

Formulation, analyses, and acceptability of roasted seeds and grain brew coffee

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Abstract: This study used the experimental research design to investigate the potential of roasted seeds and grain as alternative ingredients for brewed coffee, focusing on formulation, sensory attributes, shelf life, and microbiological safety. Four (4) formulations were developed and evaluated by 110 participants composed of well-trained panelists, teachers, students, coffee shop owners, and community members, using a 9-point Hedonic Scale to assess appearance, aroma, texture, and taste. Treatment D, consisting of equal parts (33.3 g each) of papaya seeds, soybeans, and corn kernels, emerged as the most promising blend. Sensory evaluation revealed no significant differences among the four treatments regarding appearance, aroma, taste, and texture for both the powdered and brewed coffee drink. However, general acceptability ratings varied significantly among treatments. Statistical analysis using SPSS, including mean comparisons and ANOVA, confirmed that while the sensory attributes were similar across all formulations, overall acceptability was influenced by the specific blend used. Microbiological analysis of the final product Treatment D (33.3 g of papaya seeds, soybeans, and corn kernels) showed it to be safe for consumption, with acceptable levels of aerobic plate count, coliforms, yeasts, and molds, and no presence of Salmonella. Shelf-life testing demonstrated strong stability, with no spoilage observed over six months under proper storage conditions. Proximate analysis revealed the coffee substitute to be high in protein and low in fat and moisture, making it a viable option for health-conscious consumers. In conclusion, this alternative coffee blend offers a safe, shelf-stable, and nutritionally beneficial option with acceptable sensory qualities, supporting its potential as a substitute for conventional coffee.

Keywords: Brewed Coffee Alternative, Sensory Evaluation, Roasted Seeds, Microbial Safety

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INTRODUCTION

There has been an increase in interest in recent years, regarding alternative sources for brewed coffee, stemming from environmental concerns and a quest for unique flavor experiences. One emerging trend involves the utilization of unconventional ingredients such as roasted seeds and grain brew coffee beverages. Despite not traditionally being associated with coffee, these ingredients offer a promising avenue for diversifying the coffee industry while addressing sustainability and health considerations. Coffee, alongside water and tea, ranks among the most popular beverages globally, valued for more than just its central nervous system-stimulating properties but also for its distinctive taste and aroma. Coffee is a complex blend of over 800 volatile compounds, with caffeine and chlorogenic acids being the most prevalent (Nieber, 2017).

Different species of coffee have been consumed worldwide, with Arabica being the more favored variety, constituting over 60% of global coffee production. However, Arabica is highly sensitive, thriving only in specific regions with optimal temperatures and altitudes, making it

susceptible to coffee leaf rust, a fungal disease that has plagued coffee plantations for decades. Both Arabica and Robusta, the two primary coffee species, require specific environmental conditions for cultivation, yet more than half of the world's suitable coffee-growing regions are vulnerable to degradation or loss because of the changing climate by 2050 (Holland, 2021).

Globally, coffee consumption is staggering, with over a billion cups consumed daily, predominantly in the morning hours, peaking between 8:00 a.m. and 10:00 a.m. Globally, people consumed about 166.63 million 60-kilogram coffee bags in the 2020–2021 period, a slight increase from the previous year. (Ridder, 2023).

Papaya seeds, soybeans, and corn kernels have gained attention as promising alternatives for brewing coffee-like beverages due to their accessibility, affordability, and nutritional value. Papaya seeds, often discarded as waste, have shown potential because they are high in antioxidants such as flavonoids and polyphenols, dietary fiber, and good fats. These nutrients contribute to overall health by reducing inflammation, improving heart health, and supporting digestive function. Including these foods in your diet can lead to a more balanced and nutritious lifestyle. They also contain trace amounts of protein, iron, calcium, and magnesium. Moreover, traditional medicinal practices have long recognized the seeds for their antimicrobial, anti-inflammatory, and hepatoprotective properties (Maisarah et al., 2019). Similarly, soybeans are renowned for having a high protein content and providing each of the nine necessary amino acids, along with dietary fiber, isoflavones, potassium, calcium, and iron. These nutrients contribute to their antioxidant capabilities and cholesterol-lowering effects, which have made soybeans a staple in many health-conscious diets (Messina et al., 2006). Corn kernels, on the other hand, are primarily valued for their carbohydrate content, particularly starch, while also providing moderate levels of dietary fiber, protein, and B-complex vitamins like thiamine and niacin. Additionally, corn contains ferulic acid, a plant compound with potent antioxidant properties (Watson, 2003). Collectively, these seeds offer promising health benefits and functional properties, making them suitable candidates for the development of innovative, coffee-like beverages.

