

COMPARATIVE NUTRIENTS COMPOSITION OF SMOOTHIES MADE FROM FRUITS,
PLANT BASED MILK AND EGG SHELL POWDER

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CERTIFICATION

This is to certify that **Ayomide Abimbola Fasakin** with matriculation number **LCU/PG/002595** carried out this research work titled “Comparative Nutritional Composition of Smoothies Made from Fruits, Plant Based Milk and Eggshell Powder” in the department of Human Nutrition and Dietetics, Faculty of Basic Medical and Health Sciences, Lead City University Ibadan, Oyo state, for the award of Master of Science Degree (MSc) in Human Nutrition and Dietetics and that this has not been previously submitted.

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DEDICATION

I dedicate this work to God Almighty, the source and giver of knowledge.

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I express a sincere appreciation to Lead City University, Ibadan for providing the opportunity to pursue my research and the facilities that helped in completing this thesis. I am indebted to the institute's faculty which has enabled me to explore my research interest and help achieve my academic goals.

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Even though the above mentioned institution and persons have assisted in the process of this research work, I alone stand responsible for the errors, if any found in my work.

ABSTRACT

Undernutrition caused by a lack of access to high-quality, nutritious food is a prevalent problem in Sub-Saharan Africa, affecting the health and survival of vulnerable groups. Inadequate dietary intake causes nutritional deficiencies, especially calcium, essential for growth and physiological function. This study looked into improving calcium consumption by adding heat-treated crushed eggshells to smoothies. A panel of 15 trained sensory assessors rated the instantly blended smoothies based on appearance, aroma, flavour, texture, and overall acceptability.

An experimental sample design which consisted of a mixed method approach of literature review, comparing micronutrient levels, phytochemicals, and sensory characteristics of smoothies was used to assess the practicality, safety, and acceptability of consumption of heat-treated powdered eggshells. Sample 1 has the second highest amount of Vitamin B9, (0.52 ± 0.01 mg) highest amount of Vitamin C, (14.88 ± 0.15 mg) and the overall highest vitamin content. Sample 2 has the second-highest amount of Vitamin C, (12.97 ± 0.03 mg) and the overall second highest vitamin content. Sample 4 presented the highest quantities of vitamin D (0.06 ± 0.00 mg), vitamin E (0.15 ± 0.00 mg), and the second highest calcium levels (1739.45 ± 0.00 mg), along with total phenolics (0.45 ± 0.00 mg) and other phytochemicals. Conversely, Sample 3 contained greater concentrations of potassium (615.67 ± 8.07 mg) and flavonoids (5.25 ± 0.05 mg).

The sensory analysis revealed no notable differences in colour or aroma; however, Sample 1 achieved the second highest scores across all sensory evaluations and garnered the second-best overall score. Sample 4 received the second-highest rating for texture among the smoothies. Samples 1 and 5 attained the top ratings for all sensory aspects and were deemed the most enjoyable overall. Powdered eggshells could be a highly equitable approach to raising calcium intakes in rural Sub-Saharan Africa, where calcium intake is low and village poultry ownership is prevalent.

Keywords: Smoothies, Calcium-Supplements, Eggshell Powder, Plant Based Milk, Nutrient Composition

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List of Acronyms

Abbreviation	Meaning
USDA	United States Department of Agriculture
FDA	Food and Drug Administration
LMIS	Low and Medium Income Countries
HIS	High Income Countries
SSA	Sub-Sahara Africa

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Chapter One Introduction

1.1 Background to the Study

Fruits that have been combined and consumed without any filtration or preservation methods are referred to as "smoothies". A smoothie is made from having the fluid basis for juiced fruits and or milk, yoghurt or ice cream blended with other ingredients. Some other accompanying ingredients like nutritional supplements, crushed ice, non-dairy milk, vegetables may be incorporated. Smoothies are a great source of fiber because they contain such a large amount of fruits and vegetables, they can assist in bridging the gap between typical diet intake and USDA's recommended daily fiber intake, reducing the risk of chronic illness and improving general health ^{1,2}

Calcium is an indispensable mineral for human health. Its functions involve nerve transmission, preservation of cell membrane structure, relaxation and contraction of muscle, blood clotting, and membrane penetrability. Several studies in age adults found that calcium, when given alone or in conjunction with other nutrients, have a positive effect ^[3]. There were reports of calcium deficiencies in most Nigerian diets due to the presence of chelators like phytates in most grain staples ⁴.

Osteoporosis, characterized by weak bones and high chances of falling is due to calcium deficiency. This deficiency of calcium can cause the mineralization processes of bone cartilage to be abnormal causing irreparable alterations in the skeletal structure thereby resulting to rickets in kids and some other bone related diseases in adults. Another problem associated with chronic calcium deficiency in both children and adults resulting in poor bone mineralization and bone softening is osteomalacia ⁵.

Many health disorders produce calcium imbalances in the body, which have a knock-on effect on health reported changes in the serum calcium levels in elderly people with thyroid surgery.

[6] Highly vulnerable to dietary calcium insufficiency are three key population groups; this include women (amenorrhea, the female athlete triad, and postmenopausal), people with milk allergies or intolerant to lactose, and anyone at risk for dietary deficient intake are among those at risk. The body contains approximately 26 to 30g calcium at birth; this number rapidly increases after parturition, reaching approximately 1.2kg and 1.4kg in women and men, respectively. This level in men remains constant, but falls in females as remodeling of bone intensifies due to decreasing production of estrogen at the onset of menopause ^{7,8}.

Calcium-rich natural sources include milk, yoghurt, and cheese ⁹ The most common source of calcium in Nigeria is cow's milk which is usually the first thing that springs to mind when you think of calcium. Cow's milk, without a doubt, is a wonderful source of calcium. However, cow milk is a source of calcium in Nigeria which is not accessible to half of the country; Nigeria faces challenges such as limited milk supply from indigenous cows, poor grass quality, and insufficient storage and processing equipment. Other challenges include inadequate infrastructure, such as access roads, energy, transportation, and storage facilities ¹⁰

Dietary calcium shortage is thought to be widespread over the world, as roughly half of the global population is deprived of dietary calcium. Low calcium intakes are most common in countries with low and middle income (LMIs), but many in high income countries (HIs) do not reach recommendations as well ¹¹.

Milk made from plants is a vegetable-based fluid having a milk-like appearance made with water-soluble extracts from plants for flavour and smell, plant milks are taken as substitutes to dairy milk and can have a creamy feeling. "Horchata de chufa", known as "aya" in Northern Nigeria is a plant milk from tiger nuts, mostly consumed fresh in Nigeria ^{12,13,14}.

The egg shell powder also called egg shell flour is made from ground egg shells that are obtained from the outer covering of the egg. The eggshell is made up of about 95-97% CaCO₃ (calcium carbonate) crystals stabilized by a matrix of protein¹⁵.

Consumption of 400g, of some fruits and vegetables daily reduces the chances of non communicable diseases, other forms of malnutrition and aids to enhance sufficient daily intake of dietary fiber. The cultivation and eating of fruits and vegetables have become more significant as a result of economic growth and dietary pattern changes. Particularly in a developing nation like Nigeria, the fruit and vegetable sector is crucial for household nutrition, economic growth, poverty alleviation, food security, and sustainable agriculture¹⁶.

Citrullus lanatus (Watermelon), is an edible fruit and a trailing vine-like flowering plant species of the Cucurbitaceae family with over 1,000 varieties cultivated worldwide. The fruit is made up of 6% sugars, 91% water, and low fat. It ranks among the most crucial fruit beverages for people and preserves health by making up for dietary deficiencies according to the US FDA (2001), watermelon juice is typically pasteurized in order to eliminate some bacteria pathogen which can cause a hazardous effect in the health of the consumers.^{17, 18}.

Ananas cosmosus (Pineapples) are a tropical edible fruits; the main economic and important crop of the Bromeliaceae family^[19]. Due to its delicious flavour, aroma, and many useful qualities, fresh pineapple juice is a well-liked product made from the pineapple fruit because of its health-promoting qualities, pineapple juice is regarded as a functional fruit beverage²⁰.

Musa genus (Banana) classified botanically as a berry is an extended edible fruit, formed by a diverse species of the *Musa* genus. Bananas that are cooked are called plantains in order to differentiate them from the dessert ones²¹.

Horchata de chufa (Tigernut milk) is plant milk made from tiger nuts that is widely consumed in Spain. Plant milk has several health benefits than animal milk, especially for persons who have milk allergies or lactose intolerance ²².

Egg Shell Powder: Eggshells are one of the cheapest and most effective sources of calcium. It is the most affordable and widely used dietary calcium supplements. Eggshells contain about 40% calcium, with 381-401 mg of calcium per gram ²³.

Researchers aimed to improve the nutritional value, shelf life, and sensory qualities of fruit-based smoothies and purees by combining fruits and vegetables. As a result, the objective of this study is to produce new smoothie formulations with watermelon, pineapple, banana, tiger nut milk and eggshell powder, as well as to compare the nutritional composition and assess the sensory quality of the resulting products ²⁴.

1.2 Statement of the Problem

Dietary diversity is low nationally, and evidence suggests that rural-dwelling women and infants' diets are low in energy, protein, fat, and micronutrients such as iron, zinc, and calcium. Micronutrient supplementation and food fortification have been effective in reducing stunting in a variety of settings, but their long-term viability is frequently jeopardised by funding, supply and access issues, low acceptability, and/or poor compliance, particularly among the rural poor. Chicken eggshell is a highly available and accessible calcium source in rural populations; approximately 85% of rural households in Sub-Saharan In general, these communities consume all edible parts of the animal, the prospective use of ground eggshell aligns with these principles ²⁵.

Osteoporosis in high income countries contributes to an estimated 1.5 million fractures every year, the majority of which occur in the hip, vertebrae, wrist, pelvis, and ribs ²⁶ According to the Centres for Disease Control and Prevention, 4.2% of men and 18.8% of women over 50

have osteoporosis of the femoral neck or lumbar spine, as determined by the density of bone minerals tests. Nutritional rickets is the leading cause of juvenile bone disease globally, particularly in LMICs such as India, Africa, and the Middle East ²⁷.

This study can help improve nutritional status and boost public health programs by recommending smoothie formulas with optimal nutrient profiles. The nutritional makeup of smoothies made with fruits, plant-based milk, and eggshell powder has not been studied.

1.3 Justification of the Study

Fruits are a great way to get necessary nutrients. Many health-promoting antioxidants, such as flavonoids, are available from them. Fruits provide lots of fibres. Regularly eating a diet rich in fruits and vegetables gives the body the critical nutrients it needs to stay healthy and lowers the risk of heart disease, cancer, diabetes, inflammation, Alzheimer's disease, cataracts, and other age-related conditions ^{28, 29, 30}.

Smoothies are popular dietary items that have the potential to help people include more fruit and vegetables in their diets. Smoothies are blended beverages that often contain various ingredients. Smoothie bars that serve made-to-order smoothies, ready-to-drink (i.e., pre-packaged) beverages, and kitchen appliances that make it easier to make smoothies at home are all now widely available in the market, despite the fact that published scientific data on smoothie consumption rates are scarce ³¹.

The proportion of teenagers consuming ≥ 1 serves of vegetable (an average of 4.3 vs. 45.1%) and the quantity consumed (< 0.1 vs. 0.6 serves student⁻¹) Enhanced when smoothies with fruit were created as opposed to whole fruit, were provided as part of a school meal program, according to a recent study. The scientist identified that fruit would be more palatable and approachable in a smoothie form—that is, without needing to be peeled or chewed—because it would resemble well-liked "dessert drinks," like milkshakes ³².

Smoothies are versatile beverages that can be made with a wide range of ingredients, notably the smoothies in this study were composed of fruits, plant-based milk, and novel additives like eggshell powder. While each component offers unique nutritional properties on its own, there is a knowledge deficit regarding their nutritional composition when combined in smoothies. This study seeks to address this deficiency by comparing the nutritional composition of fruit smoothies, plant-based milk smoothies, and eggshell powder smoothies. The potential implications for enhancing dietary choices, addressing nutrient deficiencies, and promoting health and wellness justify this study.

1.4 Aim and Objectives of the Study

The aim of the study is to compare the micronutrient composition, phytochemicals and sensory evaluation of smoothies made from watermelon, pineapple, banana, tiger nut milk, and eggshell powder

1.5 Research Questions

- i. How is smoothie produced with watermelon, pineapple, banana, tiger nut milk, and egg shell powder?
- ii. What is the micronutrients present in smoothie produced from watermelon, pineapple, banana, tiger nut milk and egg shell powder.
- iii. What is the phytochemicals present in smoothie produced from watermelon, pineapple, banana, tiger nut milk and egg shell powder.
- iv. What is the sensory properties and general acceptability of the smoothie produced from watermelon, pineapple, banana, tiger nut milk and egg shell powder.

The study's specific objectives is to:

- i. Produce a smoothie with watermelon, pineapple, banana, tiger nut milk, and egg shell powder.
- ii. Evaluate the micronutrients present in smoothie produced from watermelon, pineapple, banana, tiger nut milk and egg shell powder.
- iii. Evaluate the phytochemicals present in smoothie produced from watermelon, pineapple, banana, tiger nut milk and egg shell powder.
- iv. Conduct the sensory properties and general acceptability of the smoothie produced from watermelon, pineapple, banana, tiger nut milk and egg shell powder.

1.6 Significance of the Study

Consumers are now looking for healthier offered options with less processing, good nutritional content, and food hygiene³³. To suit customer demands in the twenty-first century, the food sector is creating functional commodities through new processing methods³⁴. One of the study's primary contributions is a better understanding of the nutritional composition of smoothies. The specific nutrition provided by each item is established by comparing its micronutrient and phytochemical compositions, as well as sensory evaluation. The study contributes to our understanding of smoothies' impact on food consumption, which is completely determined by frequency, ingredients, and customer preferences. Knowing these details can assist clarify the role of smoothies in people's meals and inform diet-improvement strategies³⁵.

Studying the nutritional potential of these smoothies provides a practical and nutrient-dense option for improving overall dietary quality and addressing specific nutritional needs.

1.7 Scope of the Study

The scope of the comparative study on the nutritional composition of smoothies made from fruits, plant-based milk, and eggshell powder incorporates a number of essential factors:

The study concentrated on a variety of locally available fruits, including watermelon, pineapple, bananas, tiger nut milk and eggshell powder is considered a supplement. Smoothie ingredients choices vary based on seasonal fruits and consumer preferences,³⁶ the research evaluated the micronutrient content of the smoothies and phytochemicals.

