The Food Acceptability of Citrus Sinensis (Orange Peel) As A Processing Alternative for Industry-Standard Coffee

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Abstract

This developmental research aims to show the potential benefits of utilizing citrus sinensis (orange peel) as an alternative ingredient for industry-standard coffee, addressing the escalating issue of food waste. A comprehensive survey was conducted, targeting food experts and consumers proficient in this domain, to gauge the acceptability of aroma, taste, and texture/body in coffee incorporating orange peel. Our findings reveal a favorable reception of these attributes, advocating for the continued integration of orange peel in coffee powder alternatives. This shows the procedures for creating orange peel as a coffee powder through sun drying or a food dehydrator. Moreover, the acceptability of the orange peel coffee among food experts highlights its potential as an alternative. Distinguishing from other research, which primarily explores the use of orange peel as an additive in beverages, this study innovatively presents orange peel as the primary component in coffee powder, showcasing its versatility. The perceptions of food experts and consumers are similar to the quality of the orange peel coffee concept. This research shows the significance of coffee powder, recognizing its important role in coffee production. By providing an overarching view of coffee powder, this research provides knowledge and its impact on the coffee-making process, further validating the feasibility and acceptability of orange peel as a sustainable coffee ingredient.

Keywords: *food acceptability, sensory acceptability, food innovation, food waste, orange peel, citrus sinensis, sustainability*

INTRODUCTION

Food waste is an extensive issue that affects many areas, including the environment, ethical behavior, and economics. Food and Agriculture Organization said that waste and losses account for 10% of global energy use, making them a significant problem—contributor to climate change. The study also highlights the development of inefficiencies that result from the route food takes as it passes through various actors, such as farms and manufacturers, households, shops, and customers. Food waste raises moral issues for humanity and increases the disparity between the wealthy and poor segments of the population. Sadly, food is wasted even though a substantial percentage of the globe suffers from hunger and malnutrition (Närvänen et al., 2019). The primary citrus fruit, the orange, is one of the top five fruit commodities on the world fruit market. The Food and Agriculture Organization reports that global orange output surpassed 68 million tons or 8.5% of all fruit production. The countries that produced the most oranges in 2012 were Mexico, China, India, Brazil, and the US. Of the oranges used to create juice, 40–60% are discarded, including the segment membrane, seed, and peel. According to estimates, these solid wastes are produced at a rate between 15 and 25 million tons annually. Citrus peel makes up most of these wastes, making up around 44% of the weight of the fruit bulk (Rachma et al., 2015).

In international studies, according to Taherzadeh et al. (2010), citrus fruit is grown most extensively worldwide, and the juices it produces are the most popular. Of the 50.2 million oranges produced worldwide in July 2017, only Brazil produced 19.2 million tons, making it the world's greatest producer of oranges (USDA, 2017).

In a local study, every year, one-third of the food provided for people to consume is lost or

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squandered. Food wastage weakens global food security, which increases the number of hungry people worldwide. Food waste limits both the available amount of food and the resources needed to create it for future generations (Aviyan, 2021). In Metro Manila alone, 2,175 tons of food leftovers are discarded daily. In the Philippines, 52% of all solid waste comprises biodegradables, food waste, and garden debris. Three billion people could be fed by the 1.3 billion tons of crops lost or wasted annually worldwide (Space, 2021).

The Rutaceae family of plants produces citrus fruits such as orange, grapefruit, mandarin, lemon, lime, and sour orange, which are known to be a promising source of several essential elements for human consumption. Due to the enormous volume of peel produced, processing citrus products may be a rich source of dietary fiber. These orange fruit remnants, typically thrown away as garbage, could serve as sources for nutraceuticals (Shafiya et al., 2018). Orange peel is sometimes used for composting and came up with the idea to produce a product that has yet to be on the market. Flavonoids linked to antioxidant activity are found in orange peel, the main waste component in the manufacture of orange juice (Kanaze et al., 2008).

According to Mourad (2019), An extensive number of environmental consequences, such as greenhouse gas emissions, loss of land, deforestation, air and water pollution, and contamination that happen during the procedures of food manufacturing, storing shipping, and waste management, are indirectly brought on by food losses and wastes.

Orange is the most popular citrus fruit consumed globally, and after consumption, more than half of the fruit is left as by-products. Since the use of citrus fruit residues not only affects the issue of its disposal but also offers methods to eliminate the resulting contamination, it is vital to consider new research directions in this area. From January 2021 to 2022, the globe produced about 48 million metric tons of oranges, with the United States, China, Brazil, the European Union, and Mexico being the largest exporters.

Oranges are mostly grown for their juice, responsible for 1.7 million metric tons of orange output through January 2022–2022. Oranges are grown in several nations. (USA, 2022).

Literature Review

Beans from the coffee plant are used to make coffee. Usually, the fruit, or cherry, of the plant—a member of the Rubiaceae family—is used to extract the seeds known as coffee beans. A natural stimulant found in coffee, Among the most popular drinks in the world, is this one. To make a special, aromatic drink, ground coffee beans are mixed with heated water to be prepared in many methods, including drip brewing, coffee, or French press Pendergrast (2005).

Coffee is a highly popular beverage worldwide, favored for its invigorating properties owing to its high caffeine content. Although cold brew and iced coffee are popular alternatives, it is usually sipped hot. Culture and geography have a major impact on coffee consumption, which is highest in the US, Brazil, Germany, Japan, and other nations. Espresso's popularity is due to its preparation methods and the range of coffee drinks it provides, such as espresso, latte, and cappuccino. 2.25 billion mugs of coffee are drunk globally every day, according to recent research, highlighting coffee's central role in everyday tasks and cultural traditions Standage, T. 2005.

