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The Effectiveness of Calamansi *(Citrus Microcarpa)* Seed and Tomato *(Solanum Lycopersicum)* Seed as a Potential Coffee

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Abstract: ***The popularity of coffee is often limited by its caffeine content, which can cause anxiety, restlessness, and sleep problems. This has led to interest in finding healthier, caffeine-free options. This study investigates the effectiveness of Calamansi (Citrus Microcarpa) and Tomato (Solanum Lycopersicum) seeds as potential coffee substitutes. The research aimed to evaluate the characteristics of these seeds and determine their effectiveness as a coffee alternative in terms of taste, aroma, color, concentration, preparation methods, and shelf life. This research employed an experimental research design within the quantitative research branch. The preparation methods (brewing, dripping, mixing, and boiling) were tested on calamansi and tomato seeds individually and mixed. Statistical analyses, including one-way ANOVA and t-tests, were conducted to determine significant differences in the performance of these variables. Findings revealed that calamansi seeds produced a darker color and stronger aroma due to higher melanoidin and polyphenolic content, while tomato seeds exhibited a lighter color and milder flavor profile. The combination of calamansi and tomato seeds resulted in a balanced flavor and concentration, with a shelf-life comparable to traditional coffee. Results indicate that calamansi and tomato seeds are effective as a sustainable and caffeine-free coffee substitute, demonstrating notable improvement in sensory characteristics such as taste and aroma across the preparation methods. This research suggests that coffee offers an eco- friendly alternative, reduces agricultural waste while providing health benefits. Further development and refinement of preparation techniques are recommended to enhance its potential as a coffee substitute.***

Keywords: Alternative coffee, Calamansi seeds, Caffeine-free, Coffee substitute, Tomato seeds

I. INTRODUCTION

Coffee is one of the world's most popular beverages, alongside water and tea, and a highly profitable international commodity. While coffee is the base for drinks like espresso, cappuccinos, and lattes, its popularity is primarily due to caffeine, an alkaloid that provides an invigorating effect (Myhrvold, 2024). According to Harvard T.H. Chan School of Public Health (2023), low to moderate caffeine consumption can improve alertness and focus. However, excessive intake can cause anxiety, restlessness, insomnia, and a rapid heartbeat. Consequently, there is growing interest in caffeine-free alternatives with similar benefits.

Tomato and calamansi seed coffee is caffeine-free, making it a suitable alternative for those avoiding caffeine. Caffeine overuse is associated with increased alertness, high blood pressure, and other side effects (Harvard T.H. Chan School of Public Health, 2024).

Tomato and calamansi seed coffee offers health benefits instead. Calamansi seeds have potential anti-cancer properties (Ascendens Asia Publishing, 2018), while tomato seeds aid blood circulation, digestion, and heart health (Boldsky, 2019). However, this coffee may not provide the energy boost needed by coffee drinkers like call center agents.

Calamansi seeds, though bitter, have antioxidant, antimicrobial, anti-inflammatory, and anti-tumor properties (Barluado et al., 2016). Similarly, tomato seeds contain digestive fiber and amino acids, aiding nutrient absorption and gut health (Times of India, 2021). These health benefits make tomato and calamansi seeds a viable alternative to coffee.

Coffee is often consumed for energy and enjoyment, but calamansi and tomato seeds share similar properties, making them a potential substitute (Barluado et al., 2016; Times of India, 2021). This study explores the feasibility of using these seeds as coffee. The objectives include determining their suitability as a coffee replacement, identifying cost- effective alternatives to expensive coffee beans, and evaluating the seeds' health benefits and natural properties.

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II. METHODOLOGY

The researchers employed an experimental research design within the quantitative research approach which used to investigate cause-effect relationships by manipulating variables and observing their impact on outcomes (Webber & Prouse, 2019). Wherein the independent variable (Calamansi seed and Tomato seed Coffee) was manipulated and compared with the dependent variable (Arabica) in terms of characteristics (color, texture, aroma and shelf-life) and in terms taste concentration and the four (4) types of preparation method: brew, drip, mix and boil. To see the effectiveness of Calamansi (Citrus Microcarpa) and Tomato Solanum Lycopersicum) seed as a potential coffee.

