African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

MICROBIAL ASSESSMENT OF HERBAL TEA PRODUCTION WITH NATURAL INGREDIENTS

Deha, C. I.[1], Fraikue, F. B.[2], Twum, N.[3] and Abanga, G.[3]
[1,2,3&4]Department of Hospitality Management, Takoradi Technical University, Ghana.
[2]frances.fraikue@ttu.edu.gh

ABSTRACT

Purpose: The study aimed to assess the microbial safety and quality of herbal tea production using natural ingredients. The objectives of the research were to: determine the sensory characteristics of herbal tea produced using lemongrass, cloves, "precise", and negro pepper. To evaluate critical control points for microbial contamination.

Design/Methodology/Approach: The study employed an experimental research design with staff from the Western Regional House of Chiefs as the population. A sample size of one hundred (100) respondents was selected for the study using purposive and convenience sampling methods. The sensory evaluation utilised a 7-point hedonic scale whilst mineral content and proximate analysis were conducted. Analysis of Variance (ANOVA) was employed to evaluate differences among the various tea samples.

Findings: Participants showed a strong preference for Lemongrass (201) and Basic tea (204) due to their delightful taste experience, which encompassed appealing attributes such as colour, aroma, texture, and aftertaste. The investigation revealed notable differences in the nutrient composition of the herbal tea samples. Cloves (202) stood out for its higher protein and fat contents, with the highest counts of both aerobic microorganisms and yeast and molds, while Lemongrass was found to have more fibre and carbohydrates.

Research Limitation: This research focused on the production of herbal tea using negro, pepper, "prekese", cloves and lemongrass.

Practical Implication: Healthcare systems benefit from validated safety standards for herbal products, reducing the burden of foodborne illnesses and contamination-related health issues.

Social Implication: The research contributes to food security by ensuring the safety and reliability of traditional herbal beverages while maintaining their cultural significance.

Originality/Value: This research contributes to food safety science by bridging traditional herbal knowledge with modern microbiological assessment methods, potentially influencing industry standards and regulatory frameworks.

Keywords: *Beverages. cloves. herbal tea. lemongrass. sensory*

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

INTRODUCTION

Tea is currently the most widely consumed beverage in the world (Jianming, 2016) due to its attractive aroma and taste and its unique place in many societies' cultures. There is renewed interest in tea because of growing consumer awareness of the health benefits derived from tea consumption (Czarniecka-Skubina et al., 2022). A new trend is that tea is gaining popularity among consumers, as it is prepared from plants other than Camellia (Ruchika, 2022). For instance, green tea consumption in female rats has been shown to have an anti-obesity effect and lower cholesterol levels, triglycerides, and leptin (Boccellino & D'Angelo, 2020). According to Ravikumar (2014), unlike most other forms of tea, 'teas do not contain caffeine, they taste great and are easy to drink'. Most teas may consist of one main herbal ingredient or a blend of herbal ingredients intended to bring about a specific purpose, such as relaxation, rejuvenation, or relief from a specific condition, amongst other things (Anwar et al., 2023).

Indigenous herbs are generally heavily under-exploited despite their huge dietary potential (Ruchika, 2022). Some fruits and vegetables are also used as spices and herbs combined for tea by homemakers. The lemongrass plant has leaves and oil used to make medicine (Toungos, 2019). It is also commonly used as a lemon flavour in teas (Kanatt, 2016). Ginger is also known to possess anti-inflammatory, antinausea, anticarcinogenic, and antioxidant effects (Shahrajabian et al., 2019). The combination of tea and ginger has also been reported to possess a synergistic antioxidant effect (Makanjuola et al., 2015). Clove is one of the Orient's most ancient and valuable spices (Arimalala et al., 2019), whilst Prekese is described as an exotic African food or spice (Adesina et al., 2016). Negro pepper is an African spice and flavour used for food and medicine (Bekoe et al., 2018).

Indigenous herbs are generally heavily under-exploited despite their huge dietary potential (Ruchika, 2022). There is limited information on the use of lemongrass, "prekese", cloves, and negro pepper in tea preparation. Although lemongrass relieves people from stomach disorders, insomnia, respiratory disorders, fever, aches, infections, rheumatism, and edema, consumers are generally unwilling to buy food which contains lemongrass due to the poor sensory appeal (Neequaye et al., 2017; Czarniecka-Skubina *et al.*, 2022). Likewise, the appealing appearance of food is more important to most consumers as they consider that, irrespective of the health or nutritional benefits of food. Lots of work has been done on other herbs in the preparation of tea, but there is limited information on the use of a four-in-one product made from lemongrass, "prekese", cloves, and negro pepper in tea preparation. Similarly, combining these four to unveil their potential nutritional advantage is needful.

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

Hence the study sought to explore the use of lemongrass, "prekese", cloves and negro pepper in the preparation of tea.

The objectives of the study were to determine the formulation ratio of lemon grass, cloves, "prekese", and negro pepper in the production of herbal tea. It was also to assess the sensory characteristics of herbal tea produced using lemongrass, cloves, "prekese", and negro pepper. The study further performed a consumer preference test for the developed product. Finally, it analysed the physicochemical and safety parameters of the herbal tea made from lemongrass, cloves, ''prekese'' and negro pepper.