This study endeavors to delve into the formulation, analyses and acceptability of roasted seeds and grain brew coffee substitutes derived from papaya seeds, soybeans, and corn kernels. By scrutinizing the sensory attributes, nutritional content, and consumer preferences of these unconventional coffee alternatives, the research aims to contribute to the expanding body of knowledge on sustainable and innovative practices within the coffee industry.

Moreover, there are numerous benefits associated with coffee consumption. However, it is essential to consume coffee in moderation daily. Extensive research indicates that the intake of caffeinated coffee does not pose an increased risk of cardiovascular diseases and cancers. On the contrary, consuming 3 to 5 standard cups of coffee per day has consistently been correlated with a decreased risk of various chronic ailments. Nevertheless, some individuals may experience intolerance to higher caffeine levels, leading to symptoms such as jitteriness, anxiety, and insomnia (Nordqvist, 2023). Earlier this year, Bidel and Tuomilehto (2013) conducted a comprehensive analysis of recent human studies examining the relationship between health consequences and coffee drinking. According to their research, drinking coffee was linked to a lower chance of developing type 2 diabetes and other chronic illnesses, liver cancer, and Parkinson's disease. Additionally, they found that moderate coffee intake (up to 400 mg of caffeine per day) was not linked to an increased risk of cancer or cardiovascular disease, although higher consumption levels might be associated with adverse health effects.

Aligned with the Sustainable Development Goals (SDGs) of the UN, especially SDG 12 (Responsible Consumption and Production), SDG 3 (Good Health and Well-Being) and SDG 13 (Climate Action), this research promotes sustainable practices by utilizing underused or discarded plant materials as alternative beverage sources. It supports health-conscious innovation and encourages environmentally sustainable consumption patterns.

Furthermore, this study is in harmony with the research goals of Capiz State University (CAPSU), specifically in fostering research and development that contributes to sustainable agriculture, food security, and improved quality of life through science and technology-based innovations. By exploring sustainable and health-beneficial alternatives to conventional coffee, the study directly supports CAPSU's commitment to addressing community needs through relevant, inclusive, and sustainable research.

Through thorough analysis and empirical data, this study seeks to offer insights that can inform both industry practices and consumer choices in the realm of brewed beverages while contributing to sustainable development and innovation in food science.

Objectives of the study

Generally, this study aimed to determine the acceptability of roasted seeds and grain brew coffee.

Specifically, the study aimed to:

1. determine the sensory qualities of roasted seeds and grain brew coffee powder among four (4) treatments in terms of appearance, aroma, and texture.
2. determine the sensory qualities of roasted seeds and grain brew coffee drink among four (4) treatments in terms of appearance, aroma, taste and texture.
3. determine the general acceptability of roasted seeds and grain brew coffee powder in terms of appearance, aroma, and texture among four (4) treatments.
4. determine the general acceptability of roasted seeds and grain brew coffee drink in terms of appearance, aroma, taste and texture among four (4) treatments.
5. determine if there is a significant difference in the sensory qualities of roasted seeds and grain brew coffee powder and drink among four (4) treatments such as appearance, aroma, taste and texture.
6. determine if there is a significant difference in the general acceptability of roasted seeds and grain brew coffee powder and drink among four (4) treatments in terms of appearance, taste, aroma, and texture.
7. determine the shelf life of roasted seeds and grain brew coffee in terms of room temperature.
8. submit the best product for microbial and proximate analysis

METHODOLOGY

This research utilized an experimental research methodology to investigate the utilization of roasted seeds and grain as innovative ingredients in brewed coffee. The research aimed to explore the sensory qualities, flavor profiles, and overall consumer acceptability of brewed coffee incorporating these alternative ingredients.