The food industry has fostered the creation of novel products that have good sensory acceptance and great nutritional value³⁷. Sensory evaluation measures people's reactions to things based on their appearance, aroma, taste, texture, and aftertaste, rather than labeling or other imagery³⁸. The objective is to identify any significant differences or similarities in the nutritional composition and to highlight the potential contributions of each ingredient to the smoothies' overall nutritional value. The information can be used by nutritionists to develop personalized dietary recommendations, while policymakers can consider the findings when developing nutrition and public health guidelines and interventions.

By defining the scope of the study, the factors guides the research process, ensure the relevance and applicability of the findings, and contribute to the existing body of knowledge regarding the nutritional composition of smoothies made from fruits, plant-based milk, and eggshell powder.

1.8 Limitation of the Study

The study, which evaluated the nutritional profiles of smoothies prepared from fruits, plant-based milk, and eggshell powder, gives useful insights into the nutritional profiles of these beverages; nevertheless, certain limitations must be recognized and addressed. This

guarantees that the data and conclusions are properly comprehended, and that future study can expand on them. This section presents a critical review of the study's limitations, focusing on issues that may affect the generalability and reliability of the findings. One of the study's key weaknesses is the sample's selection and representativeness. Smoothie ingredients such as fruit, plant-based milk, and eggshell powder may not represent the whole spectrum of available possibilities.

This may limit the application of the results to other smoothie combinations or ingredients. Furthermore, the sample size and diversity may have an impact on the study's representativeness, as it may fail to sufficiently document the variations in nutritional composition that can exist between areas or groups. Variability in the nutritional content of the listed substances is an additional constraint. Fruits, plant-based milk, and eggshell powder's nutrient makeup might vary depending on cultivar, ripeness, seasonality, and processing method. This variance may introduce uncertainty into the study's conclusions because the nutritional makeup of the smoothies may differ based on the batches of ingredients utilized. To address these disparities and maintain uniformity in nutritional analysis, strong measures should be employed.

1.9 Operational Definition of Terms

1. **Smoothies:** For the purpose of this study, smoothies are defined as blended beverages made from a combination of fruits, plant-based milk, and eggshell powder. They are typically prepared by blending these ingredients together until a smooth and homogeneous consistency is achieved.
2. **Plant-based milk:** Plant-based milk refers to non-dairy milk alternatives that are derived from plants such as soy, almond, coconut, or oat. These milk substitutes are

used as a base ingredient in the preparation of smoothies, providing nutrients such as protein, calcium, and vitamins.

3. **Eggshell powder:** Eggshell powder is a powdered form of crushed eggshells, which is a potential nutritional resource due to its calcium content. In this study, eggshell powder is used as an ingredient in smoothies to assess its contribution to the overall nutritional composition.

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Endnotes

- [1] Atiase Y, Quarde A. A call to action for osteoporosis research in sub-saharan Africa. *Ghana Med J.* 2020 54(1):58-67.
- [2] Marlene Chakhtoura, Dania S Bacha, Charbel Gharios, Sara Ajjour, Mariam Assaad, Yara Jabbour, Francesca Kahale, Aya Bassatne, Stephanie Antoun, Elie A Akl, Roger Bouillon, Paul Lips, Peter R Ebeling, Ghada El-Hajj Fuleihan, Vitamin D Supplementation and Fractures in Adults: A Systematic Umbrella Review of Meta-Analyses of Controlled Trials, *The Journal of Clinical Endocrinology & Metabolism*, Volume 107, Issue 3, (2022), Pages 882–898
- [3] Tan, L., He, R. & Zheng, X. Effect of vitamin D, calcium, or combined supplementation on fall prevention: a systematic review and updated network meta-analysis. *BMC Geriatr* 24, 390 (2024).
- [4] Christakos S, Li S, De La Cruz J, Bikle DD. New developments in our understanding of vitamin metabolism, action and treatment. *Metabolism.* (2019); 98:112-120.
- [5] Michaëlsson, K., Baron, J.A., Byberg, L. *et al.* Declining hip fracture burden in Sweden 1998–2019 and consequences for projections through 2050. *Sci Rep* 14, 706 (2024).
- [6] Abdullah AT, Mousheer ZT. Vitamin D Status in Epileptic Children on Valproic Acid; a Case-Control Study. *Arch Acad Emerg Med.* Feb 27; (2020) 8(1):e13.
- [7] Martha S Field, Regan L Bailey, Patsy M Brannon, Jesse F Gregory, III, Alice H Lichtenstein, Ian J Saldanha, Barbara O Schneeman. Scanning the evidence: process and lessons learned from an evidence scan of riboflavin to inform decisions on updating the riboflavin dietary reference intakes. Volume 116, Issue 2p 299-302 August (2022)
- [8] Arise, R. O., Acho, M. A., Yekeen, A. A., Omokanye, I. A., Sunday-Nwaso, E. O., Akiode, O. S., & Malomo, S. O. Kinetics of angiotensin -1 converting enzyme inhibition and antioxidative properties of *Azadirachta indica* seed protein hydrolysates. (2019).

- [9] Sivamani, Kalaimani & Venkatesh, R & Tumbanatham, A & Green, Siva. A Rare Case of Extensive Brain Calcinosi and Features of Parkinsonism Secondary to Iatrogenic Hypoparathyroidism. *Journal of Clinical and Diagnostic Research*. (2019).
- [10] Kemper B. "Nut Milks Are Milk, Says Almost Every Culture Across the Globe". *Smithsonian Magazine*. (2020).
- [11] Matejic, Vesna & Petrovic, Milos & Kurćubić, Vladimir & Petkovic, Marko & Miletic, Nemanja & Đurović, Igor. Comparison of Cow's Milk with Plant-Based Milk Alternatives: Selected Chemical and Physical Analysis. (2023).
- [12] Oliver Franklin-Wallis. "White gold: the unstoppable rise of alternative milks". *The Guardian*. (2019).
- [13] Nweze, Chibuzo & Abdulganiyu, M & Erhabor, Osas. Comparative Analysis Of Vitamin C In Fresh Fruits Juice Of *Malus Domestica*, *Citrus Sinensi*, *Ananas Comosus* And *Citrullus Lanatus* By Iodometric Titration. (2019).
- [14] Motalab, M., Mumtaz, B., Mohajan, S., Saha, B.K. and Jahan, S. Institute of Food Science and Technology, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka-1205, Bangladesh. *Food Research* 6 (5): 403 - 411 (2022).
- [15] Lewis, Susana; Lewis, Charles. *A Taste of Paradise*. Psy Press. (2012).p. 18.
- [16] United States Food and Drug Administration. "Daily Value on the Nutrition and Supplement Facts Labels". *FDA*. (2024).
- [17] Park YB, Kim M, Nam HC, Jeon JW, Ha CW. Total knee arthroplasty and periprosthetic distal femoral fracture: looking beyond the osteoporosis to previous osteoporotic fracture. *Osteoporos Int*. (2024)
- [18] Glasser, N. J., Pollack, H. A., Ranney, M. L., & Betz, M. E. Economics and Public Health: Two Perspectives on Firearm Injury Prevention. *The ANNALS of the American Academy of Political and Social Science*, 704(1), 44-69. (2022).
- [19] Samuel Ayofemi Olalekan, Adeyeye. . 'Banana Drying Kinetics'. *Banana Nutrition - Function and Processing Kinetics*. IntechOpen. (2020).

- [20] Madanhire T, Ó Breasail M, Kahari C, Kowo-Nyakoko F, Ebeling PR, Ferrand RA, Ward KA, Gregson CL. Prevalence of HIV-associated osteoporosis and fracture risk in midlife women: a cross-sectional study in Zimbabwe. *J Bone Miner Res.* 26; 39 2024 (10):1464-1473.
- [21] de Oliveira, Andressa Alves, Alexandre Guedes Torres, Daniel Perrone, and Mariana Monteiro. "Effect of High Hydrostatic Pressure Processing on the Anthocyanins Content, Antioxidant Activity, Sensorial Acceptance and Stability of Jussara (*Euterpe edulis*) Juice" *Foods* 10, no. 10: 2246. (2021).
- [22] Cormick, Gabriela, and Jose M Belizán. "Calcium Intake and Health" *Nutrients* 11, no. 7: 1606. (2019).
- [23] Ginsberg, Charles, Joachim H. IX Diagnosis and Management of Osteoporosis in Advanced Kidney Disease: A Review *American Journal of Kidney Diseases*, Volume 79, Issue 3, 427 – 436. (2022).
- [24] Gentile, C., & Chiarelli, F. Rickets in Children: An Update. *Biomedicines*, 9(7), 738. (2021).
- [25] Salehin, S., Rasmussen, P., Mai, S., Mushtaq, M., Agarwal, M., Hasan, S. M., Salehin, S., Raja, M., Gilani, S., & Khalife, W. I. Plant Based Diet and Its Effect on Cardiovascular Disease. *International journal of environmental research and public health*, 20(4), 3337. (2023).
- [26] Kabwama, S.N., Bahendeka, S.K., Wesonga, R. Low consumption of fruits and vegetables among adults in Uganda: findings from a countrywide cross-sectional survey. *Arch Public Health* 77, 4 (2019).
- [27] Chitta R.Db., Neilazonuo o. Assessment of Nutrient Composition and Antioxidant Activity of Some Popular Underutilized Edible Crops of Nagaland, India Vol.12 No.2, February 26, (2021)
- [28] Da Silva-Mojón, L., Pérez-Lamela, C., & Falqué-López, E. Smoothies Marketed in Spain: Are They Complying with Labeling Legislation?. *Nutrients*, 15(20), 4426. (2023).
- [29] Cohen, J. F. W., Hecht, A. A., Hager, E. R., Turner, L., Burkholder, K., & Schwartz, M. B. Strategies to Improve School Meal Consumption: A Systematic Review. *Nutrients*, 13(10), 3520. (2021).

- [30] Houška, M.; Silva, F.V.M.; Evelyn; Buckow, R.; Terefe, N.S.; Tonello, C. High Pressure Processing Applications in Plant Foods. *Foods*. (2022).
- [31] Yi, H., Siu, Q. K. Y., Ngan, O. M. Y., & Chan, D. F. Y. Parents' experiences of screening, diagnosis, and intervention for children with autism spectrum disorder. *American Journal of Orthopsychiatry*, 90(3), (2020). 297–311.
- [32] Škegro, M., Putnik, P., Bursać Kovačević, D., Kovač, A. P., Salkić, L., Čanak, I., Frece, J., Zavadlav, S., & Ježek, D. Chemometric Comparison of High-Pressure Processing and Thermal Pasteurization: The Nutritive, Sensory, and Microbial Quality of Smoothies. *Foods (Basel, Switzerland)*, 10(6), (2021). 1167.
- [33] Kidoń, Marcin & Uwineza, Pascaline. New Smoothie Products Based on Pumpkin, Banana, and Purple Carrot as a Source of Bioactive Compounds. *Molecules*. 27. 3049. (2022).
- [34] Aryaee, H., Ariaee, P., Zare, D., Mirdamadi, S., & Naghizadeh Raesi, S. (2020). Sensory evaluation of strawberry fruit juice by fuzzy logic and evaluation of antioxidant activity during frozen storage. *Innovative Food Technologies*, 8(1), 111-128. (2020).
- [35] Alhassan, U. S., & Dajal, J. S. Health risk assessment from the consumption of moringa oleifera leaves cultivated along river ginzo, Katsina. *FUDMA journal of sciences*, 7(6), (2023). 66-74.

Chapter Two Literature Review

A smoothie is a drink created by mixing components in a food processor ¹. A smoothie usually comprises a liquid base, such as juice from fruits, dairy product, yoghurt, or a frozen treat. Additional elements which may be added are veggies, fruit, dairy-free milk, ice chunks; protein powdered form, as well as nutritional supplements. Smoothies, a form of mixed fluid that includes numerous ingredients, can help consumers include more veggies and fruit into their diets ². Smoothies are common in developing countries such as Nigeria, where they are made on request and are offered in shops, hotels, and relaxation spots that use fruit combos ³. Consumers are able to take smoothies with them from the point of purchase owing to improved packaging materials. Smoothies' impact on dietary intake varies according to frequency, ingredients, and customer ideas and attitudes. Understanding these aspects can help clarify the significance of smoothies in eating habits and inform measures for improving diet quality.

2.1 Smoothies; History, Nutritional Composition, Types and Sensory Properties

2.1.1 History of Smoothies

After the electric blender was developed Food markets on the western Shore of the Americas began selling smoothies. By the middle of the 1980s, the word "smoothie" itself was used in trademarks and recipes ^{4,5}.

In the 1960s, began experimenting with smoothies after becoming inspired by his employment as a beverage salesman⁵. They were a substitute for Kuhnau's lactose-intolerance in order for him to taste his own concoctions, which he made by combining unusual combinations of fruit liquids, veggies, protein powder, and vitamins. Smoothie King was formed by Kuhnau after he experienced early success with his smoothie sales. As it expanded

across the country, Smoothie King served as a model for other smoothie companies like Jamba Juice. Fast food restaurants later altered the smoothie by including sweeteners like Splenda and chocolate ⁶. The smoothie was first prepared at home as an alternative to everyday fruit and vegetable consumption in the 2000s ⁷.

2.1.2 Nutrient Composition of Smoothies

The ingredients and their ratios in a smoothie determine its nutritional value. Big or several portions of vegetables and fruits, often advised in a balanced diet and meant to replace meals, are frequently included in smoothies ⁸. Fruit juice with a lot of sugar, however, might increase calorie consumption and encourage weight gain ^{9, 10}. One can utilize ingredients like protein powders, sweets, or ice cream ^{8, 11, 12}. Even though smoothies have similar energy content as unblended meals; one study revealed that they are less filling ¹³.

2.1.3 Types of Smoothies

The following are the common ones

1. **Green Smoothie:** This has 40 to 50% (approximately half) green veggies, mainly green raw leafy vegetables like broccoli, collard greens, kale, Swiss chard, parsley, spinach, celery, while most of or all the other additional ingredients are fruits ^{13, 14, 15}. When served fresh, they most times have bitter taste, although this can be reduced by selecting less bitter veggies (such as baby spinach) or mixing them with sweeter products ¹⁶.
2. **Protein Smoothie:** Protein powder, water and or some other dairy products, fruits, and veggies are all ingredients in a protein smoothie. They serve as supplements for individuals who desire to enhance their intake of protein and could be ingested at any time of the day. When blended alone with milk or water, protein powder might have a gritty flavor. By adding fruit or other sweeteners, it enhances the flavor of the powder ¹⁷

3. **Yoghurt Smoothie:** Contains yoghurt as a protein source and also provide the beverage with a creamy texture. Particularly Greek yoghurt is added as a thickening (because to its stretched consistency) and to benefit from its alleged health advantages ¹⁸.