LITERATURE REVIEW

Description of Lemongrass, "Prekese'', Cloves and Negro Pepper

Lemongrass is well known and utilised for its distinct lemon flavour and citrusy aroma. Lemongrass is widely used in herbal teas and other non-alcoholic beverages in baked food and confectionaries (Kanatt, 2016; Toungos, 2019). Again, it is commonly taken orally, applied directly to the skin, or inhaled as aromatherapy for many different conditions (Toungos, 2019). Ruchika (2022) affirmed that tea made solely from lemongrass has poor sensory appeal. The health benefits of lemongrass include relief from stomach disorders, insomnia, respiratory disorders, fever, aches, infections, rheumatism, and edema (Begum, 2022).

The defensive antioxidant activity of the lemongrass herb protects against antibiotic-resistant Staphylococcus aureus and helps in maintaining optimum cholesterol levels, cellular health, nervous system, healthy skin, and immune system (Begum, 2022; Ebuete et al., 2022). It is also effective in treating type 2 diabetes, cancer, and obesity while aiding in detoxification (Rani et al., 2016). Some types of lemongrass include Cymbopogon Flexuosus (East Indian), flexuosus var. flexuosus(red grass), flexuosus var. Flexuosus (white grass), Cymbopogon citratus (DC) (West Indias) and Cymbopogon pendulus (Jammu lemongrass).

"Prekese", scientifically known as Tetrapleural tetraptera, is a deciduous plant that thrives in the outer regions of the rainforests in West and Central Africa. It can be found across various countries from Uganda to Nigeria, including Mali, Burkina Faso, Mauritania, and those within the Gambia-Nigeria range (Akintola et al., 2015). The optimal growth of "precise" occurs in the lush rainforest environment, where it can reach heights of 20 to 25 metres and possess a circumference of approximately 1.2 to 3 metres. It is also present in the southern savannah woodland, riverine forests, and the forest outliers on the African plains.

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

Herb sellers and food vendors in West Africa and some parts of Europe have displayed this fruit for sale as an item for culinary use and a recuperative tonic and have advertised products made from leaves and fruits (Adesina et al., 2016). In all the regions where it grows, the sweet smell or fragrance of the fruit is highly valued. It is used to spice dishes, and its fruit and stem bark are used for medicinal purposes. The products control cholesterol levels, promote breast milk production, enhance the healing of reproductive wounds, control hypertension, and are used as scents in perfumery industries (Ganapi Ghana Ltd, Kumasi, Ghana).

A deficiency of essential amino acids usually leads to a slow down and development of growth in children, allowing diseases and causing the destruction of cells in adults. Aspartic acid, measured as aspartate + asparagine, occurred in the fruit at 14.47±0.04 (Makanjuola *et al.,* 2015). It was reported that the fruit contained crude protein (7.44%-17.5%), crude lipid (4.98%-20.36%), crude fibre (17%-20.24%), carbohydrate (43.18%-49.06%) and food energy (234.42-379.48 g/cal.). Calcium, phosphorus, potassium, zinc, and iron are also major minerals in fruit. The chemical composition of the fruit was evaluated by Abdou et al. (2016) and Udourioh and Etokudoh (2014).

Cloves are derived from the French word ‘Clou’ and the English word ‘Clout’, meaning ‘nail’- from the likeliness of the flower bud of the Clove tree to a broad-headed nail (Arimalala et al., 2019). The use of clove as a spice reached Europe around the 4th century A.D. when commercial trading started with the Arabs, who acquired these dried and fragrant buds from the cultures to the East in Asia (Dey & Mukherjee, 2021). Its source and place of origin were shrouded in mystery until the Portuguese discovered Moluccas Island or Indonesia in the 16th century. The Clove tree is an evergreen tree that grows to a height ranging from 8-12 m, with large square leaves and sanguine flowers in numerous groups of terminal clusters. Cloves are the aromatic dried buds of a tree (Eugenia caryophyllata also sometimes Syzgium aromaticum) used as a spice in virtually all the world’s cuisine (Denker, 2015; Wellfelt, & Djonler, 2019). The dried clove bud contains carbohydrates, fixed oil, steam-volatile oil, resins, tannins, proteins, cellulose, pentosans, and mineral elements. Almost half the world's commercial supply of cloves is consumed by Indonesians (Denker, 2015; Wellfelt, & Djonler, 2019). Good-quality clove buds contain 15–20% essential oils, The oil is dominated by Eugenol (70–85%), eugenyl acetate (15%) and β-caryophyllene (5–12%), which together make up 99% of the oil. The constituents of the oil also include methylamylketone, methyl salicylate, αand β-humulene, benzaldehyde, β-ylangene and chavicol (Dey & Mukherjee, 2021; Zachariah & Leela, 2018).

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

Negro Pepper (Xylopia aethiopica) is in the family Annonaceae. It is a tree found in most of Africa's wet tropical forests to the savannah vegetation zone (Czarniecka-Skubina *et al.*, 2022). The tree can reach a height of 30 metres or more, and it is characterised by lanceolate leaves glossy at the upper surfaces and dull-greyish at the lower surfaces, which are arranged alternately on the secondary branches. It treats many diseases, including cough, malaria, constipation, uterine fibroid and amenorrhea (Begum, 2022).

Negro pepper is sometimes put into jars of water for purification purposes (Bekoe et al., 2018). It can be added whole or crushed to prepare assorted food dishes such as soups, yam porridge, pepper soup, stews, sauce, meat and fish (Qasem, 2015). The fruit is also used to season the patient's food.

