male. The sample size was not large enough to generalize the results to the entire population, but it provides an initial indication of the attitudes towards using banana stem as a substitute for traditional ingredients in making kimchi.

This indicates that the steamed banana stem kimchi is more acceptable among the respondents regardless of their position. It can be inferred that the texture of the steamed banana stem is more preferred compared to the other samples. It is also worth noting that the overall acceptability of the sample B is higher than the other samples. The results suggest that using banana stem as an alternative ingredient in producing Korean kimchi is acceptable and can be a potential substitute for the commonly used ingredients.

The Kruskal Wallis Test is a non-parametric statistical tool used to compare more than two independent groups, and it is commonly used when the data does not meet the assumptions of normality or equal variance. In this study, the test was used to compare the three samples of kimchi made from banana stem in terms of color, aroma, texture, taste, general appearance, and overall acceptability. The result of the test showed that there was no significant difference between the three samples based on the evaluation of the respondents. This means that the three samples, which were fermented, steamed, and boiled banana stem kimchi, were equally acceptable in terms of their sensory qualities. Therefore, the null hypothesis that there is no significant difference between the three samples was accepted. The finding suggests that banana stem can be a viable alternative ingredient in making Korean dietary kimchi. The study implies that banana stem can be used to create a new taste and niche in the food industry. It also encourages farmers to use the excess parts of fruit or vegetable plants in food processing procedures that will create an increasing demand for the said plants. Additionally, it promotes the awareness of different food preparations using banana stem for children's health.

This means that the age, sex, and position of the respondents did not significantly affect their color preference for the samples. The same can be said for the aroma, texture, taste, general appearance, and overall acceptability of the samples. The study shows that the banana stem can be used as an alternative ingredient in producing dietary Korean kimchi without compromising its acceptability in terms of sensory qualities. This finding can benefit various stakeholders such as students, professors, parents, farmers, entrepreneurs, food establishments, and consumers. It can provide an opportunity to innovate and introduce new products using less popular plant materials, which can create a niche in the food industry. Additionally, it can create new tastes for customers and encourage them to accept less commonly used ingredients, leading to wider opportunities for banana stem to be used in other food products and increase the overall income of the community.

The relationship between the demographic profile, such as age, sex, and position in terms of aroma, has no significant relationship considering that the result of the computed value and p-value implies acceptance of the hypothesis using chi-square as the statistical tool. In relation to the respondent's demographic profile, such as age, sex, and position in terms of texture, the researcher decides to accept the hypothesis since the result of the computed value and p-value come up to a relationship that is not significant using the statistical tool of chi-square. In the test for the relationship of the demographic profile in terms of taste, there is no significant relationship between the age, sex, and position of the respondents, which led to the decision to accept the hypothesis based on the computed value and p-value that were acquired using chi-square as the statistical tool.

In terms of the relationship of the demographic profile of age, sex, and position in terms of general appearance, shows that the computed value and p-value have no significant relationship, leading to the decision to accept the hypothesis using the statistical tool of the chi square. Lastly, the relationship of the demographic profile, such as age, sex, and position, in terms of overall acceptability revealed that the computed value and p-value determined that there was no significant relationship in terms of overall acceptability, which led to accept the hypothesis using the statistical tool of chi-square.

4. Conclusion

Based on the findings and null hypotheses used in this study, the researchers concluded that the majority of potential consumers for the product belong to Generation Z, or the post-millennial group, and have an interest in Korean trends. The marketability of steamed banana stem kimchi is promising, with a higher degree of likeness and acceptability compared to the traditional or underground fermentation methods currently being served in the market. This is due to the fact that chefs, nutritionists, and random customers who consume kimchi have shown a preference for the steamed banana stem kimchi.

The study revealed differences between the samples in terms of color, aroma, texture, taste, general appearance, and overall acceptability. These differences can affect the choices of future consumers when selecting their preferred kimchi method if all three samples used in the study are produced. However, the data gathered from respondents suggest that consumer preferences will not be affected by their overall interpretation of the product's color.

Moreover, the aroma of the steamed banana stem kimchi is not influenced by factors such as the consumer's gender, age, or occupation. Similarly, the texture of the steamed banana kimchi has no relationship with the sex, age, or work position of potential consumers, making it suitable for a variety of groups or individuals with different kimchi preferences. The degree of likeness of the steamed banana stem kimchi in terms of taste will not impact its effectiveness even when served to different groups with varying preferences for kimchi products.

Furthermore, the general appearance of the steamed banana stem kimchi is not related to the consumer's age, sex, or position, indicating that it can still be marketable to all consumers with different demographic profiles. The preferences of consumers have no bearing on the overall acceptability of the banana stem kimchi, as it can be made marketable simply by improving the production process.

To further the scope of the study, the researchers offered several recommendations. To maintain the product's acceptability among future consumers, it is essential to endorse the product across different generations, including those who have not tried kimchi. This would secure the product's marketability once it is produced in stores or markets. Additionally, marketing platforms should be proposed to highlight the banana stem kimchi's distinction from common kimchi available on the market, as recommended by random customers, chefs, and nutritionists.

To maintain its acceptability among future consumers, it is crucial to innovate other samples by catering to the sensory attributes of future consumers. Improving not only the steamed banana stem kimchi, which is the most preferred by respondents but also the traditional and the fermented under the soiled banana stem kimchi can help the study demonstrate that all samples are acceptable and can be produced through different processes.

With regards to consumer preferences, it is recommended to improve the color of the banana stem kimchi by relying on the standard color of Korean kimchi. A specific place with proper and consistent room temperature should be designated to preserve the aroma of the banana stem kimchi. The moisture and fat content, as well as the air during production, should be properly analyzed to maintain the crispiness of the banana stem kimchi.

To maintain its acceptability among future consumers, standard measurements should be followed, and the product should be stored at a consistent room temperature to prevent mold or microorganisms from damaging the taste of the banana stem kimchi. Using old but ripe banana stems will sustain its appearance and be more eco-friendly. Lastly, to maintain its acceptability among future consumers, it is crucial to continuously improve all the sensory attributes that the samples did not attain to achieve higher marketability once the product is produced.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors of this manuscript declare that, to the best of their knowledge, there are no conflicts of interest that could influence the impartiality and objectivity of the research findings presented in this manuscript. We have no financial, personal, or professional relationships that could be perceived as potential conflicts of interest.

Statement of ethical approval

This study has been reviewed and approved by the appropriate ethics committee in accordance with the principles of research ethics, and all participants have given their informed consent prior to their inclusion in the study.

Statement of informed consent

The study obtained informed consent from all participants involved in the research. All participants were informed of the purpose of the study, their rights as participants, and the confidentiality of their information. The study was conducted in accordance with ethical principles and guidelines for research involving human subjects.

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