2.1.4 Sensory Properties of Smoothie

Organoleptic evaluation of smoothie made from pineapple, watermelon, and mango was evaluated using 20 panelists. Results showed that smoothie samples have similar properties except for taste. The control (CONT) had higher taste score followed by mango smoothie, water melon, and pineapple smoothies in that order.

When compared to its contemporaries, the smoothie sample with the highest level of pineapple had more levels of Ca and K with lower Fe concentration. Calcium is an important component of teeth and bones, regulates muscle and nerve function, and aids in milk coagulation; while K forms a component of intercellular fluid by maintaining contraction of muscles and nerve transmission ¹⁹.

In this study, the mineral profile of the smoothies opposed the earlier findings in Lagos markets ²⁰on increased mineral contents of smoothies being sold there.

The authors discovered that smoothies produced from a blend of watermelon and pineapple had 254mg and 54.45mg of calcium and iron, respectively. In contrast, the current investigation discovered more potassium than, ²¹ who discovered less potassium at 34.63mg. The explanations for observed differences in minerals could be due to varied techniques and ecological circumstances associated with growing and storage of the fruits. There were variations in the vitamin profile of the smoothies as sample with pineapple had more vitamin C while that with 50% watermelon had higher pro vitamins. Increased vitamin C content observed was not unexpected due to reports that it has more vitamin C than most fruits and also a vital antioxidant that enhances the immunity and aids the absorption of iron for optimal

bodily function and collagen synthesis. Pro-vitamin is essential for healthy eye health and promotes red blood cell proliferation in the marrow of bones²² Furthermore, Victor-Aduloju et al. found greater vitamin A levels of 466.001.73-642.001.73 IU and reduced vitamin C levels of 9.300.00-10.670.02 mg in their smoothie samples²³.

In this study, the smoothies achieved moderate to high approval in all of the criteria tested. No discernible change in the texture, colour, flavour, or overall acceptability was noticed in the smoothie samples²⁴. The control smoothie tasted better than others which were judged as having equal taste levels. This demonstrated that when individual taste of one fruit is projected above others, often times it does not appear to give the greatest acceptable smoothie taste, in comparison to a homogeneous blend as observed in the control. Sensory qualities in this study contrasted previous research work where mango flavoured smoothies were ranked above other choices²⁵.

2.2 Choice of Fruits Its History, Classification, Uses and Nutrient Composition

2.2.1 Watermelon (*Citrullus lanatus*)

Citrullus lanatus(Watermelon), is an edible fruit and a trailing vine-like flowering plant species of the Cucurbitaceae family with over 1,000 varieties cultivated worldwide. It has an enormous edible fruit, and it is widely produced globally spanning the tropics to the temperate regions. The fruit is botanically known as a “pepo”. Though there are some varieties without seeds, the flesh is sweet, juicy with deep crimson to pink colour and contains several seeds that are black-colored. It can be consumed fresh, cooked, pickled, and even the rind can also be consumed. Additionally, it could be drunk as a juice or a component of mixed drinks. The Sudanese Kordofan melons are the closest relatives to modern water melon and perhaps the ancestors of these cultivated melons²⁶.

Dating back to 3500 BC in ancient Libya, watermelon seeds were discovered in the wild. Even though at that time they were not these present delicious kinds, they became domesticated in the eastern part of North-Africa but were later cultivated in the 2000BC by Egyptians. Also, at the time of the Roman Empire, the sweet variety became widespread across the Mediterranean ²⁷.

2.2.1.1 Uses

Watermelon is a sweet, popular summer fruit typically eaten fresh, chopped in various fruit salads, or juiced ^{28,29} Watermelon juice can be combined with other juices from fruits or turned into wine ³⁰. The seeds are nutty-flavored and can be dried, roasted, or crushed into flour ³¹. Watermelon rinds can be eaten, however their unpleasant flavour may be reduced by pickling ³². They are also sometimes eaten as a vegetable, a stir-fried or simmered ^{33,34}

Citrullis lanatus, variances caffer, blooms naturally in the Kalahari Desert and is referred to as tamma ³⁵ The San people and wild animals depend on the fruits for both water and sustenance, allowing them to survive for six weeks on a tamma diet ³⁶.

2.2.1.1 Composition (Nutrients)

Watermelon fruits include 6% sugars, 91% water, with low fat content (table) ³⁷. A 100-gram portion has low levels of important nutrients and 125 kilojoules (30 kilocalories) of food energy (see table). At 10% Daily Value (the table), just the vitamin C compound is present in any substantial level. Lycopene and other carotenoids are found in the pulp of watermelons. ³⁸

Watermelon rind is where the amino acid citrulline is made ^{39,40}.

Table 2.1: Watermelon flesh, raw

Energy-value	127 kJ (30 kcal)	
Protein	0.61g	
Sugars	6.2 g	
Fat	0.15 g	
Dietary fiber	0.4 g	
Carbohydrates	7.55 g	
<i>The amount of nutrition per 100 g (3.5 oz)</i>		
Vitamins	Quantity	%DV
Vitamin A equiv.	28ug	4
Riboflavin (B2)	0.021mg	2
Thiamine (B1)	0.033mg	3
Niacin (B3)	0.178mg	1
beta-Carotene	303ug	3
Vitamin b6	0.045mg	3
Vitamin C	8.1mg	10
Choline	4.1mg	1
Pantothenic acid (B5)	0.221mg	4
Minerals	Quantity	%DV
Zinc	0. 1mg	1
Magnesium	10mg	3
Potassium	112	2
Calcium	7mg	1
Phosphorus	11mg	3
Iron	0.24mh	2
Sodium	1mg	0
Manganese	0.038mg	2
Other constitutes	Quantity	
Water	91.45g	

(Source: ^{39, 40})

2.2.2 Pineapple (*Ananas Comosus*)





Ananas cosmosus (Pineapples) are a tropical edible fruits; the main economic and important crop of the Bromeliaceae family. In the 17th century it found its way into Europe from South America, it became an important cultural symbol of luxury and in early 80s it became popular and cultivated in greenhouse facilities and on tropical farms for commercial use ^{42, 43}.

They often grow as short shrubs; and the each flower of the plants that are not pollinated merge to yield numerous fruits. The crop offset often spreads from the head or side of the fruit and become fully grown in one year ^{44, 45 46, 47}.

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2.2.2.1 Classification

Table 2.2 the pineapple comprises five botanical varieties, formerly regarded as separate species:

Image	Varieties	Distribution
	<i>Ananas comosus</i> var. <i>bracteatus</i> (L.B.Sm.) Coppens & F.Leal	Paraguay, Bolivia, Ecuador, Brazil, Argentina,
	<i>Ananas comosus</i> var. <i>comosus</i> (Linnaeus) Merrill	Paraguay and Brazil; naturalized in parts of Africa, Central America, Mexico, the West Indies, Asia, Australia, northern South America, and various islands in the Pacific
	<i>Ananas comosus</i> var. <i>erectifolius</i> (L.B.Sm.) Coppens & F.Leal	Peru, French Guiana, Colombia, Venezuela, Ecuador, northern Brazil,
	<i>Ananas comosus</i> var. <i>microstachys</i> (Mez) L.B.Sm.	Paraguay to Costa Rica
	<i>Ananas comosus</i> var. <i>parguazensis</i> (Camargo & L.B.Sm.) Coppens & F.Leal	Colombia, Venezuela, northern Brazil, Guyana, French Guiana

Source: ^{46, 47}

2.2.2.2 Nutrient (Composition)

Raw pineapple pulp has a water content of 86%, 13% in carbs, There is only 0.5% protein and very little fat (see table). Raw pineapple does not have appreciable quantities of micronutrients though a 100-gram reference quantity yields 209 KJ and a good yield of vitamin C and manganese.

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Table 2. 3 : Raw pineapple (nutrient content / 100 grammes) (3.5 oz).

Energy	209 kJ (50 kcal)
Fat	0.12g
Sugars	9.85g
Protein	0.54g
Dietary fiber	1.4g
Carbohydrates	13.12 g

Vitamins	Quantity	%DV
Thiamine (B1)	0.079mg	7
Choline	5.5mg	1
Pantothenic acid (B5)	0.213mg	4
Niacin B3	0.5mg	3
Vitamin C	47.8mg	58
Riboflavin (B2)	0.032mg	3
Folate B9	18ug	5
Vitamin (B6)	0.112mg	9
Minerals	Quantity	%DV
Zinc	0.12mg	1
Manganese	0.927mg	44
Potassium	109mg	2
Calcium	13mg	1
Magnesium	12mg	3
Sodium	1mg	0
Phosphorus	8mg	1
Iron	0.29mg	2

Other constituents	Quantity
Water	86.00g

Source: 48, 49

2.2.3 Banana (*Musa genus*)

Banana is an extended edible fruit, formed by a diverse species of the *Musa genus*⁵⁰ the banana plant is among the vastest herbaceous flowering plant⁵¹. A banana plant's above-ground components originate from a structure known as a corm⁵². Plants are often strong and sturdy, like trees, however what appears to be a trunk may be a pseudostem composed of many leaf stalks (the tips). Bananas flourish on a wide variety of soils as long as they are at least 60 centimetres (2.0 feet) deep, well-drained, and not compacted⁵³. They are among the fastest growing of all plants, with daily area growth rates ranging from 1.4 to 1.6 square metres (15 to 17 square feet)^{54,55}.

2.2.3.1 Classification

Carl Linnaeus named the genus *Musa* in 1753⁵⁶. This nomenclature could have originated from the name of Antonius Musa, the Emperor Augustus' physician, at that time or Linnaeus could have adopted "mauz", the Arab word for banana⁵⁷.

Musa is the family Musaceae's type genus. Musaceae is assigned to the order Zingiberales under the APG III classification. As at January 2013, 70 *Musa* species Families were recognised;⁵⁸ many yield edible fruits, while the others are planted as ornaments⁵⁹.

Taxonomists have long struggled with the classification of cultivated bananas. Originally bananas were classified into 2 spp. solely on their culinary applications: as dessert bananas (*Musa sapientum*) and for plantains (*Musa paradisiaca*). Thereafter, some more names were included though this strategy did not work effectively for the numerous cultivars available in southeastern Asia where there was many variations in the genus thus most of the cultivars

were labelled with names that were more or less substitutes ⁶⁰. Ernest Cheesman demonstrated in a series of publications published beginning from 1947 that *M. sapientum* and *M. paradisiaca* named by Linnaeus were descendants of *M. acuminata* and *M. balbisiana*, two wild species, which were initially identified by Colla, Luigi Aloysius ⁶¹.

Cheesman argued for the termination of the Linnaeus' spp in favour of reclassification of bananas into 3 distinctive categories based on morphology of their cultivars: as those mainly displaying *Musa balbisiana* attributes, those mainly displaying *Musa acuminata* botanical characteristics, and those displaying both ⁶².

In 1955, scientists Ken Shepherd and his colleague Norman Simmonds developed a genome-based naming scheme. This system resolved nearly all of the challenges and contradictions associated with the previous classification of bananas, which was focused on allocating scientific names to bananas that are cultivated. In spite of this, some authorities continue to recognize the original names, causing confusion ^{63, 64}.

2.2.3.1.1 Uses

Many tropical cultures rely on bananas as their primary source of carbohydrate. The flesh can taste starchy to sweet and have a texture ranging from firm to mushy depending on the cultivar and ripeness. The skin and inner portion can be eaten raw or cooked. Isoamyl acetate (also known as banana oil) is the principal component of fresh banana scent, and it contributes significantly to banana flavour, along with other chemicals such as butyl acetate and isobutyl acetate ⁶⁵

Plantains are typically eaten cooked, as fried ⁶⁶. In Southeast Asia, pisang goreng, or battered-fried bananas, is a popular street snack ⁶⁷. Bananas are used in Philippine cuisine, including delicacies like maruya banana fritters ⁶⁸. Fruit preserves can be prepared with bananas ⁶⁹

Banana chips, a popular snack in Kerala, are made from sliced and fried bananas. Banana flour is made by grinding up dried bananas ⁷⁰. Matoke bananas are cooked in a sauce with meat and vegetables such as peanuts or beans to produce katogo, a morning dish ⁷¹. Bananas are commonly used in Western countries to make delicacies like banana bread ⁷².



Lemony banana curry



Sweet gravy with banana



Banana fritters

i. **Flowers**

Banana flowers (also known as "banana hearts" or "banana blossoms") are a vegetable ⁷³ in South and Southeast Asian cuisine. It has an artichoke-like flavour. The fleshy part of the bracts and the heart are both edible, just like artichokes are ⁷⁴.



Banana flowers



ii. **Leaf**

Banana leaves are big, flexible, and watertight. While they are typically too difficult to eat, they are frequently used as environmentally friendly disposable food containers or "plates" in South Asia and numerous Southeast Asian countries ⁷⁵. Banana leaf is used in Indonesian cuisine in cooking methods such as pepes and botok; banana leaf bundles containing food items and spices are cooked in steam, boiled water, or grilled over charcoal. Banana leaves are used to wrap some tamales instead of corn husks ⁷⁶.

When used for steaming or grilling, banana leaves keep food ingredients from burning while also adding a slight sweet flavor ⁷⁷ In South India, it is common to serve traditional dishes on banana leaves ⁷⁸ In Tamil Nadu (India), dried banana leaves are used to pack food and construct cups for liquids ⁷⁹



iii. Trunk

The sensitive core of the banana plant's trunk is frequently used in South and Southeast Asian cooking ⁸⁰ Examples includes the Burmese cuisine mohinga, as well as the Filipino delicacies inubaran, kadyos, manok, and kag ubad ^{81, 82}.



iv. Fibre

Banana fibre from the pseudostems and leaves has been utilised in Asian textiles from at least the 13th century. Both fruit-bearing and fibrous banana varieties have been used ⁸³. Kijōka-bashōfu, a Japanese technique; involve cutting plant leaves and shoots at regular intervals to maintain softness. Harvested shoots are first cooked in lye to prepare them for yarn production. These banana shoots produce fibres with varied degrees of softness, resulting in yarns and textiles with varying characteristics for specific applications. For example, the coarsest fibres of the shoots are suitable for tablecloths, whilst the softest interior fibres are preferable for kimono and kamishima. This ancient Japanese cloth-making technique consists of numerous processes, all of which are completed by hand ⁸⁴.

v. Other uses

Locals utilise huge banana leaves as umbrellas ⁸⁵. As with other purification materials, banana peel may be capable of extracting heavy metal contamination from river water ^{86,87}. Waste bananas can be fed to livestock ⁸⁸. Bananas, like other living things, generate tiny quantities of radioactivity from the potassium-40 (K-40) isotope ⁸⁹. The banana equivalent dose of

radiation was created in 1995 as a simple teaching tool to inform the public about the natural, modest amount of K-40 radiation found in everyone and in common foods ^{90,91}.