The fruits are often incorporated in preparations for enemas and for external uses where their revulsive properties can be put to good use for treating any painful area (Rahman & Debnath, 2015). They are also used in the treatment of boils and skin eruptions. The fruit contains a volatile aromatic oil, a fixed oil and rutin. It can be taken as a decoction, concoction or even chewed and swallowed to manage various aches and pains (Khan, Talucder, Das, Noreen, & Pane, 2021). In order to prevent blood clots from forming in the womb after delivery and to treat respiratory discomforts, including pneumonia, bronchitis, and asthma, new moms must consume negro pepper (Ebuete *et al.*, 2022). Negro pepper's antioxidant qualities fight syphilis-causing bacteria and germs as well as cancerous cell growth (Khan *et al.*, 2021). Furthermore, it contains copper, zinc, protein, camphene, manganese, alkaloids, Diter penic, Limonene, Folic acid, Flavanoid, and Vitamins A, B1, B2, C and E.

Health Benefits of Herbal Tea

According to Kodagoda and Wickramasinghe (2017), a cross-sectional study of 1,276 older women 65 to 76 years in the U.K. found that tea drinkers had significantly higher bone mineral density BMD at the lumbar spine and hip than non-drinkers. The mechanisms for the beneficial effect of tea consumption on bone mineral density were not precise. Although tea is a relatively good source of fluoride, an element known to increase bone density in pharmacologic doses, there is little evidence that the amount of fluoride supplied by tea would significantly affect BMD (Waugh et al., 2017). The oxidative stress-responsive transcription factor, NF- has been found recently to play a role in bone resorption, and increased levels of urinary 8-iso-PGF2α, a biomarker for oxidative stress, were significantly associated. However, tea consumption has been found to increase urinary oxalate levels in

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

healthy individuals, and some experts continue to advise those prone to calcium oxalate stone formation to limit tea consumption (Anwar *et al.,* 2023; Ferraro et al., 2020).

Sensory Evaluation

Sensory evaluation is a scientific approach for evoking, weighing, evaluating, and describing responses to products as experienced through the senses of sight, hearing, touch, smell and taste (Howes, 2015). The primary role of sensory analysis is to include product information, ingredients or other similar information linked with consumer liking and the quality features perceived by the consumer (Mihafu et al., 2020). Martinsdoitir (2021) added that sensory evaluation or analysis has been referred to as a field of research used to induce, evaluate, analyse and describe product reactions as conducted by sensory factors such as visual image (sight), smell, sensation of touch, sensation of taste and sensation of hearing. Sensory evaluation plays a vital role in quality assurance and product marketing. This is mainly used in food industries to produce new products and product modification for recipes (Calanche et al., 2020).

Description of Taste, Appearance, Texture and Aroma

Taste is a sensory experience representing taste, aroma, and mouthfeel (Aeran, Seth, Saxena & Sharma, 2015). Flavouring substances are aromatic compounds created by mixing taste and odour and experienced through the mouth and nose. Good taste helps to identify, recognise, and enjoy foods (Howes, 2015). The taste buds possess four experiences: sweet, salty, sour, and bitter (Mihahu et al., 2020).

Appearance is the first feature perceived by human senses and plays an essential role in identifying and finalising food selection (Anwar, 2023), the visual food experience. The appearance of a meal affects the stimulation of appetite or depression, leading to satisfaction or complete depression (Owusu & Vieira, 2022). The presence of a food or drink affects cravings and approval before the product reaches the lips. That is because we generally view a product before tasting it. Food appearance covers its size, shape, colour, structure, transparency or turbidity, dullness or gloss, and degree of wholesomeness or damage (Mihafu, *et al.,* 2020; Sharif et al., 2017).

Texture is perceived through a combination of senses such as touch, mouth sensation, sight and hearing (Anwar, 2023) and is one of the food's most imperative traits (Mihafu, *et al.,* 2020). If a customer bites a soggy biscuit or eats sandy textured ice cream, the person is unlikely to revisit or recommend it. The texture is a prerequisite for accepting numerous

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

examples of foodstuffs (Baumgarthuber, 2021). It also covers consistency, thickness, fragility, chewiness, particle size and shape in food.

Aroma/flavour is another vital factor next to taste, appearance and texture. They are volatile compounds detected by the scent receptors of nasal cavity tissues (Calanche *et al.*, 2020). During the mastication cycle, the aromatic compounds are released, whilst smell appreciates the fragrance of food, which is essential to flavour gratitude. Howes (2015) hinted that the pleasant smell of food makes it delicious as the stuff must be in a gassy state to provoke a smelling sensation (Mihafu *et al.*, 2020). As scent is described as necessary for the understanding of fresh, rancid or intermittently poisonous foods, the nose also detects the aromas released from food when it is green, cheesy, nutty, spicy, and rancid (Howes, 2015; Anwar, 2023).

MATERIALS AND METHODS

Redman-MacLaren and Mills (2015) state that the research design is a plan or blueprint that outlines how data related to a specific problem should be collected and processed. The experimental approach was used since it aimed to provide a variety of outcomes that may or may not be predicted. The target group were staff from the Western Regional House of Chiefs. A sample size of one hundred (100) respondents was selected for the study using purposive and convenience sampling methods. The product was developed in the small-scale kitchen of the Department of Hospitality Management at Takoradi Technical University. On that same day, the beverages were packaged and sent to the Research Laboratory of the Department of Laboratory Technology, College of Agriculture and Natural Sciences, University of Cape Coast, for microbiological and physicochemical examination.