Ethiopia's historic coffee forests are where coffee first originated. Legend has it that Kaldi, a goat herder, discovered coffee when he saw his goats were exceptionally active after consuming berries from a particular tree. Inquisitive about this phenomenon, Kaldi brought his discoveries to the attention of a nearby monastery, where the monks discovered that brewing a drink from the berries kept them awake for extended periods of meditation. Gradually, this revelation made its way to the Arabian Peninsula, where coffee trading and cultivation started in the fifteenth century. From there, it traveled to Persia, Egypt, and the Ottoman Empire before arriving in Europe by the 17th century and quickly gaining popularity there Pendergrast 2005.

The physical-chemical characteristics and the coffee tastes of coffee beans roasted at various temperatures. An atmospheric liquid analytical method was used to determine four distinct types of roasted coffee. As coffee beans were roasted at increasing degrees, the moisture level and overall tartness of the roasted coffee dropped while the pH and reduction in weight (%) improved. As the coffee beans' processing temperatures rose, Hunter's color measurements of the roasted coffee, which represent L (lightness) and B (yellowness), decreased; however, the value of a (redness) remained constant on moderate being roasted Dong Min et al., (2013).

Arabica (Coffea arabica) kind of coffee is well-known for having an exceptional flavor profile and quality. With 60–70% of the world's coffee produced, it is the most frequently farmed species of coffee worldwide. Arabica beans are usually farmed at higher elevations (between 600 and 2000 meters) in areas with rich, well-drained soil and colder weather. Arabica coffee's flavor is frequently characterized as smooth and nuanced, exhibiting a variety of taste notes such as fruit, sugar, berries, and floral tones. In addition, Arabica beans are lower in caffeine and more acidic than other coffee species like Robusta Pendergrast, (2005).

Robusta (Coffea canephora) is distinguished from Arabica coffee by having a stronger flavor and more caffeine. Its earthy scent and powerful, bitter flavor make it a popular ingredient in blends and instant coffee Pendergrast, (2005).

Liberica coffee (Coffea liberica) Grown mostly in West Africa and Southeast Asia, is a lesser-known variety of coffee. In comparison to Arabica and Robusta, it is distinguished by its distinct flavor profile and bigger beans Pendergrast, (2005).

Excelsa coffee is native to the highlands of Southeast Asia, where it grows in diverse ecosystems ranging from mountainous regions to lowland forests. It is often found alongside other coffee species, contributing to the region's rich coffee biodiversity. Excelsa beans are known for their unique and complex flavor profile. They often exhibit a tart, fruity taste with hints of spice and a distinctive aroma. Compared to Arabica and Robusta, Excelsa coffee has a more pronounced tartness and a broader range of flavor notes Pendergrast, (2005).

Coffee's phytochemistry, which includes caffeine, hydroxyhydroquinone (HHQ), the stimulant caffeic acid, chlorine dioxide, and other substances, is widely credited with its beneficial effects on health. Coffee and its byproducts also support normal mental abilities. Caffeine, in fat portions, modifies detoxification nutrients and protects certain cancerous cells. It contains coffee beans and kahweol. However, their increased levels also result in an increase in blood cholesterol, which could be dangerous for coronary heart disease and cause problems like cardiac issues, stroke, sleeplessness, and cardiovascular illnesses. These receptors are similarly impacted by coffee, and in people addicted to the substance, relapse symptoms include discomfort in the muscles (Butt, M. S., and Sultan, M.T. 2011).

Kanaze et al., (2008), orange peel, the main waste fraction used to make orange juice, includes flavonoids that have antioxidant properties. The major components of citrus peel extracts that are thought to have antioxidant properties are the glycosides naringin and hesperidin. Additional phenols contained in orange peels, such as coniferin and phlorin, have been proven to support radical scavenging when consumed as orange-peel molasses (Manthey, 2004).

Brazil, the United States of America, China, Japan, Mexico, Pakistan, and nations in the Mediterranean area are the main producers of citrus. Because citrus fruits and their byproducts have so many applications in the food industry, cosmetics, and traditional medicine, for example, they are highly valuable both medicinally and economically. Anatomically, the fruit is made up of two separate sections: the pericarp, sometimes referred to as the peel, epidermis, or rind, and an endocarp or pulp, which contains juice sac glands. The skin's distinct scent is produced by a multitude of tiny, aromatic oil glands that are scattered throughout the epidermis of epicuticular wax. The pericarp is composed of the cuticle and parenchymatous cells that make up the outer flavedo, or epicarp.

The Peel of Citrus as a Sustainable Bioresource: Converting Waste into Food Additives is the title of the study. Citrus fruits are extensively cultivated globally and are mostly utilized in the production of citrus-based food items, including drinks, jams, and canned fruits (Cai et al., 2020, Huang et al., 2021). It is commonly known that citrus fruits are high in nutrients. Citrus-based dietary items have been shown in numerous studies to protect against degenerative illnesses such as low blood sugar, cancer, heart disease, and hypertension (Gupta et al., 2021; Park and Shin, 2021). Given this information, the food industries centered around citrus fruits are growing. This results in the production of citrus peel, a substantial waste product in different processing sectors, and the development of citrus-based byproducts. Citrus skins, seeds, and membrane leftovers from the citrus processing sector account for about 50–60% of the fruit's weight (Mahato et al., 2019). It is therefore essential to look into the possibilities of converting this waste into items that may be sold commercially.

Numerous studies have looked into citrus peel's possible use in food processing applications since it contains several active ingredients, such as soluble fiber, pectin, amino acids, color, flavonoids, which and essential oils (Huang et al., 2021). Additionally, advantageous bioactive substances present in different citrus peel species and effective extraction techniques for isolating these substances from the peel have been the subject of numerous studies. (Zarate-Vilet et al., 2020). Studies have indicated that these bioactive compounds have broader use across a range of industries, including food, cosmetics, and pharmaceuticals. These industries focus on a variety of biological traits, such as antioxidant, antidiabetic, anticancer, and anti-inflammatory properties (Liu et al., 2021, Panwar et al., 2021).