2.2.3.2 Nutrient (composition)

Raw banana (not counting the peel) comprises 23% carbs, 75% water, minimal fat and 1% protein. A 100g portion contains 89 calories, 31% vit. B6 and moderate quantities of manganese, vit. C, and dietary fiber, with no substantial content of additional micronutrients. Though bananas are commonly assumed to possess high K content, ^{93,93} it has only 8% Daily Value and their rank amidst vegetables, fruits, legumes, and several other potassium food sources relatively moderate ^{94,95}.

Whole grain oats 0.350 g per 100 g, raw baby spinach contains 0.582g/100g, ground flaxseed contains 0.793g per 100 g, dry-roasted almonds contains 0.684g/100g, white button mushrooms 0.393g per 100 g, and peanut butter contains 0.654 g per 100 g, all have more potassium content than 0.326g per 100 g raw dessert bananas. The potassium content of raw yellow-coloured plantains is 0.487g per 100 g while banana powders (dehydrated dessert bananas) have higher potassium content of 1.490 g per 100 g ⁹⁶.

Table 2.4: Bananas, raw (Daily Value)

Energy	317kj (89 kcal)	
Fat	0.33g	
Sugars	12.23g	
Dietary fiber	2.6g	
Protein	1.09g	
Carbohydrates	22.84g	
The nutritional content per 100 grammes (3.5 ounces)		
Vitamins	Quantity	%DV
Thiamine (B1)	0.031mg	3
Vitamin C	8.7mg	10
Choline	9.8mg	2
Niacin (B3)	0.0665mg	4
Folate B9	20ug	5
Vitamin B6	0.4mg	31
Pantothenic acid (B5)	0.34mg	7
Riboflavin (B2)	0.073mg	6
Minerals	Quantity	%DV
Phosphorus	22mg	3
Magnesium	27mg	8
Sodium	1mg	0
Manganese	0.27mg	13
Iron	0.26mg	2
Potassium	358mg	8
Zinc	0.15mg	2
Other constitutes		
Quantity	Quantity	
Water	74.91g	

Source: ⁹⁶

2.3 Comprehensive Utilization of Tigernut

2.3.1 History of Tigernut

Cyperus esculentus is found throughout the majority of the world ⁹⁷. It is found over the majority of the Eastern Hemisphere, including Africa, the Middle East, Madagascar, Southern Europe, and India ^{98,99,100}. The plant is grown for its edible tubers, known as tiger nuts, as snack and to produce a sweet, milk-like beverage ^{101,102}. *C. esculentus* is seen in the wild, as crop and as weed, highly invasive especially outside the natural abode and can easily be mistakenly introduced to become invasive. *C. esculentus* is classified a weed in many nations ^{103,104}. During the summer, it can be found in wet areas where peanuts and rice paddies are cultivated, and also in golf courses and highly-irrigated lawns/fields.

2.3.2 Utilization of Tiger Nut

Tiger nut could be eaten in its raw form, baked, dried, roasted, or as drink, oil or milk. The dry nut tastes smooth, sweet, delicate, and nutty.

1. **Drink:** Horchata de chufa (known as kunun aya in West African nations such as Mali and Nigeria is the unique form of horchata in Spain. It's created by soaking, grinding, and sweetening tiger nuts with sugar ¹⁰⁵

It is still popular in Spain, where the product is regulated to verify the product's quality and in order to trace the origin or destination. It is served with ice as refreshment, frequently with fartons in the summer. The most of the tiger nut plants are dedicated to producing is used to make Spanish horchata de chufas. Alboraya is the major manufacturing center in Spain while the tubers could be roasted or crushed to make substitute for coffee.

2. **Food:** The tubers can be eaten cooked or raw ¹⁰⁶. The tubers have a slightly sweet, nutty flavor in comparison to related tuber of *Cyperus rotundus* which is bitter-tasting.

Because of their hard nature, they are often soaked to soften them before eating and for an improved texture. In West Africa, it is a popular snack while the tubers are also dried and crushed to produce flour as well ¹⁰⁷.

It is known as aya in Northern Nigeria and is mostly consumed fresh. It is occasionally dried and then rehydrated before being eaten. The Hausa youngsters of Northern Nigeria like snacks produced from the toasted nuts coated with sugar. Roasted tiger nut flour is occasionally used in making biscuits and other baking items, as well as in the production of soaps, oil, and starch extracts as well as to make beer, jam, nougat, and as flavouring agent in the production of ice cream and kunu (a Nigerian beverage). It was discovered to be an excellent alternative for cereals and especially to compensate for the low nutrient value of cereal-based kunu. They are also used in salads and in deep frying due to its nutrient-rich oil. Its milk is used as alternate milk source in fermented goods, like yoghurt in various countries of Africa, and may therefore be effective in substituting milk in diets of persons who are lactose intolerant to a degree ¹⁰⁸.

3. **Oil:** Because *C. esculentus* tubers has about 20-36% oil, the tuber is been proposed as a possible oil crop for biodiesel production ¹⁰⁹. Due to yield of 5.67 tonne/ha with oil as much as 26.4%, it was reported that the nut yielded 1.5 MT/ha of oil ¹¹⁰. In another trial, the tuber yields 4.02 - 6.75 tonne/ha, with mean oil of 26.5% mean yield of 1.47 tonne/ha ¹¹¹. The tuber oil was reported to be 18% saturated and 82% unsaturated ¹¹².

2.3.3 Comprehensive Utilization of Tiger Nut Milk and its By-Products

Plant milk possesses several health benefits than animal milk, especially for persons who have milk allergies or lactose intolerance. Wet grinding, filtration, ingredient addition, sterilisation, homogenization, aseptic packing, and chilling are all used to make tiger nut milk.

It is high in un-saturated fatty acids, phenolic compounds, and physiologically active chemicals ¹¹³.

Despite its benefits, the drink has not gained wide spread as a result of huge loads of microbes and unstable shelf-life. Furthermore, traditional treatments that involves pasteurizing and sterilizing of milk result in loss of its sensory attributes. As a result, the food sector is looking for alternate skills that can enhance the shelf life and at the same time keep the sensory qualities. Non-thermal processing methods such as short-wave UV treatments, ultra-high-pressure homogenization ¹¹⁴, and pulsed electric field can successfully prevent microbe development and extend shelf life. Also, using a mixture of adjusted tiger nut starch and inulin to microencapsulate tiger nut milk on the other hand, has been shown in experiments to produce products with quality features and better shelf life ^{115,116,117}.

By-products from the manufacturing of tiger nut milk often times accounts for around 60% of the harvest and can be used as antioxidants (polyphenols and vitamin E), oils, polysaccharides, and fibres ¹¹⁸. Through compression and filtering, by products are separated into 2 phases: 1. liquid phase containing biologically active compounds like phenols, and 2. solid phase containing fibres ^{119, 120}.

Table 2.5 Application of tiger nut milk by-products in the food industry.

Tiger Nut By-Products	Source	Food Product
Liquid phase	phenolic compounds	natural antioxidants
	replacing water	cooked pork liver meat product
	carbon source for growth of probiotic bacteria	fermentable substrates
Solid phase	Tiger nut fiber	cereal foods (such as chips, breakfast cereal or dry pasta) pork pies, pork burgers and dry-cured sausages

Source: ^{112,122}

2.3.4 Sensory Properties of Smoothies Flavored with Tiger nut Milk

In a study, twenty trained panelists were selected to assess the sensory properties of smoothie samples were served and participants were to rank these attributes on a 9-point hedonic scale for flavor, color, taste, mouth feel and general acceptability.

Table 2.6: Chemical and Sensory Properties of Soursop Smoothie Formulated from Soursop, Tiger Nut Milk, Date Palm and Noni Juice

Sensory properties	A	B	C	D
Flavor	6.96a±1.59	6.78a±1.34	6.68a±1.96	7.78b±0.99
Color	6.92a±1.36	6.62a±1.58	6.78a±1.59	7.78b±1.07
Taste	7.46b±1.38	6.46a±1.75	6.56a±1.83	7.98b±0.97
Mouth feel	6.54a±2.15	6.56a±1.47	6.90a±1.94	7.46b±0.97
Overall acceptability	7.22b±1.56	6.46a±1.85	6.58a±2.20	7.46b±1.04

(30%) + Date palm (10%) + noni juice (10%). Sample B = soursop (40%) + tiger nut (30%) + date palm (20%) + noni juice (10%). Sample C = soursop (30%) + tiger nut (40%) + date palm (20%) + noni juice (10%). Sample D = soursop (30%) + tiger nut (30%) + date palm (30%) + noni juice (10%)

The sensory qualities of these smoothies were in line with recent studies by ¹²³ to the findings, smoothie containing 30% each of tiger nut, sour sop, date palm, and 10% noni concentrate had the best sensory qualities of taste, flavour, aroma, and mouth-feel, and overall acceptance. The authors believed that the rating might be due to the amount of tiger nut and date palm milks used as sweet items have more acceptances, regardless of nutritional content. Sugar produced by date palm can be used to substitute sugar in smoothies ^{124,125}

2.4 Chicken Eggshell Powder A Source Of Calcium And Its Application

Figure 1 depicts the global increase in egg production from 2009 to 2019, which was more than 30%. In 2008, European Union countries produced more than 6.5 million tonnes of eggs, trailing only China in first and the United States in third ¹²⁶. In Poland, the average yearly consumption of chicken eggs was more than 200 per capita ¹²⁷. Not only does the increased consumption of eggs contribute to eggshell waste, but so do hatcheries, homes, and the food industry ¹²⁸. According to ¹²⁹, eggshells account for approximately 9-12% of total egg weight. If these eggshells are not used and end up as waste, they could pollute the ecosystem.

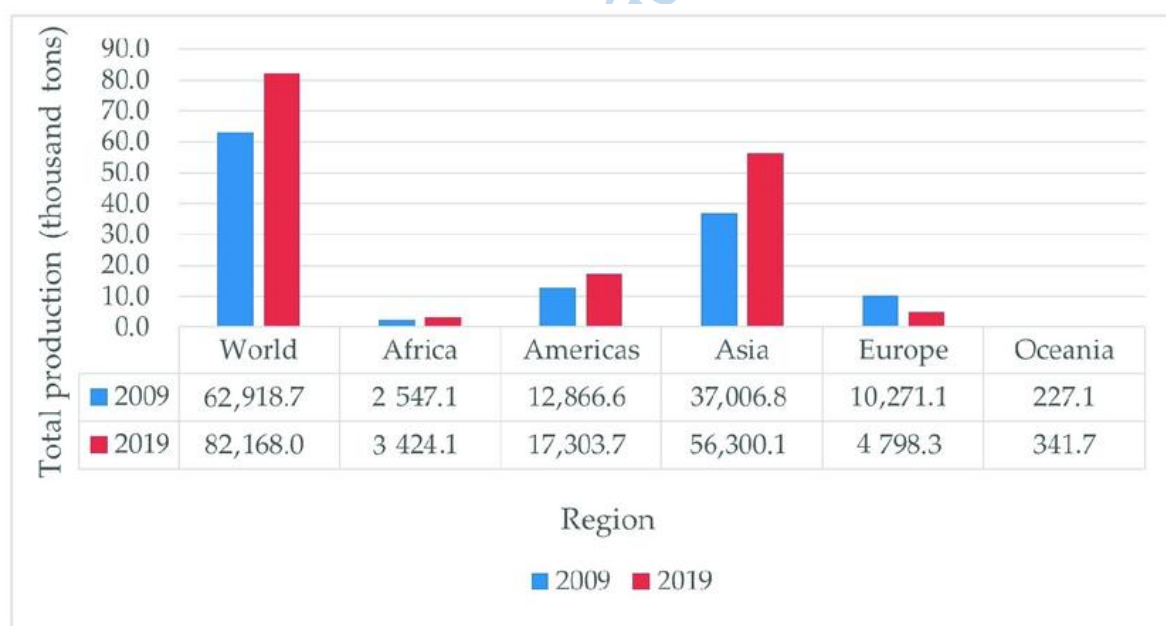


Figure 1 illustrates global and regional chicken egg production between 2009 and 2019 ¹³⁰.

Many studies have reported that chicken eggshells have the potential to be a calcium source^{131,132,133,134}. Nutritional intake, including adequate calcium intake (ranging from 200-1200 mg daily, especially after menopause), has been known as an excellent approach for the maintenance of healthy bone status at all stages, starting from early infancy¹³⁵. The eggshell contains 95% CaCO₃ along with other valuable compounds.

A variety of factors influence eggshell quality, including bird strain or age, induced moult, heat and general stress, diseases, production method, and the inclusion of proprietary goods to meals¹³⁶. As a result, nutritional parameters such as feed composition (calcium, phosphorus, vitamins D, C, E, and A, non-starch polysaccharides, enzymes, and pollutants, such as mycotoxins) and water quality have a significant impact on both eggshell composition and internal egg quality. Many studies have looked at the effect of plant-based ingredients on egg quality, and their influence on the composition of the inner part of the eggs has been confirmed, but the composition of the eggshell has not been analysed, except for physical parameters^{137,138,139,140}.

Table 2.7 Composition of chicken eggshells

Specific Minerals Present in the Eggshell	Unit of Measurement	According to the Prior Research			
		141	142	143	144
Total ash content	g/100 g	89.9–91.1	90.2	N.D. ¹	N.D.
Calcium	mg/100 g	35,100–35,400	35,080	38,200	40,100
Magnesium	mg/100 g	370–400	262.0	N.D.	450
Iron	mg/100 g	N.D.	13.06	N.D.	2.24
Phosphorus	mg/100 g	120	150.2	N.D.	99
Zinc	mg/100 g	N.D.	145.1	N.D.	0.513
Sodium	mg/100 g	150–170	47.9	510	N.D.
Potassium	mg/100 g	100–130	50.00	140	N.D.
Copper	mg/100 g	N.D.	4.1	N.D.	0.77
Manganese	mg/100 g	N.D.	149.9	N.D.	N.D.
Strontium	µg/g	N.D.	N.D.	140	372
Fluorine	µg/g	N.D.	N.D.	N.D.	3.75
Selenium	ng/g	N.D.	N.D.	N.D.	23.5

1. ¹ N.D. = not determined.