The questionnaire was administered sensorily using a 7-point hedonic scale, after which the respondents were given ample time to taste the samples prepared and complete the questionnaire. These were collected from the respondents when they had completed, and it was subjected to further analysis. The mineral content and proximate analysis were conducted following the methodologies outlined by the Association of Official Analytical Chemists (AOAC) 2020. Analysis of Variance (ANOVA) was employed to evaluate differences among the various tea samples. Data processing, statistical analysis, and generation of visual representations was facilitated using SPSS software.

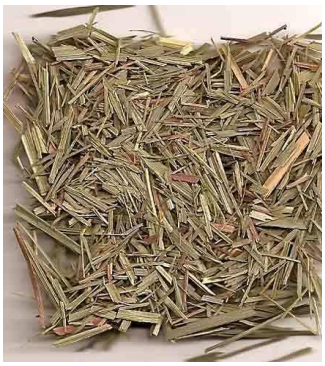
Procedures for Herbal Tea Preparation

The production of herbal tea began with washing each ingredient separately to ensure cleanliness. After washing, the ingredients were dried under sunlight to remove any moisture.

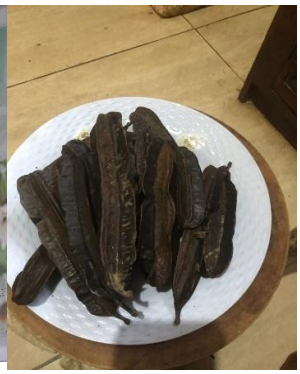
ISSN: 2408-7920

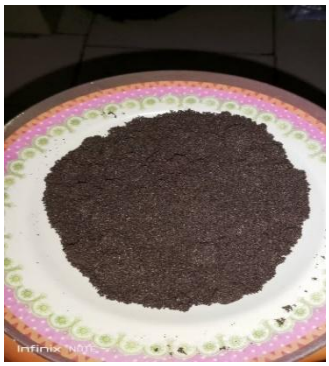
African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

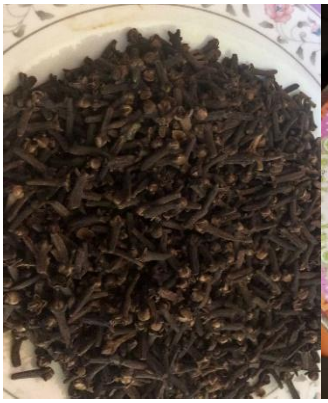
Next, the lemongrass and "prekese" were carefully cut into smaller sizes for easy handling. These cut pieces were then individually blended into a powdered form using a blender or grinding equipment. To ensure measurement accuracy, each powdered ingredient was measured separately with the help of a measuring scale. Once measured, all the powdered ingredients were combined in a bowl and thoroughly mixed to ensure a uniform mixture. The resulting mixture was then portioned into tea bags and sealed to preserve freshness. Finally, the tea bags were neatly arranged in a box for storage and repeated for each sample (Researchers Recipe, 2023).

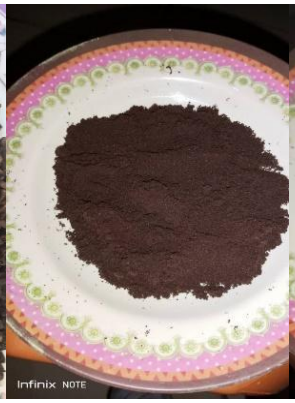

Fresh Lemongrass

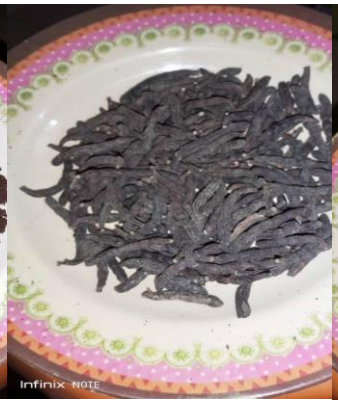

Milled Lemongrass


Fresh 'Prekese'


Milled 'Prekese'


Fresh Cloves


Milled Cloves

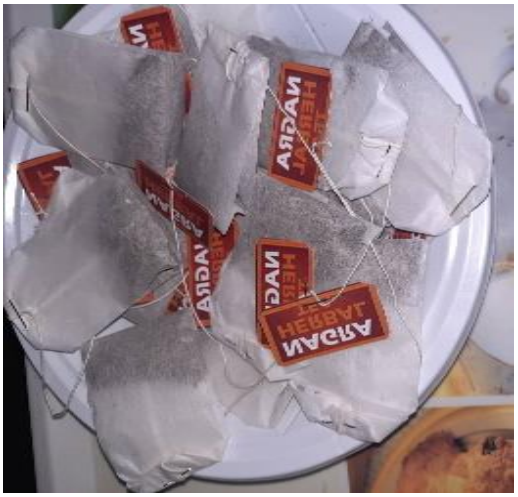

Fresh Negro Pepper


Milled Negro Pepper

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

Combined products for Herbal Tea



Packaged Herbal Tea

Plate 1: Whole and Milled Products used for Herbal Tea Production
Source: Researchers Recipe, 2013

Plate 1 depicted the images of lemongrass, "prekese", cloves and negro pepper. Each product was milled separately before being combined and packaged using three different formulation ratios. These varying combinations were also depicted in Table 1 for easy assessment. Lemongrass remained constant throughout the samples because it was a flavouring agent in herbal tea production.