Research on the toxicity and safety of goods containing citrus peel is becoming more and more necessary, nevertheless. Value-added food items are produced through recycling, however, the emergence of this novel concept loop in the food chain prompts concerns about potential dangers. The conversion of byproducts into food ingredients is known to provide serious issues, including the possibility of contamination and identity loss. Furthermore, orange peel products are typically created as novel food products with specific characteristics, therefore there is little information available on how safe use of them is. This makes it vital to research the safe use of products in food industry uses (Lavelli, 2021). Comparably, to be used safely, chemicals derived from fruit by-products must meet all applicable regulatory standards and pass a risk assessment.

An additional study was carried out at the Saudi Society of Agricultural Sciences entitled "Antimicrobial and antioxidant properties of orange peel (Citrus sinensis)." The demand for natural antimicrobial agents is rising as a result of the processed food industry's explosive growth and rising food consumption. Cons are aware of how artificial preservatives, which are used in food, affect health. As a result, natural preservatives are created to satisfy market demand. These natural antimicrobials are made from plants or their parts; animal waste from the food industry is being explored as a potential substitute for plants when making natural antimicrobials. The goal of the current study was to make use of the waste produced by the citrus fruit processing (peel) industry in food (olive oil and cream dessert can be used as an antimicrobial). (Bouhadi, 2017).

Another study conducted by the National Library of Medicine in the United States, the study has demonstrated that because agricultural wastes contribute to preventing global warming and have a large biomass supply, they have tremendous potential for use as adsorbent material. An estimated 1.2 billion tons of oil, or twenty-five percent of the worldwide current oil production, are produced annually worldwide from the approximately 5 billion metric tons of waste from agriculture that are produced. With an estimated 32 million tons produced annually, orange peel is a material that can be used for the biosorption of pollutants. The application of orange peel for environmental cleanup has been extensively studied; nevertheless, the majority of research focuses on researches on the absorption of heavy metals and dyes, although there are few papers that discuss the oil adsorption capability of orange peel, it is crucial to note that its adsorption capacity is

relatively low when compared to materials such as kapok fiber and cotton fiber. However, the abundance of orange peel in nature, combined with its low water adsorption capacity, establishes it as a highly effective biosorption material for a wide range of contaminants. Therefore, the main objective of this research is to analyze existing literature on the adsorption of various contaminants by orange peel, and to identify the specific structural characteristics of the peel that influence the adsorption process. This will involve a comprehensive examination of the FTIR spectra and SEM images of both untreated and modified orange peels to pinpoint the key characteristics that play a role in biosorption.

The synthesis of current research underscores the remarkable versatility of citrus sinensis, particularly its role as an antimicrobial and antioxidant agent. From enhancing the flavor profile of culinary creations to contributing to health and wellness through antioxidant-rich extracts, orange peel has proven to be a valuable resource. Its inclusion in beverages and household products further attests to its widespread applicability, showcasing the diverse ways in which this botanical component continues to make a significant impact across various industries. As research progresses, the potential for new discoveries and applications of citrus sinensis remains ripe for exploration. Citrus sinensis, commonly known as orange peel, has garnered considerable attention in contemporary research due to its multifaceted applications, particularly as an antimicrobial and antioxidant agent. This versatile botanical component has found its way into various industries, making a significant impact not only as a flavor enhancer but also as a functional additive in beverages and other consumables. Numerous studies have delved into the antimicrobial properties of citrus sinensis, revealing its effectiveness against a broad spectrum of microorganisms. The peel's natural compounds, such as flavonoids and essential oils, have demonstrated notable inhibitory effects against bacteria and fungi. This antimicrobial prowess positions orange peel as a promising natural alternative in the ongoing quest to develop novel antimicrobial agents, especially in the face of rising concerns over antibiotic resistance. Beyond its culinary and health-related applications, citrus sinensis has also carved a niche for itself in the realm of household products. The peel's natural oils have proven effective in cleaning applications, leading to its use as a detergent and household cleaner. This environmentally sustainable option is per the increasing market requirement for eco-friendly and organic cleaning remedies, thereby broadening the impact of orange peel.

This research synthesis shows the utilization of orange peel in coffee represents a novel frontier in culinary exploration, and the groundbreaking nature of this venture is underscored by the pioneering efforts of researchers from the City College of Angeles pursuing a Bachelor of Technical Vocational Teacher Education. The confluence of innovation and academic curiosity has propelled these researchers to embark on a journey that could potentially redefine the sensory landscape of a beverage deeply ingrained in global culture.

Conceptual Framework

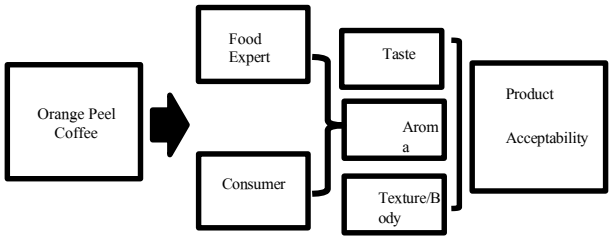
Stone et al. (2004) proposed the Sensory Evaluation Theory. This strategy emphasizes the importance of sensory characteristics in product development to food expert and consumer acceptance and may offer a broad viewpoint on the study “The Food

Acceptability of Citrus Sinensis (Orange Peel) as a Processing Alternative for Industry- Standard Coffee”.