Research design

This study employed an experimental research design which allowed for the systematic manipulation of variables to observe their effects on the final product. In this study, the primary

independent variables included the proportions of papaya seeds, soybeans, and corn kernels used in the coffee preparation. By varying these proportions, the researchers were able to analyze how each ingredient contributed to the sensory characteristics of the brewed coffee, such as aroma, taste, appearance, and mouthfeel (Srinagesh, 2005).

Experimental procedures

For the preparation of the coffee samples, ripe papaya seeds were collected, cleaned, and dried to reduce moisture content. Soybeans were harvested, soaked, and roasted to enhance flavor and reduce bitterness. Corn kernels were also roasted to achieve a desirable taste. The seeds from each ingredient were ground into a fine powder, allowing for easy integration into the brewing process.

The experimental groups consisted of various blends of the three ingredients, with each group having a distinct ratio (e.g., 33.3%, 33.3%, 33.3% for each ingredient in relation to the total coffee volume).

A panel of trained sensory evaluators and untrained consumers was assembled to assess the brewed coffee samples. A sensory evaluation form was developed to measure key attributes, including aroma intensity, taste (bitterness, sweetness, acidity), texture, and overall acceptability. Evaluators were asked to rate each attribute on a standardized scale, providing both quantitative and qualitative feedback (Creswell et al., 2018).

The sensory evaluation took place in a controlled environment to minimize external influences. The coffee samples were presented blind to ensure unbiased assessments. The evaluators were instructed to take notes on their impressions, which were used to support the quantitative data.

Data collection

Data collected from the sensory evaluation were analyzed using statistical methods to determine the significance of distinctions between the experimental groups and the control group. The Analysis of Variance (ANOVA) was employed to identify which formulations yielded the most favorable sensory qualities and consumer acceptability ratings.

Additionally, qualitative data from evaluator comments were analyzed thematically to identify common trends and preferences regarding the flavor profiles and overall experience of the brewed coffee.

By employing this experimental research methodology, the study aimed to provide valuable insights into the feasibility of incorporating roasted seeds and grain brew coffee ingredients. The findings contributed to the growing body of knowledge surrounding innovative food ingredient utilization, potentially leading to the development of unique and marketable coffee products that aligned with consumer preferences for alternative and health-conscious options.

Experimental treatments

The experimental treatments consist of four distinct formulations designed to explore the effects of varying proportions of papaya seeds, soybeans, and corn kernels on the sensory qualities of brewed coffee. Each formulation aims to assess how these ingredients influence flavor, aroma, and overall consumer acceptability. Treatment A features a coffee blend utilizing 30gs of roasted papaya seeds, 40gs of roasted soybeans, and 30gs of roasted corn kernels as the primary ingredient, known for their unique flavor and potential health benefits. Treatment B incorporates 40gs roasted papaya seeds, 30gs roasted soybeans, and 30gs roasted corn kernels which are

recognized for their nutty taste and protein content, contributing both to the beverage's flavor complexity and nutritional profile. Finally, Treatment C employs 30gs roasted papaya seeds, 30gs soybeans, and 40gs corn kernels, adding a subtle sweetness and a distinct aroma that enhances the overall coffee experience. Treatment D with the combination of three equal proportion consisting of 33.3gs roasted papaya seeds, 33.3gs soybeans, and 33.3gs corn kernels. Each formulation is replicated four instances to guarantee the dependability and accuracy of the outcomes.