Table 1. Formulation Ratios for the Herbal Tea Production

INGREDIENTS	SAMPLE/QUANTITY							
	A 201		B 202		C 203		D 204	
	tsp	g	tsp	g	tsp	g	tsp	g
Powdered lemongrass	½	2.8	½	2.8	½	2.8	Constant was	
Powdered "Prekese"	¼	1.4	⅛	0.7	⅛	0.7	1tsp (5.6g) of basic tea	
Powdered Cloves	⅛	0.7	¼	1.4	⅛	0.7		
Powdered Negro Pepper	⅛	0.7	⅛	0.7	¼	1.4		

Source: Researchers Recipe, 2023

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

RESULTS AND DISCUSSION

Sensory Assessment of Herbal Tea

The findings evaluated sensory characteristics of herbal tea using a different combination of lemongrass, "prekese", cloves and Negro pepper. The formulation in Table 1 provided three samples labelled A:201, B:202, and C:203. Here, the fourth sample that served as the constant D:204 was the basic tea, which was many drinks. Tables 2, 3, 4, 5 and 6, representing taste, appearance, texture, aroma/flavour and aftertaste, postulated the sensory assessment of respondents using the 7-point hedonic scale to describe the result.

Table 2: Taste

Sample	**Mean**
Lemongrass **(201)**	5.47
Basic Tea **(204)**	5.06
Cloves **(202**)	4.86
Negro pepper (**203)**	4.62

Note: A mean of 0.1-1.0 indicates dislike very much, 1.1-2.0 indicates dislike moderately, 2.1-3.0 indicates dislike slightly, 3.1 -4.0 indicates neutral, 4.1-5.0 indicates like slightly, 5.1-6.0 indicates moderately and 6.1-7.0 indicates like very much.

Source: Field Work, 2023

Table 3: Appearance

Sample	**Mean**
Lemongrass **(201)**	5.03
Basic Tea **(204)**	4.78
Negro pepper (**203)**	4.73
Cloves **(202**)	4.42

Source: Field Work, 2023

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

Table 4: Texture

Sample	**Mean**
Lemongrass **(201)**	5.33
Basic Tea **(204)**	4.91
Negro pepper (**203)**	4.79
Cloves **(202**)	4.59

Source: Field Work, 2023

Table 5: Aroma/Flavour

Sample	**Mean**
Negro pepper (**203)**	5.11
Lemongrass **(201)**	4.86
Basic Tea **(204)**	4.73
Cloves **(202**)	4.58

Source: Field Work, 2023

Table 6: After Taste

Sample	**Mean**
Basic Tea **(204)**	5.06
Lemongrass **(201)**	4.79
Cloves **(202**)	4.60

Source: Field Work, 2023

Taste: Sample Lemongrass (201) received the highest mean score of 5.47, attributed to the presence of natural pigments and bioactive compounds in the ingredients used. Appearance: Sample Negro pepper (203) received the highest mean score of 4.73, indicating a relatively high level of consumer acceptance for its aroma. Texture: Sample Lemongrass (201)

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

received the highest mean score of 5.33, implying the most favourable evaluation of its texture. Aroma/Flavour: The majority (36%) liked the flavour of sample Cloves (202). The mean score of 4.86 indicates a generally positive reception, albeit slightly lower than sample Negro pepper (203). After Taste: Samples Negro pepper (203) and Cloves (202) received similar mean scores of 4.63 and 4.60, respectively, with no extreme dislikes or likes. This indicates a moderate level of acceptance of the aftertaste among consumers.

Consumer Acceptance Level / Overall Acceptance

Sample Lemongrass (201) received the highest mean scores across all categories, demonstrating the participants' strong preference for its taste, appearance, and texture. It stood out as the most favoured sample, with an overall mean score of 5.10. Sample Lemongrass (201) was the ultimate, followed closely by Sample Basic Tea (204).

Table 7: Overall Likeness

Sample Code	**Taste**	**Appearance**	**Texture**	**Flavour**	**After Taste**	**Overall Mean**
Lemongrass **(201)**	5.47	5.03	5.33	4.86	4.79	5.10
Basic Tea **(204)**	5.06	4.78	4.91	4.73	5.06	4.91
Negro pepper (**203)**	4.62	4.73	4.79	5.11	4.63	4.78
Cloves **(202**)	4.86	4.42	4.59	4.58	4.6	4.61

Source: Field Work, 2023

Physicochemical Analysis - Proximate

The nutritional components present in the herbal tea were made up of six proximate compositions. Sample Negro pepper (203) recorded the lowest mean moisture content of 12.44±0.12. Ash content, which indicated the lowest in sample Lemongrass (201) (5.53±0.07), also had a high ash content observed in sample 203 (6.16±0.04). Tea was considered to be a rich source of nutrients that influenced the activity of human health in diverse ways. All three samples recorded mean protein content ranging from 7.80±0.14 % to 10.63±0.24 %, higher than protein content between 2.09 to 18.72mg/100g. Craig, Brothers and Mangels (2022) also reported that protein and fibre content should be between 12.50% and 27.5%, respectively. Meanwhile, content obtained from this study ranged between 12.62±0.09% to 13.26±0.19 %, which is less than the earlier study conducted by Craig et al.