According to the Sensory Evaluation Theory, consumers' and food experts’ acceptance and choice of food products are largely influenced by sensory characteristics. This idea states that sensory assessment is a methodical way to comprehend and measure the sensory characteristics of orange peel coffee, such as taste, aroma, texture/body, and overall consumer experience.

Orange peel coffee's food acceptability which encompasses its taste, aroma, and texture/body may be impacted by using the sensory assessment theory during product development. This paradigm correlates with the research on orange peel as an alternative to industry-standard coffee.

By applying the principles of Sensory Evaluation Theory, product developers or researchers can create sensory-pleasing products that resonate with consumers and food experts, leading to increased acceptability and consumer satisfaction.



Statement of Objectives

This study aims to determine the food acceptability of Citrus Sinensis as an alternative ingredient for preparing coffee.

It specifically aims to attain the following objectives:

1. To process orange peel as a coffee alternative:
2. To subject the product to food tasting validation among experts in terms of:
   2.1 Taste
   2.2 Aroma
   2.3 Texture/Body
3. To survey its food acceptability among consumers through food tasting in terms of:
   3.1 Taste
   3.2 Aroma
   3.3 Texture/Body
4. To determine the significant difference in its acceptability among consumers and food experts.
5. To use citrus sinensis (Orange Peel) coffee as an alternative ingredient to industry- standard coffee.

Significance of the Study

The study's significance lies in addressing the issue of increasing orange peel waste while simultaneously creating a valuable and innovative product, which is orange peel coffee. By repurposing orange peels as the main ingredient in coffee, the researchers are contributing to sustainability and waste reduction.

BTVTED Students: this study will help the students in City College of Angeles BTVTED students and other universities and colleges taking the same course to have a broad understanding of using food waste such as citrus sinensis (orange peel) and how it will help students use this as a reference in their future research.

Food industry innovation: The study's development of orange peel coffee showcases innovation within the food industry. It demonstrates that even by-products and waste materials can be transformed into valuable and marketable products, inspiring food professionals to think creatively about waste management and product development.

Future research and development: The study's findings and methodology can serve as a foundation for future research on waste utilization and sustainable food practices. It can encourage other researchers to explore additional ways to repurpose food waste and
create new products with environmental and health benefits.

Entrepreneurs: The findings of this study will benefit the entrepreneurs in marketing the citrus sinensis (orange peel) coffee as a new product to the market.

Students: The findings of this study will help the students gather information about the benefits of citrus sinensis (orange peel) coffee and future studies related to orange peel coffee.

Consumer awareness and education: As consumers become aware of the environmental impact of food waste, the study can help educate them about waste reduction and the importance of supporting sustainable products. This awareness can lead to increased demand for environmentally friendly products like orange peel coffee.

Waste reduction and resource efficiency: By transforming orange peels into a new product, the study promotes a circular economy approach, where waste is turned into a valuable resource. This fosters

resource efficiency and encourages other industries to explore similar ways of repurposing waste material.

Overall, the study's significance lies in its potential to address multiple challenges related to waste management, sustainable product development, and consumer health. It aligns with the broader goal of achieving a more sustainable and environmentally conscious society while providing tangible benefits to various stakeholders, including future researchers, food professionals, and health-conscious consumers.

Scope and Delimitation

This study aims to evaluate orange peel (citrus sinensis) sensory acceptability as a substitute component for coffee. In this research, a focus was given to food waste derived specifically from kitchen waste. The food supply chain has many parts and factors, but this research decidedly chooses to highlight the food waste that comes from fruit peel.

This study covers the taste, aroma, and texture/body of citrus sinensis (orange peel) coffee. This study aims to produce coffee made from citrus sinensis (orange peel), and it used a purposive sampling technique to gather data on the acceptability of orange peel as an alternative ingredient for coffee.

The researchers will collect data on coffee shops, baristas, and food critics, as they are experts in this field. There will be a total of fifty (50) respondents, and there will be limited financial resources for this investigation as well as a short time frame.

METHODS

Research Design

The methodology employed in this study will be developmental research rather than simple development, characterized by the systematic investigation into the design, evaluation, and production of products that are required to fulfill the standards of sensory acceptability and efficacy (Richey, 1994).

This study will modify the procedure using the following stages: ideation, product creation, and food-tasting testing with experts and consumers of the product, under the principle of parsimony. The steps that will be taken in this investigation will assess whether citrus sinensis (orange peel) coffee is suitable for consumption as food.

Preparation and formulation of citrus sinensis (orange peel) coffee

This section shows the process of developing the citrus sinensis (orange peel) coffee.

PREPARING – DEHYDRATING – GRINDING - PACKAGING

Locale of the Study

This study was conducted at the City College of Angeles. The data will be gathered using the researcher-made questionnaire that will take place at coffee shops, educational institutions, and other settings relevant to the food business. Since it provides the researchers with the necessary data, researchers gained responses from teachers in the school with a program of Bachelor of Technical Vocational Teacher Education Major in Food Service Management and other food institutions.

Respondents and Sampling Design

The respondents in this study will be twenty (20) Food experts, and thirty (30) consumers, for a total of 50 respondents. These food professionals are the people who work in food establishments or baristas who are knowledgeable in beverages, and the consumers are the people who like coffee. It is a quantitative approach, there will be 50 total respondents to be gathered through the survey.

The respondents are baristas and coffee experts, food professionals as well as the consumer, and as for specification the respondents must be:

- Baristas/Coffee professionals who work in a coffee shop.
- A consumer of coffee

Data Collection Method

The data will be gathered using a survey questionnaire, and test sample by visiting the respondents at their places, mainly coffee shops, or food establishments. Subject to their agreement,

experts in the food and beverage sector and consumers of the product concern shall be interviewed. The responses from all the respondents will be confidential, and they shall also serve as one of the processes that form part of this study.