The experiment was conducted in O'Donell, Capas, Tarlac, Philippines. The researchers extracted the seeds with the help of mesh strainer, dried the seeds under the sun and using blow dryer, grinded the seeds using mortar and pestle then lastly roasted the seeds in an oven toaster. The researchers prepared an observational checklist as research instrument used to systematically evaluate and monitor (Joseph, n.d.) the characteristics of the of the Calamansi (Citrus Microcarpa) seed and Tomato (Solanum Lycopersicum) seed in terms of color, texture, aroma and shelf-life which was observe during the experiment and following days after the experiment. The data obtained with the used of quantitative research approach involving collecting and analyzing numerical data. (Bhandari 2020) associate with respondent which are the five (5) selected Barista's from Cristo Rey, Capas Tarlac, Philippines which are: Pablo Cuevas III of Café Loca, Jerald Agabon of Café Ador, Jo Ephraim Lopez of Café Rachela and two (2) Barista of K-APE. These baristas were selected due to their expertise in coffee preparation and their ability to provide informed evaluations of the coffee. Likert scale was applied to measure respondents' attitudes towards the coffee substitutes, assessing their opinions on taste and quality (Bhandari, 2023).

To further interpret the results the researchers employed statistical tools such as T-test and One-way ANOVA and multiple-comparison to statistically analyze the effectiveness of the coffee substitutes, determining whether differences in variables such a taste and concentration were significant (Siegle, 2015; Mackenzie, 2024). This study provides health consideration to strengthen the food safety based of Republic Act No. 10611 (2013). The data and results obtained was checked by the researcher's statistician's and research adviser ensuring the reliability of the study.

III. RESULTS AND DISCUSSION

Characteristics of Calamansi *(Citrus Microcarpa)* Seed and Tomato *(Solanum Lycopersicum)* Seed as a Potential Coffee

1) Observational Checklist of Calamansi seed and Tomato seed in terms of Color

Color is an important feature of coffee because it shows how much the seeds were roasted and gives an idea of the flavor. The researchers observed the color of calamansi *(Citrus Microcarpa)* and tomato *(Solanum Lycopersicum)* seeds after roasting and grinding. The color was compared using the roasted coffee color card to determine the roast level. This helped them understand how the roasting process affects the appearance of these seeds.

Table 1. Color of the Calamansi (*Citrus Microcarpa)* Seed Coffee and Tomato (*Solanum Lycopersicum*) Seed Coffee Powder

SEED	1st Crack (95)	City– (85)	City (75)	City + (65)	Full City (55)	Full City + (45)	French (35)	Burnt (25)
Calamansi (*Citrus Microcarpa*) Seed Coffee			✓ 					
Tomato (*Solanum Lycopersicum*) Seed Coffee	✓ 							

The table shows the colors of roasted and ground calamansi and tomato seeds. The calamansi seeds were much darker than the tomato seeds. The calamansi seeds were a dark brown color, similar to a very dark roast coffee. On the other hand, the tomato seeds were a light brown color, similar to a light roast coffee.

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2) Observational Checklist of Calamansi seed and Tomato seed in terms of Aroma

Aroma is a key part of coffee because it affects how people enjoy its flavor. In this part, the researchers observed the aroma of the Calamansi (Citrus Microcarpa) seed and Tomato (Solanum Lycopersicum) seed as a potential coffee powder, compare to Traditional Coffee (Arabica, recommended by Pablo Cuevas III (one of the respondents) of Cafe Loca) as having comparable aroma with Calamansi (Citrus Microcarpa) Seed coffee and Tomato (Solanum Lycopersicum) Seed Coffee. To observe the aroma of the coffee, the researchers used their sense of smell. This helps them evaluated its fragrance and determined its aroma.

Table 2. Aroma of the Calamansi (*Citrus Microcarpa*) Seed Coffee and Tomato (*Solanum Lycopersicum*) Seed Coffee

Aroma	Flowery	Herby	Nutty	Smoky
Calamansi (*Citrus Microcarpa*) Seed Coffee			✓	
Tomato (*Solanum Lycopersicum*) Seed Coffee		.	✓	

The table shows the aroma of the calamansi seed, and tomato seed during the roasting and grinding processes. The researchers found that the calamansi seed and tomato seed are distinctive and not overpowering, which indicates a nutty aroma.

IV. DISCUSSION

From this study, calamansi and tomato seeds can be good alternatives to coffee, each offering unique characteristics. The darker color and nutty aroma of calamansi seeds make them a good choice for people who enjoy a strong and bold coffee flavor. Tomato seeds, with their lighter color and mild aroma, might appeal to those who prefer a softer and more subtle coffee experience.