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

(2022). Fibre content (15.09-25.26g/100g), which is marginally lower than the results obtained from this study, also admonished that fibre has the property of lowering cholesterol levels in the consumer's body. Low cholesterol leads to the prevention of cardiovascular diseases and some types of cancer, such as breast and colon cancers.

Table 8: Mean±SD of the Various Proximate Analysis of Various Herbal Tea

Proximate (%)	Lemongrass (201)	Cloves (202)	Negro pepper (203)
Moisture	13.26±0.15	13.80±0.03	12.44±0.12
Ash	5.53±0.07	6.07±0.05	6.16±0.04
Protein	8.48±0.33	10.63±0.24	7.80±0.14
Fat	4.28±0.05	7.01±0.03	4.92±0.02
Fibre	13.26±0.19	12.62±0.09	13.15±0.06
Carbohydrates	68.45±0.50	63.67±0.19	67.97±0.22

Source: Lab Results 2023

Physicochemical Analysis - Mineral/Elemental

The results revealed that there were seven mineral components present in the herbal tea assessed. Potassium was observed to be in (7749.72±62.31-8266.85±177.29) ug/g among the three tea samples compared to Iron (81.21±0.52-254.11±3.56) ug/g and Zinc (87.86±1.23-121.67±1.53) ug/g. The potassium concentration recorded in the study was observed to be higher than the daily requirement of 4500 mg-5000 mg. Sodium levels in the study ranged from 1015.34±14.24 ug/g to 2224.92±25.70 ug/g with sample B recording the highest sodium concentration. Calcium and Magnesium levels were recorded from (1.58±0.02 to 1.81±0.03) % and (0.13±0.00 to 0.15±0.00) % respectively. Phosphorus content (table 2) was observed to be higher than the required daily dose of 1250 mg as reported by (Schwalfenberg et al., 2013). These elevated levels of potassium and phosphorus recorded in the herbal tea samples could be influenced by the origin of the herbal tea, the optimal concentration of these elements in the soil, rain, and other possible factors. Consumption of high levels of potassium leads to hypokalaemic conditions such as induced hepatitis and induced kidney failure (Viera & Wouk, 2015).

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

Calcium and Magnesium levels were recorded from (1.58±0.02 to 1.81±0.03) % and (0.13±0.00 to 0.15±0.00) %, respectively. These levels were less than the concentration in similar studies (Długaszek & Kaszczuk, 2020), which recorded elevated calcium (%) concentrations in herbal tea infusion. Calcium has been reported to play a significant role in the rhythmic function of the heart. Moreover, the low levels recorded could be due to inefficient extraction of Calcium and Magnesium in the solution. Długaszek and Kaszczuk (2020) reported that lower concentration could be due to the degree of maturity of the herbal plant (leaves). This implies that a consumer may have to increase the volume of tea per serving to meet the required dietary intake of Calcium and Magnesium.

Table 9: Mean±SD of the Various Mineral/Elemental Analysis of Various Herbal Tea

Mineral (ug/g)	Lemongrass (201)	Cloves (202)	Negro pepper (203)
Phosphorus	2293.27±28.11	2775.35±49.10	2145.73±37.82
Potassium	8266.85±177.29	8169.54±186.00	7749.72±62.31
Sodium	1063.33±12.54	2224.92±25.70	1015.34±14,24
Iron	81.21±0.52	110.80±8.24	254.11±3.56
Zinc	121.67±1.53	97.18±2.81	87.86±1.23
Calcium (%)	1.70±0.05	1.81±0.03	1.58±0.02
Magnesium (%)	0.14±0.00	0.15±0.00	0.13±0.00

Source: Lab results 2023

Microbiological Analysis

From this study, sample tea bags 202 and 203 recorded mean counts of 59.33±1.53x1^{2} and 50.67±2.08 x10^{2} CFU/ml for Aerobic Plate Count, respectively. Sample 201 recorded the least aerobic plate count of 39.67±0.58 x10^{2} CFU/ml. The aerobic plate count recorded from this study was less than the acceptable limit of 108 CFU/g as reported by the THIE's s Recommended Microbiological Specification (THIE, 2018). This suggested that the total aerobic microbial count for the three samples was within acceptable limits. Total coliform bacteria were isolated in samples Lemongrass (201) and Negro pepper (203). These bacteria

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

could be attributed to environmental contamination, improper handling, and poor manufacturing practices (Akanele et al., 2016). Salmonella sp, which is considered as an indicator organism for coliform testing, was not detected during the study. The absence of Salmonella sp in the products under study does not conclude that the herbal tea sample is free from hygiene indicator organisms. Other groups of indicator microorganisms, such as Enterobacteriaceae could be present (Akanele, *et al.*, 2016; Centre for Food Safety, 2014). Yeast and Mould counts were recorded in samples 201 and 203. Most of the yeast counts were within acceptable limits.