Each respondent will be given a survey questionnaire and will be asked to answer the form honestly and objectively rate the components included in the survey form. This means that the opinions of respondents on coffee are to be relied upon when researchers record this information.

Ethical Consideration

The researchers will seek consent from interested parties before beginning their investigation to uphold ethical norms in research. The responders will be made aware of the study's goals, and their identities will be kept private. The University of Nevada (2021) argues that it is necessary to preserve the respondents' information disclosures to safeguard both their consent and the participants.

Data Analysis Method

The data has been collected using quantitative methods through a researcher-made questionnaire. Since the numerical comparisons are carried out with quantitative data, statistical inferences will be used to analyze the data gathered, and the data from the respondents will be carefully analyzed using descriptive statistics, particularly frequency distribution (f), percentage (%), and mean.

The formula below can be used to calculate the percentage:

Likert Scale

Interval Scale	Verbal Descriptors
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

Food Acceptability Scale

Interval Rating	Descriptive Value
3.26 - 4.00	Highly Acceptable
2.51 - 3.25	Acceptable
1.76 - 2.5	Slightly Acceptable
1.00 - 1.75	Not Acceptable

RESULTS AND DISCUSSION

This section displays the presentation, development process, interpretation, data analysis, and discussion of the conclusions and findings related to the data collected by the researchers from consumers and food experts.

Recipe of the Developed Product (Orange Peel) Coffee

The preparation and the process as well as the tools and equipment used are listed below. The orange peel coffee was prepared by the researchers with proper health and safety to ensure that the respondents were safe.

Ingredients

- Orange Peel

Tools, Materials, and Equipment

- Mixing Bowl
- Baking Sheet
- Strainer
- Blender/Food Processor
- Oven

Product Costing

Orange Peel	Php 0

The table above shows the expenses of making citrus sinensis (orange peel) coffee. The product cost is 0 PHP if we use the orange peel from scratch; however, it will cost 180 PHP per kilo of oranges to get the peel. The production expenses will decrease if we use orange peel from scratch.

Procedures

The data below is the procedure and process of making Citrus Sinensis (Orange Peel) Coffee.

1. Preheat the oven to 180 degrees Celsius for 5 minutes and thoroughly wash the orange peel with water.

2. Pat dry the orange peel with a paper towel and sun-dry until no moisture is left.

3. Place the orange peel on a baking sheet.

4. Bake the orange peel at 180 degrees Celsius for 45-50 minutes or until brown.

5. After baking, set it aside and let it cool.

6. Using a blender or food processor, grind the orange peel until it is powdered.

7. After that, sieve the powdered orange peel using a strainer to get rid of the lumps.

8. The processed orange peel coffee.

The data below is the recipe for Citrus Sinensis (orange peel) coffee as an alternative ingredient for industry-standard coffee.

Orange Peel Iced Mocha

Yield: 4 servings
Ingredients: ½ cups filtered cold orange peel coffee
2 cups milk
¼ cup chocolate syrup
Procedure:
1. Pour coffee into a cube tray. Freeze until solid, or overnight.
2. In a blender, the integration of coffee ice cubes, milk, chocolate syrup, and sugar is conducted.
The blending process continues until a smooth consistency is achieved. Subsequently, the mixture is poured into glasses for serving.

Orange Peel Cold Brew and Almond Milk Latte

Yield: 4 servings
Ingredients: 4 cups room temperature water
½ cup filtered orange peel coffee
2 cups almond milk
Procedure:
1. Combine water and orange peel coffee.
2. Pour the coffee into a bottle through a coffee filter or cheesecloth to catch the ground.
3. Fill an ice cube tray with the cold brewed orange peel coffee and freeze until cubes are set, 6 hours to overnight. Store frozen cubes in a resealable plastic bag until ready to use.
4. Fill a glass with coffee ice cubes and top with almond
milk.

Frozen Orange Peel Caramel Latte

Yield: 3 servings
Ingredients: 3 fluid ounces of filtered orange peel coffee
1 tablespoon caramel sauce
2 tablespoons white sugar
¾ cup milk
1 ½ cups ice cubes
Procedure:
1. Combine the orange peel coffee, caramel sauce, and sugar in a blender jug. Proceed to blend at a

high speed until the sugar and caramel fully dissolve into the orange peel coffee. Introduce the milk and ice into the mixture, and blend continuously until a smooth and frothy consistency
is achieved.

Hot Orange Peel Mocha Float

Yield: 4 servings
Ingredients: ½ cup cocoa
½ cup sugar
2 cups milk
2 cups orange coffee, hot
1 cup chocolate cream
Procedure:
1. Combine cocoa and sugar in a spacious saucepan before whisking thoroughly. Introduce milk and heat the mixture on a stovetop set to medium heat, ensuring a continuous whisking motion until fully incorporated. Subsequently, take the saucepan off the heat source and gently fold in the steaming coffee.

Data of the Citrus Sinensis (Orange Peel) Coffee After the Taste Testing of Food Experts

Table 1. The Sensory Acceptability of Citrus Sinensis (Orange Peel) Coffee in Terms of Taste

Statement	Rating	Verbal Interpretation
The bittersweet taste of the orange peel coffee is appealing.	3.48	Strongly Agree
The aftertaste of the orange peel coffee is tolerable.	3.57	Strongly Agree
The sweetness of the orange peel coffee is apparent.	2.86	Agree
The commercially produced coffee and orange peel coffee are comparable.	2.95	Agree

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The sweetness of the orange peel coffee is apparent.	2.86	Agree
The commercially produced coffee and orange peel coffee are comparable.	2.95	Agree
The overall taste of the orange peel coffee is satisfactory.	3.38	Strongly Agree
Mean	**3.25**	**Acceptable**

Interpretation: 3.26 – 4.00 – Highly Acceptable; 2.51 - 3.25 – Acceptable; 1.76 - 2.50 – Slightly Acceptable; 1.00 - 1.75 – Not Acceptable

Table 1 shows the acceptability rating of citrus sinensis (orange peel) based on its taste. The evaluation of the gathered data garnered a mean of 3.25. This means that most of the food expert respondents strongly agree with the result. The bittersweet taste of the orange peel coffee gained a mean of 3.48, which equates to a rating of strongly agree.