Chicken eggshell powder could be an effective way to enhance calcium intakes in rural Sub-Saharan Africa, where calcium consumption is poor and over 85% of rural families raise poultry ¹⁴⁵. Chicken eggshell calcium has comparable bioavailability to CaCO₃. A study with rats found that calcium absorption from a diet including chicken eggshell powder was $45.59 \pm 14.43\%$, not substantially different from the supplement CaCO₃ ($39.88 \pm 16.07\%$) ($p > 0.05$) ¹⁴⁶ Table 2 shows the numerous food products that use chicken eggshell as a calcium source. The usage of eggshells can provide considerable nutritional benefits, most notably an increase in calcium content. However, the success of adding eggshells is determined by the type and pH of the food product. Its addition to bread and biscuits is determined by the desired level of calcium, the acceptability of the product's organoleptic characteristics, and, most importantly, from a technological standpoint, the increase of dough rheological properties, dough volume, and final product texture. The addition of eggshells to sweet confectionery items may have an undesirable effect on the sensory features and acceptability of both flavour and scent. However, the success of adding eggshells is determined by the type and pH of the food product. Its addition to bread and biscuits is determined by the desired level of calcium, the acceptability of the product's organoleptic characteristics, and, most importantly, from a technological standpoint, the increase of dough rheological properties, dough volume, and final product texture. The addition of eggshells to sweet confectionery items may have an undesirable effect on the sensory features and acceptability of both flavour and scent.

Table 2. 8 Application of chicken eggshell powder in food products.

Food Products	Main Findings		References
	Chicken Eggshell Powder Concentration	Notes for Recommendation	
Biscuits	6% (w/w) of wheat flour	Calcium content, texture, sensory characteristics, calcium bioavailability.	147
Bread	8% (w/w) of ingredients	Calcium content, particular amount of bread, and sensory qualities	148
Bread	2% (w/w) of wheat flour	Increase of rheological characteristics of dough and nutritional properties, decrease of the general acceptability and odor score	149
Bread strips	10% (w/w) substitution of wheat flour	Minor alterations in sensory characteristics.	150
Breaded fried meat, bread, pizza, spaghetti	500 mg Ca/person	Minor texture adjustments, no flavour changes.	151
Chocolate cakes	6% (w/w) of wheat flour	Calcium levels, texture, and sensory qualities	152
Chokeberry juice, cranberry juice	1% of chokeberry and cranberry juice	Calcium content in chokeberry and cranberry juice, with no substantial change in colour or sediment content	153
Muffin	8 g/500 g wheat flour	Mineral content and sensory characteristics.	154
<i>Nham</i> (Thai-style fermented pork sausage)	150 mg Ca/100 g of <i>Nham</i> (eggshell powder was converted to eggshell calcium lactate)	There is no change in sensory scores for sour taste, flavour, and overall acceptance.	155
<i>Ser smażony</i> (Polish bread spread)	265 mg/100 g of <i>ser smażony</i>	Calcium concentration increased by more than 2.5 times, and calcium bioavailability improved with the addition of lysine and	156

		vitamin K.	
White bread	1–1.5% (w/w) of ingredients	A high total score in sensory evaluation.	157
White bread	2% (w/w) substitution of bread flour	Consumer Preference for Sensory Assessment	158
Yogurt	0.15–0.30% (w/v) of milk	There are no significant adverse impacts on physicochemical, microbiological, or sensory characteristics.	159
Yogurt (from cow milk and buffalo milk)	0.3% of yogurt (nanosized eggshell powder)	Appropriate structure, consistency, and sensory qualities.	160

2.4.1 Uses of Eggshell Powder in Food Industry

Functional foods are those that have been supplemented with bioactive components that have a favorable influence on human well-being and health while also lowering the chances of developing certain illnesses ¹⁶¹. The most promising yet youngest sector of the food industry is the functional food sub-sector. This increase can be attributed to consumers' rising interest in functional meals, healthy nutrition, food enhanced with natural components, and organic food, particularly those with antioxidant prospects ¹⁶².

Food products derived from these fruits can also be fortified with other components, such as mineral compounds, because prior research has shown that a lack of Ca in diets poses severe problem when compared to the necessary nutritional standards ¹⁶³. Because of its high Ca²⁺ ion content (40%), calcium carbonate (CaCO₃) is now the most used source of calcium in the manufacturing of calcium supplements ¹⁶⁴. Because bioavailability of synthetic calcium carbonate is low, scientists are interested in its natural sources. Preparations created from the exoskeletons of aquatic organisms have recently gained popularity. Nonetheless, this calcium

source has a number of disadvantages, including a relatively high production cost, restricted accessibility, and the risk of heavy metal accumulation like cadmium, lead, and mercury ¹⁶⁵.

Egg shell from a medium sized egg generates roughly 0.750-0.800 g of calcium and other vital micro-nutrients. 1 teaspoon of powder, which contains mgs of elemental calcium as well as other microelements ¹⁶⁶. It has been demonstrated that consuming eggshell-derived calcium improves bone mass and has an anti-rickets effect, strengthens the bones of osteoporotic individuals by reabsorbing calcium. An eggshell's make up is extremely similar to that of the human teeth and bones. Osteoporotic patients are advised to take 0.4-0.5 mg Ca daily to augment their dietary intake. Furthermore, the pharmacological sector exploits eggshells as potent calcium source with extremely high bioavailability: 90% ^{167,168,169}

Food supplementation with other organic calcium sources and chicken eggshells is still relatively unknown. So far, research has focused on the effects of employing poultry shell powder as a source of calcium in wheat breads, chocolate cake, and biscuits. Hassan ¹⁷⁰ found that the calcium content of the generated biscuits was much higher, reaching 0.607, 1.378, and 2.175 g/100 g, respectively.

In a trial, powdered eggshells as reported to produce a positive increase in the calcium content of cake made from chocolate ¹⁷¹ while ¹⁷² reported improved calcium content in wheat breads with no observable changes in aroma, or taste and with better skin appearance, and higher acceptability ¹⁷³. Given the foregoing, it appears reasonable to expand usage of poultry shell in the food sector, particularly in the beverage sub-sector because Ca⁺ and most minerals in the shell are soluble in acidic juices, and as such they can be better absorbed.

2.4.3 A Review Of Functional Foods For The Elderly That Contain Antioxidants And Calcium From Chicken Eggshells Can Reduce The Risk Of Osteoporosis.

Solving environmental issues, such as food waste and loss is equally vital as addressing health concerns. To feed a global population of nine billion by 2050, food waste and loss remain a major challenge. According to the Food and Agriculture Organization of the United Nations ¹⁷⁴ reducing food loss and waste can lower production costs, improve food security and nutrition, and contribute to environmental sustainability by reducing demand on natural resources and greenhouse gas emissions. Food loss and waste refers to the edible components of plants and animals that are produced or harvested for human use but are not consumed ¹⁷⁵. Food waste also comprises edible material that is purposely fed to animals or is a byproduct of food processing that has been redirected away from human consumption ¹⁷⁶. Food waste during consumption ranges from 6-11 kg/person/year in Sub-Saharan Africa and South/Southeast Asia to 95-115 kg/person/year in North America and Europe ¹³³. The Netherlands (579 kg), Belgium (399 kg), and Cyprus (334 kg) have the most per capita food waste in Europe, whereas Greece (44 kg), Malta (62 kg), and Czech Republic (71 kg) have the lowest ¹³⁴. In Poland, around 235 kilogrammes of food are wasted per person each year ¹³⁵. In Arab countries, food loss and waste totalled 210 kg per person/year.

Food waste, including chicken eggshells ¹⁷⁷, duck eggshells ¹⁷⁸, quail eggshells ¹⁷⁹, seashells ¹⁸⁰, oyster shells ¹⁸¹, and fish bones ¹⁸², contain significant levels of calcium, which can help prevent osteoporosis. Eggshell has two potential uses: as a raw material for new product manufacturing and as an operating supply ¹⁸³. Eggshell is a versatile raw material that can be used for food additives, soil amendments, cosmetics, and biomaterial composites. Eggshells can serve as catalysts and sorbents while in operation.

Food has a significant role in maintaining a healthy lifestyle, particularly for the elderly ¹⁴³. Food is the most effective way to replace the body's calcium shortage. However, it may not be sufficient, prompting the hunt for alternate calcium sources that are easily digested. Chicken eggshells are a high-quality source of calcium that can be used in meals. This research examines the potential of chicken eggshells as a functional meal for the elderly to minimize the risk of osteoporosis due to their antioxidant and calcium content.

2.4.3.1 Bone and Osteoporosis

Bone is the primary calcified tissue in vertebrates, serving many purposes including mechanical support, protection, and storage ^{184,185}. Bone is composed of 10% cells, 60% mineral crystals (crystalline hydroxyapatite), and 30% organic matrix ¹⁸⁶. The major cells responsible for bone remodelling are osteoblasts and osteoclasts ¹⁸⁷. The osteoblast is a bone-forming cell that signals osteoclast production. Osteoclasts are specialised multinucleated giant cells that resorb bone ¹⁸⁸. Bone remodelling involves osteoclasts removing old or damaged bone and osteoblasts forming new bone over several weeks ¹⁸⁹.

Cytokines, growth factors, and free radicals ¹⁹⁰. Unbalanced osteoblast and osteoclast activity can cause osteoporosis ¹⁹¹. Osteoporosis is an age-related health condition that causes reduced bone mineral density, degradation of bone microarchitecture, decreased bone mass, and increased bone fragility ^{192,193}. Osteoporosis can lead to fragility fractures and reduce quality of life in populations. Osteoporosis risk factors are classified as modifiable or un-modifiable. Modifiable factors include oxidative stress-related factors, such as low antioxidant status ¹⁹⁴. Low calcium consumption is a major contributor to osteoporosis, resulting in inadequate bone health.

Previous research reported the prevalence of osteoporosis. Despite existing preventive medications, the elderly are more likely to develop osteoporosis ¹⁹⁵. Osteoporosis is more

prevalent in women than men and rises dramatically after menopause ¹⁹⁶. Postmenopausal osteoporosis is caused by a lack of oestrogen, which affects bone mineral density and causes bone loss through increased osteoclastic activity ¹⁹⁷.

Recent research suggests that ovariectomy triggers the T-cell costimulatory cytokine LIGHT (lymphotoxin-like inducible protein), which promotes osteoblastogenesis and osteoclastogenesis by regulating osteoclastogenic cytokine expression ¹⁹⁸. LIGHT was discovered to mediate ovariectomy-induced bone loss, indicating that LIGHT antagonism has a beneficial effect in patients with postmenopausal osteoporosis.

Osteoporosis affects 9% of women over 50 in the UK, 15% in France and Germany, 16% in the US, and 38% in Japan. Males aged 50 and above had rates of 1% in the UK, 4% in Japan, 3% in Canada, and 8% in France, Germany, Italy, and Spain ¹⁹⁹. Elderly males with anaemia and a history of fractures are more likely to develop osteoporosis ²⁰⁰. Approximately 80% to 90% of Polish osteoporosis patients, including those with fractures, do not receive adequate treatment ²⁰¹.

Osteoporosis affects 9% of women over 50 in the UK, 15% in France and Germany, 16% in the US, and 38% in Japan. Males aged 50 and above had rates of 1% in the UK, 4% in Japan, 3% in Canada, and 8% in France, Germany, Italy, and Spain ²⁰².

2.4.3.2 Factors Supporting Calcium Absorption

Calcium absorption is just as crucial as the high calcium content. Some factors that positively influence calcium absorption have been described, including an acidic bowel (particularly for CaCO₃ absorption), oestrogen, vitamin D, soluble fiber/prebiotics (inulin, fructooligosaccharose, and oligofructose), probiotics, and synbiotics ^{203,204,205}.

Although studies on the bioavailability of calcium from eggshells in people are limited, they do demonstrate its potential. Schaafsma and Pakan ²⁰⁶ investigated the short-term effects on

lumbar spine and hip bone mineral density in adults who took dairy-based supplements including eggshell powder. The results showed that bone mineral density in the lumbar spine, whole proximal femur, and trochanter rose significantly, indicating that eggshell powder is a source of bioavailable calcium. Other studies on the effect of eggshell eating found that healthy late postmenopausal women with adequate calcium intake at baseline could increase hip bone mineral density within a year of supplementation ²⁰⁷

2.4.3.2.1 Vitamin D

There is a "calcium paradox," which states that hip fractures are more common in western countries with calcium-rich diets, whereas they are less common in developing countries with calcium-deficient diets. This paradox can be partially understood by looking at the vitamin D concentration of the local population's serum ²⁰⁸Vitamin D is required for calcium and bone metabolism since it is the primary agent regulating calcium homeostasis and absorption ^{209,210}. Vitamin D deficiency can cause bone loss, accelerated bone turnover, osteoporosis, and fractures ²¹¹. Vitamin D comes in two primary types. The first is vitamin D2 (ergocalciferol), which is produced by UV-B radiation on ergosterol, a vitamin D precursor found naturally in plants, fungi, and invertebrates. The second is vitamin D3 (cholecalciferol), which is produced by sunlight from 7-dehydrocholesterol, a cholesterol precursor that can also function as a provitamin D3 ²¹². Although the majority of vitamin D (90%) is endogenous (produced in the skin by UV irradiation), it can also be found in some foods such as eggs, beef, seafood (salmon, tuna, sardines, herring), mushrooms, and dairy products ²¹³. It is important to be concerned about the food sources of vitamin D because the rate of cutaneous vitamin D synthesis is lowered in aged persons, putting them at danger. The activation of vitamin D is required in the human body. Serum 25-hydroxyvitamin D (25OHD), which serves as an intermediary component before generating the final physiologically active

vitamin D, is a marker for estimating a person's vitamin D nutritional status ^{214,215,216}. A 25OHD level of less than 27-30 nmol/L is associated with rickets, whereas a level of at least 50 nmol/L (20 ng/mL) is considered sufficient, despite the fact that the ideal level for intestinal calcium resorption is approximately 80 nmol/L ^{217,218,219}. Vitamin D is hydroxylated in the liver to 25OHD and then transformed in the kidney to 1,25-dihydroxy vitamin D, the most active metabolite that stimulates calcium and phosphate absorption from the gut while also influencing bone cells ^{220,221}.