Table 10: Mean±SD (cfu/ml) x10^2 of the Various Microbiological Analyses of Various Herbal Tea

Microbial Components	**Lemongrass (201)**	**Cloves (202)**	**Negro pepper (203)**
Aerobic Plate Count	39.67±0.58	59.33±1.53	50.67±2,08
Total Coliform Count	3.33±5.77	ND	69.33±1.53
Salmonella sp.	ND	ND	ND
Yeast & Moulds Count	ND	53.33±2.89	17.67±2.08

ND=Not detected

Source: Lab results 2023

CONCLUSION

The study concluded that participants strongly preferred Sample Lemongrass (201) and Sample Basic Tea (204) due to their delightful taste experience, which encompassed the other appealing attributes. The investigation revealed notable differences in the nutrient composition of the herbal tea samples. Sample Cloves (202) stood out for its higher protein and fat content, while Sample Lemongrass (201) was found to have more fibre and carbohydrates. These variations in nutrient contents had implications for each tea's taste, texture, and potential health benefits. Additionally, it became evident that herbal Tea sample Cloves (202) had the highest counts of both aerobic microorganisms and yeast and moulds. Conversely, sample Negro pepper **(**203) showed a high Total Coliform Count, indicating the possibility of contamination during production or storage. The microbiological quality and safety of all tea manufacturers should greatly concern producers. Herbal tea sample Cloves (202) stood out due to its higher phosphorus, potassium, iron, calcium, and magnesium levels than the other teas. On the other hand, herbal tea sample Lemongrass (201) appeared to have a higher zinc content. These

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

mineral and elemental composition variations significantly influenced herbal teas' potential health benefits and flavours, providing consumers with diverse options based on their nutritional preferences and tastes. The study found a significant demand for herbal tea infused with lemongrass, "prekese", cloves, and Negro pepper. The combination of these ingredients offered unique flavours and potential health benefits, making it an attractive option for consumers seeking both variety and natural remedies to support the well-being of mankind.

REFERENCES

Abdou Bouba, A., Ponka, R., Augustin, G., Njintang Yanou, N., Abul-Hamd El-Sayed, M., Montet, D., & Mbofung, C. M. (2016). Amino acid and fatty acid profile of twenty wild plants used as spices in Cameroon.

Adesina, S. K., Iwalewa, E. O., & Johnny, I. I. (2016). Tetrapleura tetraptera Taub-ethnopharmacology, chemistry, medicinal and nutritional values-a review. *British Journal of Pharmaceutical Research*, 12(3), 1-22.

Aeran, H., Seth, J., Saxena, S., Sharma, G., & Principal, D. (2015). Taste perception–a matter of sensation. *International Journal of Oral Health Dentistry*, *1*(2), 88-93.

Akanele, A. E., Chukwu, S & Ahudie, C (2016) Microbiological Contamination of Food: The Mechanisms, Impacts and Prevention. *Int J Sci Technol Res*; 5(3):65-78

Akintola, O. O., Bodede, A. I., & Ogunbanjo, O. R. (2015). Nutritional and medicinal importance of Tetrapleura tetraptera fruits (Aridan). *African Journal of Science and Research*, 6(4), 33-38. Journal of Agriculture and Food Sciences

Anwar, S., Syed, Q. A., Asmat, U., Arshad, M., Rehman, M. A., Ahmad, W., & Muzammil, H. S. (2023). Antioxidants quantification, minerals profile, colour properties and sensorial quality of Laurus nobilis composite tea infused with ginger and stevia. *Journal of Food Measurement and Characterization*, *17*(5), 5144-5153.

AOAC (2020) Official Methods of Analysis of the Association of Official Analytical Chemists. 18th Ed. Washington D.C.

Arimalala, N., Penot, E., Michels, T., Rakotoarimanana, V., Michel, I., Ravaomanalina, H., & Danthu, P. (2019). Clove based cropping systems on the east coast of Madagascar: how history leaves its mark on the landscape. *Agroforestry Systems,* 93(4), 1577-1592.

Baumgarthuber, C. (2021). *Fermented foods: the history and science of a microbiological wonder*. Reaktion Books.

Bekoe, E. O., Kitcher, C., Gyima, N. A. M., Schwinger, G., & Frempong, M. (2018). Medicinal plants used as galactagogues. Pharmacognosy-Medicinal Plants.

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

Begum, J (2022) Lemongrass: Are there health benefits? Retrieved from https://www.webmd.com/diet/lemongrass-health-benefits on 3rd July, 2023.

Boccellino, M., & D'Angelo, S. (2020). Anti-obesity effects of polyphenol intake: Current status and future possibilities. *International Journal of Molecular Sciences*, 21(16), 5642.

Calanche, J. B., Beltran, J. A., & Hernandez Arias, A. J. (2020). Aquaculture and sensometrics: The need to evaluate sensory attributes and the consumers' preferences. *Reviews in Aquaculture*, 12(2), 805-821.

Craig, W. J., Brothers, C. J & Mangels, R. (2022) Nutritional Content and Health Profile of Single-Serve Non-Dairy Plant-Based Beverages. *Nutrients*, 14(1):162-170.

Czarniecka-Skubina E, Korzeniowska-Ginter R, Pielak M, Sałek P, Owczarek T, Kozak A. (2022) Consumer Choices and Habits Related to Tea Consumption by Poles. *Foods*, 11(18), 2873-2881. doi: 10.3390/foods11182873.

Denker, J. S. (2015). The Carrot Purple and Other Curious Stories of the Food We Eat. Rowman & Littlefield.

Dey, B. K., & Mukherjee, S. S. (2021). Potential of Clove and its Nutritional Benefits in Physiological Perspective: A Review. *Int. J. Physi. Nutr. Phys. Educ*, 6(1), 103-106.

Długaszek, M., & Kaszczuk, M. (2020). Assessment of the nutritional value of various teas infusions in terms of the macro-and trace elements content. *Journal of Trace Elements in Medicine and Biology*, *59*, 126428.