The aftertaste of the orange peel coffee gained a mean of 3.57, which equates to a rating of strongly agree. The sweetness of the orange peel garnered a mean of 2.86, which equates to an agreed evaluation. The commercially produced coffee is comparable; it garnered a mean of 2.95, which equates to a rating of agree, and the overall taste of the orange peel coffee gained a mean of 3.28, which

equates to a rating of strongly agree, which means that the food experts and baristas rated it as acceptable.

As seen above, the citrus sinensis (orange peel) coffee in terms of taste is rated as acceptable, and it shows that the taste of the orange peel coffee is evident. As stated by Barbarossa et al. (2020), taste is also a factor in food acceptability as it sends signals to central feeding centers that control a consumer's level of hunger and fullness.
Additionally, taste is important to consider in accepting or rejecting a food.

Table 2. The Sensory Acceptability of Citrus Sinensis (Orange Peel) Coffee in Terms of Aroma

Statement	Rating	Verbal Interpretation
The citrus aroma of the coffee is evident.	3.43	Strongly Agree
The smell of coffee and orange is balanced.	3.05	Agree
The overall smell of the orange peel coffee is acceptable.	3.24	Agree
Mean	**3.24**	**Acceptable**

Interpretation: 3.26 – 4.00 – Highly Acceptable; 2.51 - 3.25 – Acceptable; 1.76 - 2.50 – Slightly Acceptable; 1.00 - 1.75 – Not Acceptable

Table 2 summarizes the respondent's evaluation of the aroma of citrus sinensis (orange peel) coffee. Garnering a mean of 3.24, the product's aroma is rated as acceptable. The citrus aroma of the coffee is evident, which garnered a mean of 3.43 and was rated as strongly agree. (3.05) that the smell of coffee and orange is balanced, which shows that it has an agreed result. Lastly, the overall smell of the orange peel coffee is acceptable, which scored a rating of 3.24.

As presented, the aroma of the citrus sinensis (orange peel) coffee scored a rating of acceptable in terms of aroma. Based on the respondent's evaluation and comments the smell of the orange peel coffee is new and unique. The finding that aroma influences people's appetite and food intake is supported by Yin et al. (2017). Considering this, aroma increases appetite and feelings of fullness.

Table 3. The Sensory Acceptability of Citrus Sinensis (Orange Peel) in Terms of Texture/Body

Statement	Rating	Verbal Interpretation
The orange peel coffee powdery texture is evident.	3.52	Strongly Agree
The tartness of the orange peel coffee is bearable.	3.19	Agree
The orange peel coffee adheres to the standard.	3.14	Agree
The overall texture of the orange peel coffee is acceptable.	3.48	Strongly Agree
Mean	**3.33**	**Highly Acceptable**

Interpretation: 3.26 – 4.00 – Highly Acceptable; 2.51 - 3.25 – Acceptable; 1.76 - 2.50 – Slightly Acceptable; 1.00 - 1.75 – Not Acceptable

Table 3 shows the results of the respondent's evaluation of the product's texture. Most of the respondents agreed that the powdery texture of the product was evident and gained a rating of 3.52, which equates to strongly agree. The tartness of the orange peel coffee gained a mean of 3.19, which equates to an agreed rating. (3.14) that the orange peel coffee adheres to the standard, which is rated as agree. The overall texture of the orange peel coffee gained a mean of 3.33 and was rated as highly acceptable.

The gathered data from the food experts scored a highly acceptable rating.

According to food experts respondents that citrus sinensis (orange peel) coffee is comparable to commercially produced coffee. As verified by Williams (2019), the texture is vital in between consumer acceptance or rejection of food. The texture affects the product's overall acceptability.

Data of the Citrus Sinensis (Orange Peel) Coffee After the Taste Testing of Consumer

Table 4. The Sensory Acceptability of Citrus Sinensis (Orange Peel) Coffee in Terms of Taste

Statement	Rating	Verbal Interpretation
The bittersweet taste of the orange peel coffee is appealing.	3.42	Strongly Agree
The aftertaste of the orange peel coffee is tolerable.	3.39	Strongly Agree
The sweetness of the orange peel coffee is apparent.	3.00	Agree
The commercially produced coffee and orange peel coffee are comparable.	3.36	Strongly Agree

Interpretation: 3.26 – 4.00 – Highly Acceptable; 2.51 - 3.25 – Acceptable; 1.76 - 2.5 – Slightly Acceptable; 1.00 - 1.75 – Not Acceptable

Table 4 shows the results of the respondents' evaluation of the orange peel taste, the majority of the respondents agreed that the bittersweet taste of the orange peel coffee is appealing which equates to a 3.42 mean. The aftertaste of the orange peel coffee is tolerable which gained a mean of 3.39 which equates to a strongly agree rating. The sweetness of the orange peel coffee is apparent which equates to a mean of 3.00 which shows that it has an agreed result. The commercially produced coffee and orange peel coffee are comparable which equates to a mean of 3.36 and it has a description of strongly agree. Lastly, the overall taste of the orange peel coffee is satisfactory gaining a 3.39 mean for the satisfaction. The overall calculated mean of the taste is 3.31. Hence, the orange peel taste is highly acceptable.