Some studies on vitamin D, particularly to improve calcium absorption in the elderly, were described. According to meta-analyses, vitamin D supplementation alone is unlikely to reduce fracture risk; calcium supplementation alone has a moderate effect in lowering fracture risk (about 10%), but its long-term effectiveness is poor ²²². Combining vitamin D and calcium treatment, particularly for those with low vitamin D levels (<60-80 nmol/L blood 25OHD), can prevent fractures, including hip fractures ²²².

2.4.3.2.2 Prebiotics, Probiotics, and Synbiotics

Prebiotics are nondigestible fibres that help microorganisms in the stomach ferment nutrition and energy sources, improving their viability ²²³. Prebiotics have been linked to increased calcium absorption and a lower risk of osteoporosis, according to multiple studies. Fructans, including inulin, oligofructose, and fructooligosaccharide, can improve calcium absorption with a daily intake of 4 to 8 g ²²⁴. Gut microbes ferment fructans, lowering the pH in the colon and increasing macromineral absorption, including calcium. Calcium is converted to ionic form in acidic environments, making it more soluble and bioavailable ^{225,226,227}. Prebiotic fibre fermentation produces an acidic environment through short-chain fatty acids. This, combined with low pH, causes mucosal cell hypertrophy, leading to increased surface area and improved calcium absorption ²²⁸. Prebiotics can boost gut microbial growth,

benefiting the elderly and reducing bifidobacteria levels ^{229,230}, potentially impacting bone health. Including prebiotics in calcium-rich foods may lessen the incidence of osteoporosis in the elderly. A study ²³¹ found that inulin-type fructans, particularly short-chain fructooligosaccharide, increased calcium uptake from calcium-enriched gluten-free bread and stimulated intestinal bacteria (*Lactobacillus*, *Enterococcus*, and *Enterobacteriaceae*) to produce organic acids ($p < 0.05$). ²³² studied the calcium absorption of skimmed milk fortified with fibre Blend-I (psyllium husk, oat fibre, MCC, inulin), Blend-II (psyllium husk, oat bran, wheat fibre, and inulin), and the control (cellulose). Calcium absorption rates for fibre Blend-I, Blend-II, and cellulose were $94.4 \pm 1.9\%$, $96.3 \pm 1.32\%$, and $88.8 \pm 4.9\%$, respectively. The study found no significant difference in calcium absorption across groups ($p > 0.05$), suggesting that adding dietary fibres to dairy products can enhance their nutritious value. Probiotics' influence on calcium absorption has been investigated.

Probiotics increase mineral bioavailability by producing short-chain fatty acids, decreasing parathyroid hormone (PTH) levels, producing phytase to overcome mineral deficiency caused by phytate, and reducing intestinal inflammation which influences calcium absorption ^{233,234}. According to Gilman and Cashman ²³⁵, *Lactobacillus salivarius* dramatically increased calcium uptake in Caco-2 cell monolayers after 24 hours ($p < 0.05$). A study of postmenopausal women found that consuming a probiotic with three strains (*Lactobacillus paracei* 8700:2, *Lactobacillus plantarum* Heal 9, and *Lactobacillus plantarum* Heal 19) reduced bone mineral density loss by 0.71% compared to a placebo ($p < 0.05$) [145]. Scholz-Synbiotics, a combination of prebiotics and probiotics, have shown promising results.

As previously stated, the probiotic did not significantly influence bone mineralisation or gut ecology ²³⁶ Prebiotic-fed rats had higher calcium absorption, lower pH in cecal and colonic contents, and improved calcium balance ($p < 0.01$). However, synbiotics were found to have a greater synergistic effect on bone mineralisation ²³⁷.

2.4.4 Comprehensive Utilization of Eggshell Powder

The broad ranges of eggshell powder usage are described below.

1. **Cement:** The production of construction materials has a considerable environmental impact. As infrastructure development has accelerated, so has the demand for cement-based materials. Cement is a commonly utilised substance around the world. The production of cement increased rapidly in the 2000s, reaching 4000 million tonnes in the last decade. China has been responsible for more than 50% of cement output in recent years ²³⁸. The manufacturing and use of cement has contributed to 8% of worldwide CO₂ emissions ²³⁹, of which 50% is linked with clinker production and 40% is associated with fuel combustion.

Large-scale infrastructure projects are underway all over the world, and cement raw materials are geologically abundant, thus a decline in cement usage is unlikely in the foreseeable future. It is estimated that around 0.9 kg of CO₂ was emitted each kilogramme of cement produced ²⁴⁰, with more than 90% of the CO₂ emitted during the calcination process and fuel combustion ²⁴¹. Furthermore, the usage of nonrenewable resources in cement production has resulted in another environmental hazard. As a result, industry experts and researchers have devised novel solutions to address these escalating problems ²⁴².

According to the published literature, various investigations have been done to find alternate materials for cement. Converting waste materials into cement replacement may reduce cement use as well as the environmental problems created by open trash disposal ²⁴³. Trash materials are split into two categories: industrial byproducts and agricultural trash. The use of industrial byproducts as a cement alternative has been extensively investigated. These

investigations found that the addition of volcanic pozzolanas ²⁴⁴, fly ash ²⁴⁵, granulated blast furnace slag ²⁴⁶, silica fume ²⁴⁷, metakaolin ²⁴⁸, and limestone ²⁴⁹ improved the properties of cementitious materials while lowering their cost. There has also been research on using agricultural waste as a cement alternative. For example, rice husk ash ²⁵⁰ oyster shell ash ²⁵¹, sugar cane bagasse ash ²⁵², and sawdust ash ²⁵³ have all been utilised as partial replacements for cement. Even though industrial byproducts shown better mechanical behaviour, employing agricultural wastes has advantages such as being widely available, affordable, low density, biodegradable, energy-efficient, and environmentally beneficial. Eggshells, or the hard outer coating of an egg, are one type of agricultural waste. Eggshell compartments account for approximately 10% of the egg weight ²⁵⁴. Global egg production is gradually expanding, and it is predicted to generate more than 8 million tonnes of eggshell trash per year.

Although eggshells have a variety of applications, including the preparation of calcium phosphate ceramics, the raw material for biodiesel and as an adsorbent in the removal of ionic contaminants and fertiliser ²⁵⁵, a huge volume of eggshells are wasted and dumped on the land. Eggshells contain calcium carbonate, which is a primary chemical component necessary to produce binder gel (Calcium Silicate Hydrate) in cementitious materials. As a result, in powder form, it can be utilised to substitute cement in construction materials.

2. Sustainable Environment: In addition to the basic needs of food and shelter, the world's growing population necessitates a variety of resources for survival. As a result, urbanisation has expanded, as has food demand, resulting in increased food waste output. This challenge was exacerbated by the sluggish development of waste management technologies. Food waste, as a store of nutrients, can be used to manufacture a variety of value-added goods. Eggshells are one of the most common

types of food waste, and the fact that they are a precious commodity adds to the difficulty²⁵⁶

Egg consumption has increased in recent years, owing to increased affluence and dietary acceptance. This trend is more visible in developing countries, where the populace accepts eggs as a source of high-quality protein, influencing consumer purchase decisions. According to the World Agriculture Supply and Demand Estimates study, egg consumption in the United States alone is predicted to rise from approximately 7951.8 million dozen in 2019 to more than 8000 million dozen by 2020.

Per capita yearly egg consumption in the United States is estimated to be approximately 280 eggs in 2019, making it the highest egg consumption level in the preceding ten years. The United States Department of Agriculture (USDA) estimates that consumption will reach 8917 million dozen by 2028²⁵⁷. Japan, Paraguay, and China have the highest yearly egg consumption numbers, with individuals consuming 320, 309, and 300 eggs, respectively²⁵⁸. This spike in egg consumption has caused a commensurate boom in egg production internationally. For example, in the United States, egg production was recorded to be approximately 9334 million dozen in 2019 and is predicted to reach over 9410 million dozen in 2020.

The similar scenario is projected to play out globally, with egg output remaining stable or slightly increasing in the world's largest markets²⁵⁹. Egg production has increased by more than 150% over the last 30 years, with even greater success seen in Asia, where production has quadrupled. In 2016, India had a 30-year high output yield of approximately 83 billion eggs²⁶⁰. These huge quantities of eggs are used at both the residential and industrial levels to create and process foods for nourishment. Higher egg production generates more eggshell trash, which is typically discarded and disposed of in landfills. China led global eggshell production in 2019 with 24.8 billion kilogrammes, and it is predicted to increase to more than

35 million metric tonnes by 2020. Figure 1 depicts the world's major eggshell waste generators ²⁶¹, whereas Table 1 depicts the top egg-producing countries and their estimated eggshell waste. The Environmental Protection Agency has identified eggshell waste as the 15th main food industry pollution hazard. They are regarded a major cause of environmental pollution when not properly disposed of in designated areas, posing health risks later due to fungus growth on these eggshells ²⁶² Furthermore, non-effective waste disposal becomes crucial for the survival of not only humans, but also other eco-system contributors such as animals and plants. The vast majority of the waste eggshell produced is disposed of in landfills, which have already reached their limit.

Aside from that, many landfill operators avoid eggshells since the protein-rich membrane attracts rats and other vermin. Although eggshell is considered a waste product of the food industry, it should also be considered a highly sophisticated composite ²⁶³. With time, it is becoming clear that without rapid and substantial action, the worst-case climate scenario will become the norm rather than the exception ²⁶⁴. In this age of ever-increasing efforts to convert waste to wealth, it is critical to transform garbage into usable commodities for long-term growth. To accomplish this, we should aim to recycle, reuse, and channel waste goods while also directing our resources towards making high-value items. The efficiency of turning waste eggshell

Though fertilised, unfertilised, and embryo eggs have been used since prehistoric times for nutrition and treatment of a variety of diseases, it is important to remember that eggshells were primarily used to generate new life and were not intended for human consumption. One of the most significant tasks of eggshell is to provide a physical barrier that prevents pathogens from infiltrating cells. Because of the many pores on its surface, the eggshell also serves as a gas exchange medium ²⁶⁵

3. Pharmaceuticals: CaCO_3 shell has been utilized in the treatment of calcium insufficiency in people and animals ^{266,267}. An eggshell weighs six grammes and contains around 0.22 g of calcium. The eggshell particles are utilized as anti-tartar ingredient in toothpaste ²⁶⁸. Eggshell powder has been used to promote bone mineralization and growth ^{269,270}.

4. Food: Eggshells have recently been used to make calcium lactate, which is used as leavening agent, nutrient supplement, firming agent, thickener, flavour enhancer, and stabilizer ^{271,272}. They are also employed as calcium supplements in orange juice production ²⁷³.

5. Animal feed.

Eggshell contains proteins and minerals like calcium. Eggshells are recommended as a calcium addition in animal feed to meet livestock's daily calcium requirement ²⁷⁴. Research has also shown that eggshell powder in animal feed plays an important function in providing calcium supplies to chickens for egg laying ²⁷⁵. The Association of American Feed Control Officials has decided to augment feed with eggshell powder for livestock animals.

6. Others: They are introduced into the soil as fertilizers to condition the soil ^{276,277} and in the animal feed industry as feed supplement ^{278,279}. Interestingly, in recent times the CaCO_3 of the shell serves as a coat pigment in printing machines ²⁸⁰ in making paper pulp ²⁸¹ while in biodiesel production, it is used as a catalyst because of its low cost. In addition, they are included as precursor for calcium in the production of calcium-based metal-organic frameworks ²⁸². And as a biofiller to increase its sensitivity when combined with a conducting polymer. Naturally, as biofiller in detecting ammonia gas leak in polyaniline matrix, egg shells are used ²⁸³.

2.5 Calcium Requirements

Table 2. 9 Calcium requirements by age and reproductive status and contribution of 1 g of chicken eggshell as a percentage of the recommended intake (RI)

Human life stage	Calcium RI (mg)	Percentage of RI (%)
Infants and children		
0–6 months	300	126
7–12 months	450	84
1–3 years	500	76
4–6 years	550	69
7–9 years	700	54
10–18 years	1,000	38
Adult—females		
19 years—menopause	750	50
Post menopause	800	47
Pregnant (last trimester)	800	47
Lactating	750	50

Note: 1 gramme of chicken eggshell meets the "WHO/FAO theoretical calcium allowance for animal protein intake 20-40 g" recommended intake (RI) (World Health Organisation, 2003). Calcium for chicken eggshell was determined using the mean of three scientific papers measuring content, which was around 378 mg (SD = 14.8) ²⁸⁴

Protein and sodium intakes influence calcium requirements, and in general, populations in developing nations consume less sodium and animal protein than those in developed ones

²⁸⁵ Based on the estimated average calcium content of eggshells of 378 mg ²⁸⁶and the WHO recommended intakes of calcium for adult females aged 17 to menopause consuming diets with a low animal protein intake ²⁸⁷, approximately half the eggshell from a 42g egg would provide the WHO recommended intake of 750 mg. Furthermore, this would deliver six times the amount of calcium now found in Australian.