Ebuete, A. W., Ebuete, E., & Berezi, O. K. (2022). Eco-Conservation of Important African Herbs Tree for Culinary and Medicinal Purpose. *African Journal of Agricultural Science and Food Research*, 4(1), 45-65.

Ferraro, P. M., Bargagli, M., Trinchieri, A., & Gambaro, G. (2020). Risk of kidney stones: influence of dietary factors, dietary patterns, and vegetarian–vegan diets. *Nutrients*, 12(3), 779-793.

Howes, D (2015) The science of sensory evaluation: An ethnographic critique (1st Edition) United Kingdom, Routledge

Jianming, Z. A (2016). The determination of flavonoid contents in mulberry and their scavenging effects on superoxide radicals. *Food Chemistr*y, 2(1), 555-559.

Kanatt, C. A (2016). Antioxidant and radio-protective activities of lemongrass and star anise extracts. *Food Bioscience*, 2(2),24-30.

Khan, A. U., Talucder, M. S. A., Das, M., Noreen, S., & Pane, Y. S. (2021). Prospect of The Black Pepper (Piper nigrum L.) as Natural Product Used to an Herbal

Kodagoda, K.H.G.K & Wickramasinghe, I (2017), Health benefits of green and black tea: A Review, *International Journal of Advanced Engineering Research and Science (IJAERS)* 9 (6), 563-573.

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

Makanjuola, S. A., Enujiugha, V. N., Omoba, O. S., Sanni, D. M (2015), Combination of Antioxidants from Different Sources Could Offer Synergistic Benefits: A Case Study of Tea and Ginger Blend. *Nat Prod Commun*. 10(11):1829-32.

Mihafu F. D, Issa J. Y, Kamiyango M. W. (2020) Implication of Sensory Evaluation and Quality Assessment in Food Product Development: A Review. *Current Res Nutr Food Sci*; 8(3) 75-83.

Neequaye, K., Adonu, R., & Mensah, D. O. (2017). Production of Cake Using Lemongrass as Flavouring Agent. *American Based Research Journal*, 6(11), 48-60

Nwoba, E. G. (2015). Proximate and phytochemical composition of the pulp of Tetrapleura tetraptera fruits consumed in Abakaliki, Nigeria. *International Journal of Engineering Research & Technology (IJERT)*, 4(6), 1286-1294.

Owusu, A, R., & Vieira, E. (2022). Consumer Food Literacy. In *Elementary Food Science* (pp. 127-146). Cham: Springer International Publishing.

Qasem, J. R. (2015). Prospects of wild medicinal and industrial plants of saline habitats in the Jordan valley. *Pakistan Journal of Botany*, 47(2), 551-570.

Rahman, A. H. M. M., & Debnath, A. (2015). Ethno-botanical Study at the Village Pondit Para under Palash Upazila of Narsingdi District, Bangladesh. I*nternational Journal of Advanced Research*, 3(5), 1037-1052.

Rani, V., Deep, G., Singh, R. K., Palle, K., & Yadav, U. C. (2016). Oxidative stress and metabolic disorders: Pathogenesis and therapeutic strategies. *Life Sciences*, 14(3), 183-193.

Ravikumar, C (2014) Review on herbal teas. *Journal Pharm. Sci. & Res*. 6(5), 236-238

South African Journal of Botany, A, S (2022) An update on disease preventing potential of green tea in comparison with some tisanes. *South African Journal of Botany*, 144(2), 92-96.

Shahrajabian, M. H., Sun, W., & Cheng, Q. (2019). The power of natural Chinese medicine, ginger and ginseng root in an organic life. *Middle-East Journal of Scientific Research*, 27(1), 64-71.

Toungos, M. D. (2019). Lemongrass (Cymbopogon, L. Spreng) valuable grass but underutilised in Northern Nigeria. *International Journal of Innovative Food, Nutrition and Sustainable Agriculture*, 7(2), 6-14.

Udourioh, G. A., & Etokudoh, M. F. (2014). Essential oils and fatty acids composition of dry fruits of Tetrapleura tetraptera. *Journal of Applied Sciences and Environmental Management*, 18(3), 419-424.

Viera, A. J & Wouk, N (2015) Potassium Disorders: Hypokalemia and Hyperkalemia. *Am Fam Physician*, 92(6):487-95.

ISSN: 2408-7920

African Journal of Applied Research
Vol. 10, No. 2 (2024), pp. 239-257
http://www.ajaronline.com
http://doi.org/10.26437/ajar.01.12.2024.13
Special Issue: Applied Research Conference of Technical Universities in Ghana 2024
Received: November 23, 2023
Peer reviewed: June 25, 2024
Revised: November 28, 2024
Published: December 2024

Waugh, D. T., Godfrey, M., Limeback, H., & Potter, W. (2017). Black tea source, production, and consumption: assessment of health risks of fluoride intake in New Zealand. *Journal of Environmental and Public Health*, 1-27

Wellfelt, E., & Djonler, S. A. (2019). Islam in Aru, Indonesia: oral traditions and islamisation processes from the early modern period to the present. *Indonesia and the Malay World,* 47(138), 160-183.

Zachariah, T. J., & Leela, N. K. (2018). Spices: Secondary metabolites and medicinal properties. Indian Spices: The Legacy, Production and Processing of India's Treasured Export, 277-316.

ISSN: 2408-7920