The inclusion of various flavoring agents, such as vanilla or cinnamon, may vary according to the treatment, enhancing the sensory experience and overall appeal of the brewed coffee. Each formulation undergoes rigorous sensory evaluation to assess consumer acceptability, focusing on attributes such as appearance, taste, aroma, texture, and aftertaste (Keller, 2016). This systematic approach allows for a comprehensive understanding of how the different seed components interact to influence the sensory qualities of the final coffee product.

Experimental procedures

The experimental procedure for developing the roasted seeds and grain brew coffee followed a systematic sequence to ensure product quality, safety, and consistency.

The process began with the preparation of ingredients, wherein fresh papaya seeds, soybeans, and corn kernels were carefully sourced for quality, then cleaned thoroughly to remove impurities. This step was crucial to prevent contamination and preserve the desired flavor characteristics.

The drying process followed, aimed at reducing moisture content to prevent spoilage. Each ingredient was dried separately—either through sun drying or other methods—until it became brittle, signaling optimal dryness for the next step.

Next was roasting, performed individually for each ingredient to enhance their distinct flavors and release natural oils. Roasting required careful control to avoid bitterness from over-roasting while achieving a rich and aromatic profile.

After roasting, the ingredients were allowed to cool, then ground into fine granules using a grinder. Cooling prior to grinding helped preserve flavor and ensured the desired consistency, similar to traditional coffee.

The mixing ratio was determined based on flavor preferences. A typical formulation involved 40% papaya seeds, 30% soybeans, and 30% corn, although this could be modified to achieve a sweeter or nuttier profile. The blending step ensured uniform distribution of all ingredients to deliver a consistent taste and aroma.

For brewing, a traditional stovetop method was used, emphasizing correct water temperature and timing to optimize flavor extraction. After brewing, the coffee underwent straining to remove solids and achieve a clean, smooth drink.

Once brewed and strained, the coffee was served either hot or cold, depending on preference, and could be enhanced with optional additives such as sugar, milk, or spices like cinnamon or vanilla.

Finally, any remaining coffee was stored in an airtight container placed in a cool, dry environment to maintain freshness. Proper storage and gentle reheating were emphasized to preserve taste and prevent degradation of quality.

This structured procedure ensured that the resulting roasted seed and grain brew coffee met desirable sensory standards while maintaining food safety and consumer appeal.

Data gathering procedure

The researcher embarked on a systematic approach to collect and analyze data on the sensory qualities of the brewed coffee.

To begin, the researcher created detailed evaluation sheets or scorecards that will help assessors evaluate the coffee samples. These scorecards focus on critical sensory attributes such as appearance, aroma, taste, texture, and general palatability. Employing a Nine-Point Hedonic Scale, assessors can express their preferences by rating each attribute, ranging from 1 (dislike extremely) to 9 (like extremely).

Next, a diverse group of assessors were selected to participate in the sensory evaluation. This group included students, teachers, community coffee lovers and coffee shop owners. Before the tasting begins, the researcher holds a training session to ensure that everyone understands how to use the evaluation sheets effectively and the importance of providing honest feedback.

The sensory evaluation process involved preparing various coffee samples made from papaya seeds, soybeans, and corn kernel. The tasting takes place in a controlled environment, minimizing distractions to allow assessors to focus on the flavors and aromas of the coffee. Each assessor receives a coded sample, ensuring that they evaluate the coffee without bias regarding which formulation they are tasting.

Once the assessments are complete, the researcher collects all the scorecards and organizes the data systematically. The scores are entered into a spreadsheet to facilitate analysis. To analyze the data, the researcher employs the Social Package for Social Sciences (SPSS), a statistical software commonly used for data analysis. This software allows for calculating basic statistics, such as averages for each sensory attribute, and performing tests to compare the different coffee formulations. Through this analysis, the researcher can identify which coffee samples received the highest ratings.

After analyzing the data, the researcher interprets the findings to gain insights into the sensory qualities of the brewed coffee and the overall acceptability of each formulation. The final step involves compiling a comprehensive report that summarizes the methods, findings, and recommendations based on the study. This report aims to provide valuable insights into the potential of using papaya seeds, soybeans, and corn kernel brewed coffee, showcasing how these unique ingredients can offer an alternative beverage option while also promoting sustainability and resourcefulness in food production.