A study by Jang et al. (2017), entitled "Color Analysis of Roasted and Ground Coffee Beans," explains that the roasting process causes a significant change in the color of seeds, turning them darker depending on the level of roast. Specifically, seeds roasted to a dark brown color, similar to calamansi seeds in this study, tend to develop deeper Maillard reaction products, which contribute to a darker appearance, as seen in coffee beans. On the other hand, a lighter roast, like the tomato seeds in this case, produces a lighter brown shade due to the less intense roasting process. Therefore, the color difference between calamansi and tomato seeds can be attributed to differences in their roasting levels.

When calamansi and tomato seed coffee are heated, their color changes because of chemical reactions. Heat can break down certain compounds, like pigments and sugars, inside the seeds. This can lead to the seeds turning brown or darker. One of the reasons for this is a reaction called the Maillard reaction, which happens when heat affects sugars and proteins. This reaction creates brown pigments and changes the color of food. A study by Chaturvedi et al. (2020) showed that when seeds, like tomato seeds, are heated, their color changes due to the breakdown of green pigments and the formation of new brown compounds. This is why the color of seeds, such as those in calamansi or tomatoes, changes when exposed to heat.

According to Lee, et al, (2020), it explored how varying roast levels (light, medium, dark) influence and affect the sensory perception of aroma. As stated by Angeloni et al. (2019), different brewing methods can significantly influence the sensory attributes of coffee, like aroma this is present at which the aroma of the coffee when prepared is more noticeable than when grinding the distinctive aroma of tomato seed coffee arises from the complex interplay of volatile organic compounds (VOCs) present in both tomatoes and coffee. According to Bourget (2022), Calamansi seed has been found to contain different phenolic compounds such as phenolic acids, tannins, and flavonoids which dictate the nutty aroma.

The aroma of tomatoes is mainly shaped by more than 400 VOCs, with 21 essential compounds playing a crucial role in its sensory characteristics, organized into five biosynthetic clusters (Martina et al., 2021). In the case of coffee, particularly Coffea canephora, the aroma is influenced by a variety of factors, including the specific compounds that develop during the maturation of the fruit (Quintero et al., 2018). Research has investigated the incorporation of tomato extracts into coffee cultivation as a means to boost growth and possibly modify aroma, as evidenced by studies demonstrating that tomato extract enhances callus development in robusta coffee (Fahira et al., 2023).

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The study highlights that calamansi seed coffee, roasted to a dark brown color, exhibits deeper Maillard reaction products, resulting in a darker appearance and a nutty aroma due to phenolic compounds such as tannins and flavonoids. In contrast, tomato seed coffee, subjected to lighter roasting, retains a lighter brown color and an aroma shaped by its rich profile of volatile organic compounds (VOCs). These differences in color and aroma are directly linked to the varying roasting levels and chemical compositions of the seeds, emphasizing the significant impact of the roasting process on the sensory attributes of seed-based coffee products.

V. CONCLUSION

This study explored the use of calamansi and tomato seeds as alternatives to traditional coffee beans. The researchers looked at their unique characteristics and how roasting levels affected their color, aroma, and taste.

Calamansi seeds had a darker color and nutty aroma, suitable for those who enjoy strong and bold flavors. Tomato seeds, with their lighter color and mild aroma, are better for those who prefer softer and milder coffee. These differences were due to their roasting process, which can be adjusted to match different preferences.

The findings show that using calamansi and tomato seeds as coffee substitutes is sustainable and eco-friendly. Repurposing these seeds not only reduces agricultural waste but also provides a creative, low-cost alternative for coffee production. This method uses simple processes like cleaning, drying, and roasting, which are practical and easy to replicate on both small and large scales.

Further studies are needed to evaluate their nutritional content, shelf life, and consumer acceptance. Additionally, experimenting with different roasting techniques could improve their flavor and expand their appeal to more people.

Overall, calamansi and tomato seeds can be great alternatives to coffee, offering different flavors while helping reduce waste and support sustainability.