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Table 2.10 Calcium intake recommendations required to ensure calcium adequacy for the majority of women and children

	WHO/FAO (animal protein intake 20–40 g)^a	Canada and United States^b	Australia^c	WHO/FAO (developed countries)^d
	2004	2010	2006	2004
Human life stage	Recommended intake (RI) (mg/day)	Recommended dietary allowance (RDA) (mg/day)	Recommended dietary intake (RDI) (mg/day)	Recommended intake (RI) (mg/day)
Infants and children				
0–6 months	300	200 ^e	210 ^f	300
7–12 months	450	260 ^e	270 ^f	400
1–3 years	500	700	500	500
4–5 years	550	1,000	700	600
6 years	550	1,000	700	600
7–8 years	700	1,000	700	700
9 years	700	1,300	1,000	700
10 years	1,000	1,300	1,000	1,300
11 years	1,000	1,300	1,000	1,300
12 years	1,000	1,300	1,300	1,300
13–14 years	1,000	1,300	1,300	1,300
15–18 years	1,000	1,300	1,300	1,300
Adult-females				
19 years—menopause	750	1,000	1,000	1,000
Postmenopause	800	1,200	1,300	1,300
70+ years	800	1,200	1,300	1,300
Pregnancy (<18 years)	-	1,300	1,300	-
Pregnancy (>18 years)	800	1,000	1,000	1,200
Lactating	750	1,000	1,000	1,000
Adult - males				
19–50 years	750	1,000	1,000	1,000
51–65 years	750	1,000	1,000	1,000
66–70 years	800	1,000	1,000	1,300
70+ years	800	1,200	1,300	1,300

- a. Theoretical calcium allowance. Values based on low calcium excretion. (WHO, 2003).
- b. (Health Canada, 2010).
- c. National Health and Medical Research Council (2006).
- d. Based on statistics from Western Europe, America, and Canada (World Health Organization, 2003).
- e. Acceptable intake. f. Adequate intake

There were five articles on eggshell preparation for human food, which featured a variety of methods such as sterilisation, disinfection, and mechanical processing. Sterilisation is the process of destroying or removing all microorganisms, whereas disinfection is the killing, inhibiting, or removal of disease-causing germs²⁸⁸ Eggshells were sterilised using laboratory equipment such as an automatic steriliser autoclave²⁸⁹. Chemical treatments such as sodium hypochlorite (bleach) oxidise cellular components and kill vegetative bacteria and fungus, although not all spores are destroyed²⁹⁰. Temperatures above 100°C or saturated steam under pressure are necessary to sterilise bacterial endospores²⁹¹ Almost all microorganisms die within 30 minutes at 0.1-0.5% sodium hypochlorite concentrations²⁹² Disinfection procedures use 1-2% sodium hypochlorite and/or boiling water²⁹³ A typical household kitchen in SSA lacks the chemical agents and equipment needed to sterilise eggshell; but, equipment for disinfection, such as boiling, is likely to be present and was chosen as the most practical method. Placing eggshell in boiling water disinfects, but the time required for removal varies depending on the organism. After disinfection, key components for preparation included smashing eggshell into a powder form with finer grinding of powder particles, which reduced the impact on overall meal texture²⁹⁴The majority of mechanical processing preparation methods employed commercial equipment (e.g., Retsch GmbH MM2001, mixer mill), although some used rolling pins, ovens, and other household objects to mechanically treat eggshell.

Pastoral de Criança, a nonprofit organisation that assists Brazil's undernourished communities, teaches families how to make nutritious powder to help them satisfy their nutritional needs. This powder has eggshell as one of its components. The original procedure for ensuring eggshell safety for ingestion employs home methods, such as immersing the eggshell in a bleach solution for 20 minutes before boiling it in water for 20 minutes.²⁹⁵ examined the approach with shorter boiling and bleaching times, as well as two different drying processes:

sun drying for 2 hours and oven drying at 60°C for 1.5 hours. Both procedures offered adequate protection, but the sun-dried sample had some microbial contamination ²⁹⁶ also examined two methods of preparation: 1% sodium hypochlorite solution for 5 minutes followed by 10 minutes in boiling water, or boiling water for only 10 minutes. According to the Brazilian microbiological standard, both treatments demonstrated excellent cleanliness, with no Salmonella discovered in either sample ²⁹⁷

Based on these findings, we developed a preparation method that incorporates the WHO's "Five keys to safer food" (a program meant to prevent germs from causing illness):

1. Wash your hands before handling eggshell.
2. Clean and sanitise all food preparation surfaces and equipment.
3. Wash the broken eggshell (contents removed/used) under water.
4. Roughly smash the eggshell, and take off the eggshell membrane.
5. Boil eggshells for 10 minutes.
6. Dry eggshell in a low oven or sun-dry on a clean tray.
7. Crush eggshell in a mortar and pestle until it has a powder consistency.
8. Store in an airtight container.

46 women of reproductive age took part in the focused groups, which lasted 48 to 72 minutes. The authors ended after five focused groups since data saturation was evident ²⁹⁸ All Focused groups shared themes such as the ease of preparing and using ground eggshell, the availability of eggshell and equipment, skills and human resources, and batch preparation procedures. The majority of participants stated that they do not consume eggs on a regular basis due to low poultry ownership, which is related with chicken deaths, low productivity of laying poultry, eggs being kept for reproduction and money, and eggs being an expensive food item to buy.

Most participants discussed the need of selling chickens (and occasionally eggs) to generate revenue; nonetheless, the majority expressed a wish to consume more eggs. The answer to the question "What is currently done with eggshells?" was "They are disposed of," with only one member putting the eggshell to her chicken feed. As a result, shells from any accessible egg are available. All groups agreed that they had all of the necessary equipment for eggshell preparation, including a clay pan, local stove, firewood, metal pan, plate, wooden spoon, water and a local grinder (kinu nan mchi).

When discussing the eggshell preparation method, participants from all focused groups agreed that they had ample time to test the idea within their usual schedule. Overall, participants spend an average of 3 hours each day cooking meals. There was disagreement as to whether making a huge batch or one eggshell at a time would be more appropriate. Many participants believed that preparing a batch would be simpler, allowing the work to be completed less frequently.

However, many people understood that the supply of eggs to make a huge batch was a major issue. Others questioned the method of crushing the eggshell with the local grinder, preferring to mill the eggshell alongside the flour using a machine. All groups identified ugali and mlenda as their staple foods. Ugali is a stiff porridge made from maize or sorghum and boiled in water. Mlenda is formed from green leaves, usually cowpea leaves or young baobab. In addition, the concept of adding powders to food is well known. Powdered spices were commonly mentioned, yet the majority of people connected spices with flavouring food.

Adding nutritional supplements to food was a novel notion, with no participants having previously used them. Eggshells are widely seen as a waste product, and almost all participants dispose of them. When the idea of eating eggshell was presented to each group, there was a surprising reaction, with individuals giggling or chatting discreetly.

Some described the concept as "like what chickens do," implying that they had never related eggshell with human nutrition or considered it a human food. Nonetheless, after the notion was described and accepted by participants, the idea of consuming something that would typically be tossed seemed reasonable. In general, participants had little idea of why eggshell would be beneficial to their health, and they knew nothing about calcium beforehand. Some individuals declined to remark on potential health benefits until they had tasted ground eggshell.

This implies that participants associate nutrition and health with taste, subjective sensations of health, and if something is considered common practice. When asked who in their family would benefit the most, no one named pregnant women or breastfeeding. Children were frequently mentioned, with the logic being that they require a lot of nourishment to grow.

The three most common concerns concerning eggshell ingestion stated during the focused groups were the flavour of the crushed eggshell, the possibility of overdose, and gastrointestinal issues. Responses to the eggshell experiment were divided, although most participants thought it was a fantastic idea, very beneficial, and would like to try it.

Endnotes

- [1] Chikeme, P & Chibueze, P & Ndukwe, P & Nwanndi, M & Chidera, P & Okoye, P & Tope, Victor-Aduloju. Proximate and Mineral Properties of Smoothie Fortified with African Bread Fruit and Cashew Nut. (2023). 235-239.
- [2] M.O., Ekong, Freedman, B-R, Agbiji, N.N., Ibiang-Abam, E.F., Ekpenyong, G.M., Otire, G. A., and Bisong, J.A. "Bacteriological Evaluation of Locally Prepared Smoothies Formulated from Different Fruit Combinations". *Asian Journal of Food Research and Nutrition* 3 (3): (2024) 600-608.
- [3] Milczarek, Rebecca R., Carl W. Olsen, and Ivana Sedej. "Quality of Watermelon Juice Concentrated by Forward Osmosis and Conventional Processes." *Processes* 8, no. 12 (2020): 1568.
- [4] Korn, Leslie E. *Rhythms of Recovery: Integrative Medicine for PTSD and Complex Trauma*. Routledge, 2023.
- [5] DeNotto, Michael. "Food and Drink in History." *The Charleston Advisor* 22, no. 3 (2021): 23-28.
- [6] Ranga, Leocardia & Noci, Francesco & Dermiki, Maria. Insect-Based Foods: A Preliminary Qualitative Study Exploring Factors Affecting Acceptance and New Product Development Ideas through Focus Groups. *Challenges*. 15. 40. (2024).
- [7] Jeff Olsen "Mayo Clinic Minute: Get smart about smoothies". (2017).
- [8] Quang Duc Tran, Thi Hoa Huyen Nguyen, Cu Linh Le, Lan Van Hoang, Thi Quynh Chi Vu, Ngoc Quang Phan, Thi Thuy Bui. Sugar-sweetened beverages consumption increases the risk of metabolic syndrome and its components in adults: Consistent and robust evidence from an umbrella review, *Clinical Nutrition ESPEN*, Volume 57, (2023) Pages 655-664,
- [9] Tao, Jingjing. "Alert: Ultra-processed Food Is Overwhelming American's Diet." *Journal of Agricultural Science* 14, no. 4 (2022).
- [10] Darla Stoker, Carrie Durward. "Smoothies—Helpful or Harmful?". *Nutrition Extension - Utah State University*. (2022).
- [11] Kraak, Vivica I., and Katherine Consavage Stanley. "A Systematic Scoping Review of Media Campaigns to Develop a Typology to Evaluate Their Collective Impact on Promoting Healthy Hydration Behaviors and Reducing Sugary Beverage Health

Risks" International Journal of Environmental Research and Public Health 18, no. 3: 1040. (2021).

- [12] Gumussoy, Maya, Chloe Macmillan, Stephanie Bryant, David F. Hunt, and Peter J. Rogers. "Desire to eat and intake of 'insect' containing food is increased by a written passage: The potential role of familiarity in the amelioration of novel food disgust." *Appetite* 161 (2021)
- [13] Darla Stoker; Carrie Durward. "Smoothies—Helpful or Harmful?". Nutrition Extension - Utah State University. (2022)
- [14] Sigal, Abdulkadir Yussuf, Jesus Lopez Garcia, and Maria Valeria Theall. "Stuffed, flavored and packaged olives." U.S. Patent 10,842,181, (2020).
- [15] Kontak, Julia C., Hilary AT Caldwell, Rena Kulczycki, Camille L. Hancock Friesen, and Sara FL Kirk. "Process and experience of youth researchers within a Health Promoting Schools study in Nova Scotia, Canada." *Health Promotion International* 38, no. 6 (2023)
- [16] Harvard Heart Letter, Harvard Medical School. "Drink your fruits and vegetables?" (2018).
- [17] NBC News. "How to build a better smoothie, according to a nutritionist". (2022).
- [18] Puregreenfranchise.benefits-of-drinking-healthy-smoothies. (2021).
- [19] Gbarakoro, S.L., Adooh, L.S.K., & Akinfolarin, O.M. Effects of natural and artificial fruits ripening agent on the pH of selected fruits in PortHarcourt Nigeria. *Asia Journal of Science and Technology*, 12(2) (2021). 11535-11539.
- [20] Alake, O.T., Abraham, D.O., Akinola, T.O., Fatunmibi, O.O., Agboola, T.O., & Akua, S.I. Production and evaluation of smoothies made from various fruits sold in Lagos market. *International Journal of Innovative Science and Research Technology*, 7(1), (2022). 642-646
- [21] Vitor-Aduloju, A.T., Nwanja, N.M., Ezegbe, CC., Okocha, K.S., & Aduloju, T.A. Phytochemicals and vitamin properties of smoothie flavoured with mint leaves extract. *International Journal of Biochemical Research and Review*. 29(7), (2020). 24-30.

- [22] Delarue, J. Overview of sensory methods for the evaluation of nonfood products. *Non-food sensory practice*. (2022).
- [23] Fuentes, S., Gonzalez Viejo, C., Torrico, D. D., & Dunshea, F. R. Digital Integration and Automated Assessment of Eye-Tracking and Emotional Response Data Using the BioSensory App to Maximize Packaging Label Analysis. *Sensors (Basel, Switzerland)*, 21(22), (2021). 7641.
- [24] Renner, Susanne S.; Wu, Shan; Pérez-Escobar, Oscar A.; Silber, Martina V.; Fei, Zhangjun; Chomicki, Guillaume."A chromosome-level genome of a Kordofan melon illuminates the origin of domesticated watermelons". *Proceedings of the National Academy of Sciences*. 118 (23): (2021).
- [25] Van der Veen, Marijke. *Van der Veen 2022 Crop Prevalence and surplus production in Roman and medieval Northeast England*. (2023).
- [26] Paris, Harry S. "Origin of the Dessert Watermelon." In *The Watermelon Genome*, pp. 1-16. Cham: Springer International Publishing, (2023).
- [27] Barron, Aleese. "Applications of microCT imaging to archaeobotanical research." *Journal of Archaeological Method and Theory* 31, no. 2 (2024): 557-592.
- [28] Iftikhar, Muhammad Sarmad & Cheema, Hafiza & Khan, Asif & DeLacy, Ian & Basford, Kaye. Genetic diversity assessment of cucumber landraces using molecular signatures. *BMC Genomics*. 25. (2024).
- [29] Jordana, Carley N., Suzanne C. Stapleton, James C. Colee, Sangyoul Lee, Zhifeng Gao, Zachary T. Ray, Lucas R. Anrecio, Daniel J. Freed, and Xin Zhao. "How does watermelon grafting impact fruit yield and quality? A systematic review." *HortScience* 58, no. 8 (2023): 836-845.
- [30] Rotimi, Damilare E., and Rotdelmwa M. Asaleye. "Impact of Watermelon (*Citrullus lanatus*) on Male Fertility." *JBRA assisted reproduction* 27, no. 4 (2023): 702.
- [31] He, Lei, Yifan Yan, Min Wu, and Leqin Ke. "Advances in the Quality Improvement of Fruit Wines: A Review" *Horticulturae* 10, no. 1: 93. (2024).
- [32] Lunsford, Lindsey, Melvin L. Arthur, and Christine M. Porter. "African and Native American foodways and resilience: From 1619 to COVID-19." *Journal of agriculture, food systems, and community development* 10, no. 4 (2021): 241.