The data showed positive outcomes, with a mean score of 3.31, which is rated as highly acceptable. Chu et al. (2019) reported that orange peels had a well-balanced flavor of bitterness, sweetness, and bitter sweetness, which originates from a tropical evergreen plant belonging to the genus Coffee. Making sure the product has a flavor that is well-balanced and can satisfy the customer. Additionally, flavor and taste are vital in food acceptability.

Table 5. The Sensory Acceptability of Citrus Sinensis (Orange Peel) Coffee in Terms of Aroma

Statement	Rating	Verbal Interpretation
The citrus aroma of the coffee is evident.	3.42	Strongly Agree
The smell of coffee and orange is balanced.	3.42	Strongly Agree
The overall smell of the orange peel coffee is acceptable.	3.55	Strongly Agree
Mean	**3.46**	**Highly Acceptable**

Interpretation: 3.26 – 4.00 – Highly Acceptable; 2.51 - 3.25 – Acceptable; 1.76 - 2.50 – Slightly Acceptable; 1.00 - 1.75 – Not Acceptable

Table 5 presents the results of the respondents' rating of the orange peel aroma. The respondents rated the citrus aroma of the coffee as evident with a 3.42 rating which is strongly agree. The smell of coffee and orange is balanced and gained a mean of 3.42 which equates to a descriptive rating strongly agree. Lastly, the overall smell of the orange peel coffee is acceptable and gained a 3.55 mean which translates to strongly agree. The overall calculated mean of the orange peel aroma is 3.46 which shows that it is highly acceptable.

The data above showed positive results, receiving a highly acceptable rating.

Given that the smell of the orange peel blends with other sensory elements in the coffee, it affects how consumers perceive its aroma. Lalou et al. (2015) stated that orange peel coffee has the ability to produce a powerful fruity aroma. Ensuring that the consumer discovers the coffee's orange peel aroma is acceptable. Hence, the aroma is also essential in terms of accepting food and drink.

Table 6. The Sensory Acceptability of Citrus Sinensis (Orange Peel) Coffee in Terms of Texture/Body

Statement	Rating	Verbal Interpretation
The orange peel coffee powdery texture is evident.	3.29	Strongly Agree
The tartness of the orange peel coffee is bearable.	3.52	Strongly Agree
The orange peel coffee adheres to the standard.	3.61	Strongly Agree
The overall texture of the orange peel coffee is acceptable.	3.71	Strongly Agree
Mean	**3.53**	**Highly Acceptable**

Interpretation: 3.26 – 4.00 – Highly Acceptable; 2.51 - 3.25 – Acceptable; 1.76 - 2.50 – Slightly Acceptable; 1.00 - 1.75 – Not Acceptable

Table 6 summarizes the respondents' evaluation of the texture of the orange peel coffee. Garnering a mean of 3.29, the orange peel coffee powdery texture is evident and rated strongly agree based on the gathered data. It is rated as strongly agree which gained 3.52 mean that the tartness of the orange peel coffee is bearable. The orange peel coffee adheres to the standard which equates to 3.61 mean and was rated as strongly agree. Lastly, respondents rated the overall texture of the orange peel coffee as acceptable which resulted in a strongly agree rating and garnered a mean of 3.71. The overall mean of the orange peel coffee is 3.53 which translates to highly acceptable.

As shown above, the citrus sinensis (orange peel) coffee scored a mean of 3.53 in terms of texture which equates to a highly acceptable rating. Along with the aroma and taste, Texture is one important factor in food acceptability because texture plays a significant role in people's liking or dislike of a specific food as stated by Shoup (2019).

Table 7. The Overall Acceptability of Citrus Sinensis (Orange Peel) Coffee According to Food Experts

Description	Mean	Interpretation
Taste	3.25	Acceptable
Aroma	3.24	Acceptable
Texture/Body	3.33	Highly Acceptable
Grand-Mean	**3.27**	**Highly Acceptable**

Interpretation: 3.26 – 4.00 – Highly Acceptable; 2.51 - 3.25 – Acceptable; 1.76 - 2.50 – Slightly Acceptable; 1.00 - 1.75 – Not Acceptable

Table 7 shows that the sensory acceptability of citrus sinensis (orange peel) coffee in terms of taste is acceptable, with a mean score of 3.35 showing that it is acceptable.

Based on the gathered data, the aroma of the orange peel coffee is acceptable, gaining a mean of 3.24 and being rated as acceptable. For the last indicator, the food experts' respondents highly accepted the texture/body of the orange peel coffee, garnering a 3.23 mean, which showed that the citrus sinensis (orange peel) coffee is highly acceptable based on the gathered data from the food experts, gaining a mean of 3.27.

As mentioned above, the overall acceptability of citrus sinensis (orange peel) coffee has a grand mean of 3.27, which indicates that it is generally highly acceptable. Food experts have validated this rating as highly acceptable. This indicates that in terms of taste, aroma, and texture/body, the product is highly acceptable. The product is highly acceptable and meets the food expert's evaluation, as indicated by the mean. According to S.N. Thompson (2009), sensory acceptability is an important factor in food acceptability and intake, including the physical and sensory properties such as taste, aroma, and texture of the food. Additionally, sensory characteristics are considered by food experts in finding and accepting foodstuffs.

Table 8. The Overall Acceptability of Citrus Sinensis (Orange Peel) Coffee According to Consumers

Description	Mean	Interpretation
Taste	3.31	Highly Acceptable
Aroma	3.46	Highly Acceptable
Texture/Body	3.53	Highly Acceptable
Grand-Mean	3.43	Highly Acceptable

Interpretation: 3.26 – 4.00 – Highly Acceptable; 2.51 - 3.25 – Acceptable; 1.76 - 2.50 – Slightly Acceptable; 1.00 - 1.75 – Not Acceptable

Table 8 illustrates the acceptability of citrus sinensis (orange peel) coffee in terms of taste, which is highly acceptable and scored a mean of 3.31. The aroma garnered a mean of 3.46, which translated into a highly acceptable evaluation. The texture and body were rated as highly acceptable and scored a mean of 3.53. With the data presented, the citrus sinensis (orange peel) coffee is highly acceptable in terms of taste, aroma, and texture/body.