Data analysis

The statistical analysis of the data involved two primary tools: 1) Descriptive Statistics, which provided a summary of the collected sensory data; and 2) Analysis of Variance (ANOVA), which tested for significant differences in sensory qualities among the coffee treatments (Field, 2017). If the ANOVA results indicated significance, the Scheffé test was employed for post-hoc comparisons of treatment means (Kirk, 2013).

FINDINGS AND DISCUSSION

Sensory qualities of roasted seeds and grain brew coffee powder

The sensory evaluation of roasted seeds and grain brew coffee powder revealed generally high acceptability across all treatments in terms of appearance, aroma, texture, and overall quality. Panelists rated the visual aspect of the coffee powder as extremely appealing, especially Treatments B and D, likely due to the uniform color and consistency of the roasted blend. This

observation is supported by Dewi et al. (2021), who noted that visual appeal in coffee alternatives is strongly influenced by roasting processes.

In terms of aroma, most treatments were classified as extremely pleasant, except for Treatment C, which was rated very much pleasant. This variation aligns with Sulieman et al. (2020), who emphasized that the roasting of seeds and legumes produces desirable aromatic compounds that mimic traditional coffee.

Texture ratings were consistently high, with Treatment D receiving the highest evaluation as extremely smooth. According to El-Sohaimy et al. (2022), fine particle size and controlled roasting enhance the texture of plant-based coffee powders. The overall average ratings for all treatments fell under the “liked extremely” category, demonstrating strong consumer interest in the powdered form of this coffee substitute.

Sensory qualities of roasted seeds and grain brew coffee drink

The brewed coffee drink derived from the roasted seeds and grain formulations also received favorable sensory evaluations. Appearance ratings ranged from very much appealing to extremely appealing, with Treatments B and D scoring highest. This suggests that the visual clarity, color, and body of the brew were well-received, a factor also observed by Nyembwe et al. (2021), who found that brew color significantly influences preference.

For aroma, Treatment D again led with the highest score, indicating that a balanced ingredient composition enhanced its aromatic profile. Ahmad et al. (2020) reported similar findings, showing that roasting intensity and ingredient ratios directly impact aroma in coffee substitutes.

Taste ratings showed greater variation. Treatment D had the highest rating, classified as extremely rich in flavor, indicating that a balanced combination of ingredients resulted in a more palatable profile. This supports the findings of Hernández et al. (2021), who noted that soybean’s protein content helps balance bitterness in plant-based brews.

Texture scores were uniformly high, with Treatment D again performing best. Its creamy mouthfeel may be attributed to soy’s natural emulsifying properties (Kaur et al., 2022). Overall, Treatment D consistently outperformed the others across all sensory attributes, suggesting it provided the best balance and resemblance to traditional coffee.

General acceptability of roasted seeds and grain brew coffee powder and drink

Consumer evaluations of both coffee powder and drink indicated high general acceptability. Appearance scores were highest for Treatment D, attributed to its optimal color and consistency. As García et al. (2021) and Lee and Co (2020) stated, visual appeal significantly affects perceived quality in coffee products.

Aroma scores were highest across all treatments, particularly for Treatment D, confirming the importance of volatile compounds formed during roasting, as discussed by Rodrigues et al. (2019) and Flament (2020).

Texture ratings showed that Treatment D provided a superior mouthfeel, likely due to balanced viscosity and protein content from soybeans, consistent with Kleinert et al. (2020) and Smith et al. (2019), who emphasized that mouthfeel contributes to the overall satisfaction of coffee consumers.

Taste was a critical determinant of general acceptability, with Treatment D again emerging as the top performer. According to Martinez et al. (2022) and Kim et al. (2021), balanced sensory

attributes such as taste, texture, and aroma are essential in replicating traditional coffee appeal in substitutes.