VI. LIMITATION

The scope of our study is to find the effectiveness of Calamansi (Citrus Microcarpa) seed with the Tomato (Solanum Lycopersicum) seeds as a potential coffee powder substitute. The aims are to discover a new Arabica (Coffea arabica) taste coffee, that is caffeine-free because the caffeine content of the traditional/commercial can cause negative effects on human body. The study mainly determines the characteristics of the Calamansi (Citrus Microcarpa) seed and the Tomato (Solanum Lycopersicum) seeds, including the physical, chemical, and as well as the Physico-chemical properties of the Calamansi (Citrus Microcarpa) seed with the Tomato (Solanum Lycopersicum) seeds. The researchers do not include the other types of coffee and excludes the other chemical properties. Due to the limited resources and limited finances, the study will be conducted in a limited supply of Calamansi (Citrus Microcarpa) and Tomato (Solanum Lycopersicum) seeds.

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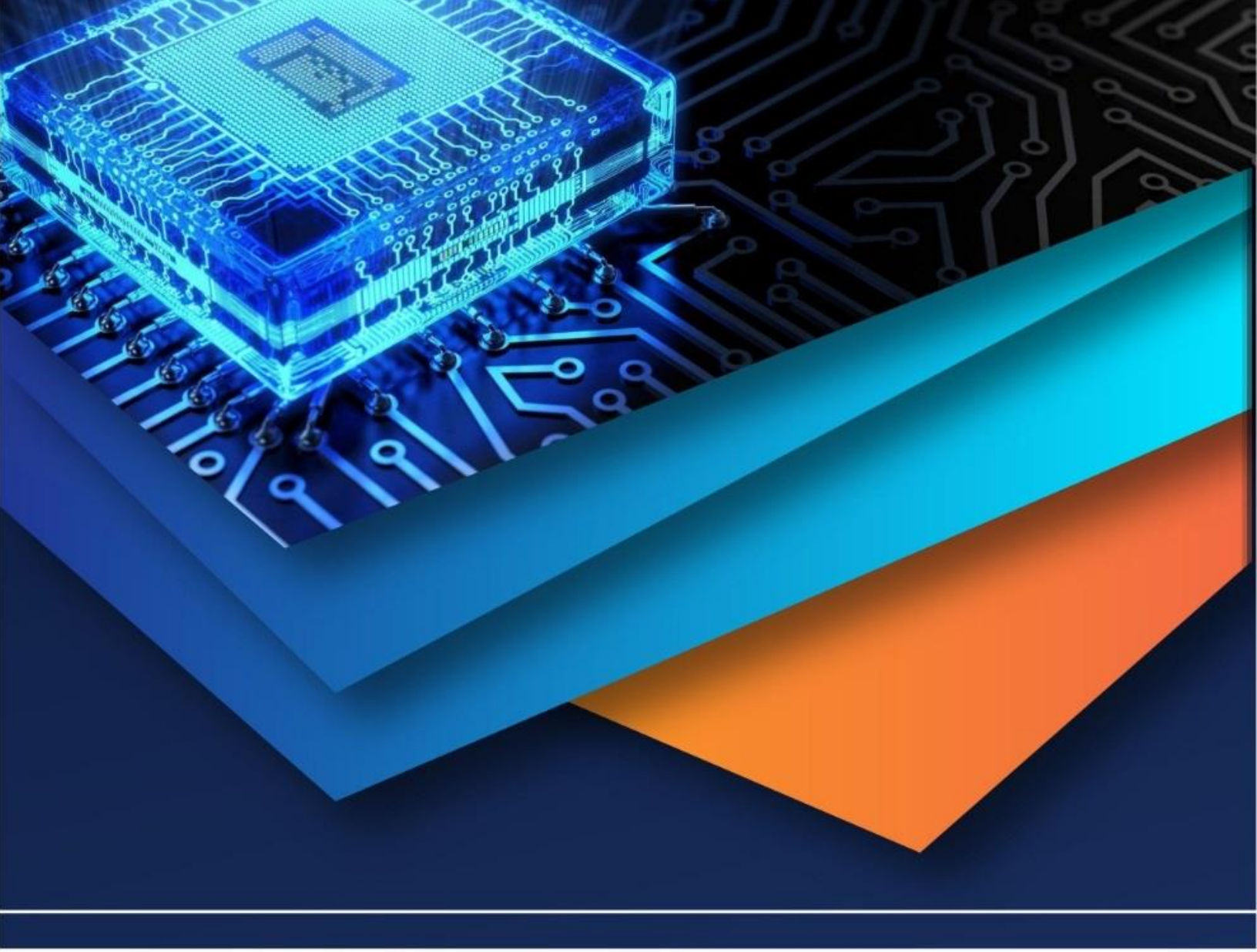

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