As stated above, the overall acceptability of citrus sinensis (orange peel) coffee garnered a mean of 3.43 in consumer evaluation, which translates as highly acceptable. This shows that the product is highly acceptable in terms of taste, aroma, and texture/body and meets the consumer's validation. This shows that citrus sinensis (orange peel) coffee is highly acceptable in terms of taste, aroma, texture, and body. According to Clark (1998), the sensory characteristics of food particularly the taste and aroma have specific effect on consumer food choice. Therefore, sensory characteristics are important in food acceptability.

Table 9. Test Of Difference Between the Ratings of Experts and Consumers of Orange Peel Coffee

Paired Samples T-Test				
Measure 1	Measure 2	t	df	p
Experts	Consumers	-2.150	11	0.055

Note. Student's t-test.

Table 9 presents the test of the difference between the ratings of experts and consumers on the orange peel coffee. If the p-value obtained from the statistical test is below 0.05, it indicates that the null hypothesis posits no substantial distinction in the evaluations provided by the two groups of assessors. The outcome revealed a p-value of 0.055, surpassing the threshold of 0.05. Marginally, there is not enough evidence to support the claim that there is a significant difference between the ratings of the two groups.

Conclusion

The researchers were capable of establishing the subsequent conclusions by analyzing the outcomes and discoveries of this investigation.

1. Food waste is one of the primary factors that needs to be addressed. Orange peel is frequently thrown in the trash after consumption. The researchers studied if the orange peel can be used as an alternative to industry-standard coffee. The findings of this study are citrus sinensis (orange peel) coffee is acceptable by food experts and consumers and it is a unique beverage made by using dried and roasted orange peels as a substitute or complement to coffee beans. To make it, you typically dry the orange peels thoroughly, roast them until they're dark and aromatic, and then grind them into a powder that can be brewed like coffee grounds. However, there is a minimal procedure for creating the orange peel coffee which is sun-drying. The sensory acceptability of orange peel coffee is acceptable based on the respondent's evaluation. This study may be used as a reference for future researchers of the same field and discipline.
2. The citrus sinensis (orange peel) coffee is highly acceptable in sensory acceptability in terms of taste, aroma, and texture/body among food experts. This shows that all the indicators are highly acceptable to the food experts.
3. The acceptability of citrus sinensis (orange peel) coffee in terms of taste, aroma, and texture/body is highly acceptable among consumers. This means that the orange peel coffee is satisfactory and meets the respondent's rating.
4. The study showed that there is no significant difference between food experts and consumers.
5. The orange peel (citrus sinensis) coffee can be used as an alternative to an industry- standard coffee.

Theoretical Implication of the Study

For the research's theoretical implications, this study emphasizes the purpose that sensory evaluation theory in assessing food goods as judged by consumers and food specialists alike. It prefers that the theory must sensor the characteristics of the orange peel as a coffee including the taste, aroma, and texture/body that can greatly impact the development of a product.

Practical Implication of the Study

In relation to practical implications, repurposing orange peels into coffee granules indeed presents practical implications with potential benefits for both waste reduction and industry. By transforming orange peels into a useful product like coffee granules, researchers can address the issue of food waste while also tapping into a new market. This approach not only reduces environmental impact but also offers economic opportunities by utilizing a resource that would otherwise be discarded. Additionally, repurposing orange peels in this way aligns with sustainability goals and promotes innovation in the food industry.

Limitations of the study

It seems like the study on food waste and Orange Peel Coffee has identified some potential limitations. The first limitation pertains to the availability of orange peel due to its seasonality in your area. The second limitation concerns the lack of assessment of the nutritional value of Orange Peel Coffee. Lastly, the lack of tools and equipment of making a coffee. These are important factors to consider for further research and development in the field of food waste management and utilization.

Future Research Direction

This study explores using orange peel coffee as an alternative to regular coffee. It suggests that instead of throwing away orange peels, they could be dried and used to make a tasty and aromatic coffee-like beverage. This idea could benefit both consumers and businesses.

For consumers, orange peel coffee offers a new and potentially healthier option. It could be a great choice for people who want to reduce their caffeine intake or try something different. Plus, using orange peels that would otherwise be wasted helps the environment by reducing food waste.

In the business world, entrepreneurs could seize the opportunity to create new products based on orange peel coffee. They could develop unique blends, market them as sustainable alternatives, and cater to consumers looking for innovative beverages. This could open up new markets and create job opportunities.

This research could inspire future studies and experiments. Researchers might investigate the best ways to process orange peels for coffee, explore different flavor profiles, or study the potential health benefits of this beverage. By building on this foundation, they could contribute to the growing field of alternative and sustainable food products.
Orange peel coffee presents an exciting opportunity for both consumers and entrepreneurs. It offers a delicious alternative to traditional coffee while also encouraging innovation and sustainability in the food industry.

Recommendations

1. To further develop orange peel coffee, using a food dehydrator instead of sun- drying is more convenient and can enhance the product's quality.
2. The researchers suggest conducting more tests in terms of the method used.
3. The use of the roasting method can be considered in the process of preparing the orange peel coffee.
4. For future researchers, creating a product using orange peel can be considered to give more information about the orange peel.
5. This study can be used as an alternative ingredient for industry-standard coffee and modified recipes.

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