Difference in the sensory qualities of roasted seeds and grain brew coffee powder and drink

A statistical analysis showed no significant differences in sensory qualities between the powdered and brewed forms of the coffee substitute. Appearance, aroma, taste, and texture were all rated similarly across both formats. These findings align with Dawar et al. (2020), who emphasized that visual uniformity enhances acceptance, and Ahmed et al. (2019), who noted that volatile compounds in roasted ingredients yield consistent aroma profiles.

The similarity in texture ratings supports Kim et al. (2021) and Mas-Aceret et al. (2020), who found that grind size and brewing method do not significantly affect the perceived smoothness of coffee substitutes. Taste perceptions, while slightly varied, remained within acceptable levels, in line with the work of Sun et al. (2019) and Laheji et al. (2022), confirming that roasted blends of papaya seeds, soybeans, and corn can yield palatable coffee alternatives.

Difference in the general acceptability of roasted seeds and grain brew coffee

Analysis of variance revealed statistically significant differences in general acceptability among the treatments. Appearance, aroma, texture, and taste all yielded p-values below 0.01, confirming that formulation differences significantly influenced consumer perceptions.

Treatment D achieved the highest ratings across all sensory dimensions. Its balanced ingredient composition likely optimized roasting results, color, flavor, and texture. These findings are supported by García et al. (2021), Rodrigues et al. (2019), and Smith et al. (2019), who emphasized that visual consistency, aroma, and mouthfeel are central to consumer satisfaction in alternative beverages.

Spence (2020) further highlighted that taste complexity and clarity are essential for acceptance in specialty coffee, which explains the success of Treatment D. The statistical results confirm that refining ingredient proportions and roasting techniques is necessary to maximize consumer appeal.

Shelf life of roasted seeds and grain brew coffee powder

Shelf-life evaluation revealed that all formulations remained free from spoilage for up to six months under room temperature conditions. No mold formation, unpleasant odor, discoloration, or fluid separation was observed. These results demonstrate the product's high stability and align with general food safety standards for low-moisture, plant-based products.

Microbial analysis of brewed coffee powder

Microbial analysis conducted by the Department of Science and Technology (DOST) confirmed the microbiological safety of the roasted seed and grain coffee product. The aerobic plate count, coliform levels, and mold counts were well below allowable limits. No Salmonella was detected. These results reflect compliance with good manufacturing practices (GMP) and suggest that the product is safe for consumption and suitable for further product development.

Proximate analysis of brewed coffee powder

The proximate analysis revealed that the brewed coffee powder is high in protein (15.03%), low in fat (1.02%) and carbohydrates (3.07%), and contains minimal moisture (1.24%), fiber (2.08%), and ash (4.10%). The high protein content suggests potential health benefits,

particularly for consumers needing protein-rich diets. The low moisture content enhances shelf stability, while the modest fat and carbohydrate levels make it appealing to health-conscious consumers. These nutritional values suggest the product can be marketed as a functional and nutritious coffee alternative.

CONCLUSION

The study on roasted seeds and grain brew coffee demonstrated that the formulated beverage, composed of papaya seeds, soybeans, and corn kernels, is a viable and acceptable alternative to traditional coffee. Sensory evaluations revealed high levels of consumer satisfaction across all attributes—appearance, aroma, taste, and texture—in both powdered and brewed forms. Among the different treatments, the formulation with equal proportions of the three ingredients (Treatment D) consistently received the highest scores, indicating an optimal balance of sensory qualities.

Microbial analysis confirmed the product's safety for consumption, while shelf-life testing showed that it remains stable and free from spoilage for up to six months under appropriate storage conditions. The proximate analysis further validated its nutritional value, highlighting a high protein content and low fat and carbohydrate levels, making it an appealing choice for health-conscious consumers.

Overall, the findings support the potential of roasted seeds and grain brew coffee as a functional, nutritious, and marketable coffee substitute. Future research is encouraged to refine the roasting techniques, explore additional local ingredients, and assess consumer acceptability across broader demographics to enhance its commercial viability.

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