- [33] Holtermann, Callie "Why the Watermelon Emoji Is a Symbol of Support for Palestinians". The New York Times. (2023)
- [34] "Watermelon: A slice of Palestinian resistance". Middle East Eye. 17 August (2022).
- [35] Sharon, Jeremy "Activists use watermelons to protest police crackdown on Palestinian flags". The Times of Israel. (2023).
- [36] Hartman, Jordan L., Penelope Perkins-Veazie, and Todd C. Wehner. "Citrulline and Arginine Are Moderately Heritable in Two Red-fleshed Watermelon Populations", *HortScience horts* 54, 2 (2019): 200-205
- [37] Gu, I.; Balogun, O.; Brownmiller, C.; Kang, H.W.; Lee, S.-O. Bioavailability of Citrulline in Watermelon Flesh, Rind, and Skin Using a Human Intestinal Epithelial Caco-2 Cell Model. *Appl. Sci.* (2023), 13, 4882.
- [38] Food and Agriculture Organization of the United Nations". *Fao.org*. Watermelon | Land & Water. Food and Agriculture Organization of the United Nations | Land & Water. (2023).
- [39] Lončarević, N., Liu, U., Stefanaki, A. et al. Database of European vascular plants red lists as a contribution to more coherent plant conservation. *Sci Data* **11**, 1138 (2024).
- [40] Adame, Jesús Juan & Cevallos-Espinosa, Judith. Pineapple cultivation under tree canopies of ancestral agroforests in Mexico. *Tropical Forest Issues*. (2024).
- [41] Leko, B.J., Olawuyi, S.T. & Okon, L.U. The mitigating effect of *Ananas comosus* on aluminum-induced oxidative stress on the testes of adult male Wistar rats. *JoBAZ* 82, 12 (2021).
- [42] Food and Agriculture Organization of the United Nations". *Fao.org*. Watermelon | Land & Water. Food and Agriculture Organization of the United Nations | Land & Water. (2023).
- [43] Nweze, Chibuzo & Abdulganiyu, M & Erhabor, Osas. COMPARATIVE ANALYSIS OF VITAMIN C IN FRESH FRUITS JUICE OF *Malus domestica*, *Citrus sinensi*, *Ananas comosus* AND *Citrullus lanatus* BY IODOMETRIC TITRATION. (2019).

- [44] Maluin, Farhatun Najat. "Enhancing Chitosan Nanofilm with Agricultural Waste Fillers for Sustainable and Safe Functional Food Packaging." *ACS Agricultural Science & Technology* (2024).
- [45] Wafaa M. Hikal, Abeer A. Mahmoud, Hussein A. H. Said-Al Ahl, Amra Bratovic, Kirill G. Tkachenko, Miroslava Kačániová, Ronald Maldonado Rodriguez. Pineapple (*Ananas comosus* L. Merr.), Waste Streams, Characterisation and Valorisation: An Overview. *Open Journal of Ecology*, Vol.11 No.9, September 3, (2021).
- [46] Villalobos Olivera, Ariel & NÁPOLES, LELURLIS & MENDOZA, JOSÉ & Escalante, Doris & Martínez, J. & CONCEPCIÓN, OSCAR & Zevallos, Byron & Martinez-Montero, Marcos & Cejas, Inaudis & Engelmann, F. & Vicente, Oscar & Lorenzo Feijoo, José. Exposure of pineapple shoot tips to liquid nitrogen and cryostorage do not affect the histological status of regenerated plantlets. *Romanian Biotechnological Letters*. (2019).
- [47] Maluin, Farhatun Najat. "Enhancing Chitosan Nanofilm with Agricultural Waste Fillers for Sustainable and Safe Functional Food Packaging." *ACS Agricultural Science & Technology* (2024).
- [48] Parvez, G M Masud & Tonu, Jannatul & Ara, Rawshon & Joarder, Md & Milon, Mohammad & Sarker, Ranjan & Naznin, Most & Sahadat Hossain, Md & Sultana, Razia & Parvin, Shumaia & Kader, Md. Phytochemical and antioxidant comparison of different varieties of banana. *Journal of Pharmacognosy and Phytochemistry*. 12. (2023). 194-199.
- [49] Scott, Gregory J. "A review of root, tuber and banana crops in developing countries: past, present and future." *International Journal of Food Science & Technology* 56, no. 3 (2021): 1093-1114.
- [50] Maseko, Kayise Hypercia, Thierry Regnier, Belinda Meiring, Obiro Cuthbert Wokadala, and Tonna Ashim Anyasi. "Musa species variation, production, and the application of its processed flour: A review." *Scientia Horticulturae* 325 (2024)
- [51] Arogundade, Olawale & Matthew, Joshua & Akinyoola, Omolara & Akin-Idowu, Pamela & Akinyemi, s.O.s. Phenotypic and Molecular Characterization of Mango Cultivars in Southwest Nigeria. *International Journal of Fruit Science*. 22. (2022). 151-159.

- [52] Govaerts, R., Nic Lughadha, E., Black, N., Turner, R., & Paton, A. The World Checklist of Vascular Plants, a continuously updated resource for exploring global plant diversity. *Scientific data*, 8(1), 215. (2021).
- [53] Probojati, R.T., Listyorini, D., Sulisetijono, S. et al. Phylogeny and estimated genetic divergence times of banana cultivars (*Musa* spp.) from Java Island by maturase K (*matK*) genes. *Bull Natl Res Cent* 45, 33 (2021).
- [54] Oyeyinka, Barnabas & Afolayan, Anthony. Potentials of *Musa* Species Fruits against Oxidative Stress-Induced and Diet-Linked Chronic Diseases: In Vitro and In Vivo Implications of Micronutritional Factors and Dietary Secondary Metabolite Compounds. *Molecules*. 25. 5036. (2020).
- [55] Probojati, R.T., Listyorini, D., Sulisetijono, S. et al. Phylogeny and estimated genetic divergence times of banana cultivars (*Musa* spp.) from Java Island by maturase K (*matK*) genes. *Bull Natl Res Cent* 45, 33 (2021).
- [56] Oyeyinka, Barnabas & Afolayan, Anthony. Potentials of *Musa* Species Fruits against Oxidative Stress-Induced and Diet-Linked Chronic Diseases: In Vitro and In Vivo Implications of Micronutritional Factors and Dietary Secondary Metabolite Compounds. *Molecules*. 25. 5036. (2020).
- [57] Ayo, J. A., A. Ochefu, and A. Agbatutu. "Effect of ripening on the Chemical Composition of Green locally Cultivated Banana Cultivars (*Musa* Spp.) Peel." *Nigerian Annals of Pure and Applied Sciences* 3, no. 1 (2020): 52-66.
- [58] Akinmoladun, Afolabi Clement, Aanuoluwapo Ruth Adetuyi, Kayode Komolafe, and Oluwafemi Omoniyi Oguntibeju. "Nutritional benefits, phytochemical constituents, ethnomedicinal uses and biological properties of Miracle fruit plant (*Synsepalum dulcificum* Shumach. & Thonn. Daniell)." *Heliyon* 6, no. 12 (2020).
- [59] Gordon Edwards. "About radioactive bananas. Canadian Coalition for Nuclear Responsibility. (2019).
- [60] Edwards, Gordon "About radioactive bananas" (PDF). Canadian Coalition for Nuclear Responsibility. (2019).

- [61] Wingle, Astrid, and Brody Sandel. "Relationships of the competitor, stress tolerator, ruderal functional strategies of grass species with lifespan, photosynthetic type, naturalization and climate." *AoB Plants* 15, no. 3 (2023)
- [62] FoodData Central, United States Department of Agriculture. (2023).
- [63] Dietitians of Canada. "What you need to know about potassium". EatRight Ontario, (2019).
- [64] Jiménez-Carrillo, Claudia Elizabeth, Karen Miroslava Piña-Ramos, Carolina Meza-Arrayales, Kathya Pamela Villaruel-Flores, and Alejandro García-Aguirre. "Latex allergy: therapeutic options." *Revista alergía México* 69 (2022): 55-68.
- [65] Kalinke, Isabel & Kulozik, Ulrich. Enhancing Microwave Freeze Drying: Exploring Maximum Drying Temperature and Power Input for Improved Energy Efficiency and Uniformity. *Food and Bioprocess Technology*. 17. 5357-5371. (2024).
- [66] Williams, Patrick. "Roast bream with fried plantain fritters and coconut sauce". BBC. Retrieved March 12, (2024).
- [67] Makinde, Oluwadamilola M., Kolawole I. Ayeni, Michael Sulyok, Rudolf Krska, Rasheed A. Adeleke, and Chibundu N. Ezekiel. "Microbiological safety of ready-to-eat foods in low-and middle-income countries: A comprehensive 10-year (2009 to 2018) review." *Comprehensive reviews in food science and food safety* 19, no. 2 (2020): 703-732.
- [68] Tsao, Kimberley "Turon, maruya, bitso-bitso and banana cue make it to Taste Atlas's list of 100 most popular deep-fried desserts in the world". (2024).
- [69] Aimi Azira, S.; Wan Zunairah, W.I.; Nor Afizah, M.; M.A.R., Nor-Khaizura; S., Radhiah; M.R., Ismail Fitry; Z.A., Nur Hanani "Prevention of browning reaction in banana jam during storage by physical and chemical treatments". *Food Research*. 5 (5): 55–62. (2021).
- [70] Pereira, Ignatius "The taste of Kerala". *The Hindu*. Chennai, India. Archived from the original on December 28, (2013).

- [71] Karmacharya, Reena. "Quality Evaluation and Shelf Life Study Of Unripe Banana Flour." (2022).
- [72] Damota, Firew Deneke, Ketamaw Salelign Yazie, Babuskin Srinivasan, and Ballekallu Chinna Eeranna. "Evaluation of the effect of the operational parameter on unripe banana (*Musa cavendishii*) flour production: case study at Arba Minch." *International Journal of Food Engineering* 18, no. 2 (2022): 161-168.
- [73] Nace, Trevor "Thailand Supermarket Ditches Plastic Packaging For Banana Leaves". *Forbes*. (2019).
- [74] The San Diego Union-Tribune. "Banana leaves transform texture of chicken tamales". (2022).
- [75] Grover, Neha "Why South Indians Eat On Banana Leaves - Health Benefits And More". *NDTV*. (2024).
- [76] Kora, Aruna Jyothi "Leaves as dining plates, food wraps and food packing material: Importance of renewable resources in Indian culture". *Bulletin of the National Research Centre*. **43** (1). (2019).
- [77] Neumann, Caryn E., Lori L. Parks, and Joel G. Parks. *Global Dishes: Favorite Meals from Around the World*. Bloomsbury Publishing USA, (2023).
- [78] De Villa, Bianca Denise M., Thea Mari M. Domingo, Rhema Jenica C. Ramirez, and Jame Monren T. Mercado. "Explicating the culinary heritage significance of Filipino kakanin using bibliometrics (1934–2018)." *International Journal of Gastronomy and Food Science* 28 (2022)
- [79] Akatwijuka, Osbert, Mohamed A-H. Gepreel, Ahmed Abdel-Mawgood, Mitsuo Yamamoto, Yukie Saito, and Ahmed H. Hassanin. "Overview of banana cellulosic fibers: agro-biomass potential, fiber extraction, properties, and sustainable applications." *Biomass Conversion and Biorefinery* 14, no. 6 (2024): 7449-7465.
- [80] Ravi, Y., M. Elizabeth, and M. Shivashankar. "Raw and ripe banana powder for nutritional and economic sustainability." (2023): 157-160.

- [81] Arumugam, Soundhar, Jayakrishna Kandasamy, Subramani Venkatesan, Rajesh Murugan, Valayapathy Lakshmi Narayanan, Mohamed Thariq Hameed Sultan, Farah Syazwani Shahar, Ain Umaira Md Shah, Tabrej Khan, and Tamer Ali Sebaey. "A review on the effect of fabric reinforcement on strength enhancement of natural fiber composites." *Materials* 15, no. 9 (2022).
- [82] Iwuozor, Kingsley O., Taiwo Temitayo Micheal, Kehinde Temitope Micheal, Stephen Sunday Emmanuel, Ebuka Chizitere Emenike, and Adewale George Adeniyi. "Plant biomass-based composites in the maritime industry: A review." *Marine Structures* 96 (2024).
- [83] Castro, Renata S. D.; Caetano, Laércio; Ferreira, Guilherme; Padilha, Pedro M.; Saeki, Margarida J.; Zara, Luiz F.; "Banana Peel Applied to the Solid Phase Extraction of Copper and Lead from River Water: Preconcentration of Metal Ions with a Fruit Waste". *Industrial & Engineering Chemistry Research*. **50** (6): (2019). 3446–3451
- [84] Alabi, Opeyemi Iyinoluwa. "Comparative Analysis And Proximate Composition Of Complementary Breakfast Cereal Produced From Composite Of Oats, Soybean And Dried Mixed Fruits (Apples, Bananas, Pawpaw)." *International Journal Of Innovation In Science & Technology* 1, No. 1 (2023): 54-63.
- [85] Frame, Paul "General information about K-40". Oak Ridge National Laboratory. (2019).
- [86] Mansfield, Gary "Banana equivalent dose". Internal Dosimetry, Lawrence Livermore National Laboratory, University of California, (2019).
- [87] Tarantino, Olivia. "You're Eating Bananas Wrong—here's the Right Way". *Eat This Not That*. (2021).
- [88] FoodData Central, United States Department of Agriculture. "Ranking of potassium content per 100 grams in common foods ("Foundation" only for search filter)". (2023).
- [89] Dietitians of Canada. EatRight Ontario,. "What you need to know about potassium". (2019).
- [90] United States Food and Drug Administration "Daily Value on the Nutrition and Supplement Facts Labels". (2024).

- [91] Maria; Harrison, Meghan; Stallings, Virginia A. (eds.). National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Food and Nutrition Board; Committee to Review the Dietary Reference Intakes for Sodium and Potassium. *Dietary Reference Intakes for Sodium and Potassium*. The National Academies Collection: Reports funded by National Institutes of Health. Washington, DC: National Academies Press (US). (2019).
- [92] Dietitians of Canada. EatRight Ontario. "What you need to know about potassium". (2019).
- [93] Royal Botanic Gardens, Kew". Kew Science. "World Checklist of Selected Plant Families: (2021).
- [94] Akabassi, Ghislain Comlan, Koffi Kibalou Palanga, Elie Antoine Padonou, Yao Dodzi Dagnon, Koffi Tozo, and Achille Ephrem Assogbadjo. "A global systematic review on biology, production constraints and uses of *Cyperus exculentus* L.(Neglected and Underutilized Crop Species): implications for valorization." (2021).
- [95] Isaev, S., T. Rajabov, G. Goziev, and A. Khojasov. "Effect of fertilizer application on the 'Bukhara-102' variety of cotton yield in salt-affected cotton fields of Uzbekistan." In *E3S Web of Conferences*, vol. 258, p. 03015. EDP Sciences, (2021).
- [96] Feys, Jeroen, Benny De Cauwer, Dirk Reheul, Clara Sciffer, Shana Clercx, and Sander Palmans. "Impact of electrocution on shoot and tuber vitality of yellow nutsedge (*Cyperus esculentus*)." *Agriculture* 13, no. 3 (2023): 696.
- [97] Nazish, Noma. "What Are Tiger Nuts And Why Should You Eat Them?". *Forbes*. (2022).
- [98] Echendu, Jane, Monday Godwin-Egein, Udensi Ekea Udensi, Kuromiayebaye Digtemie, and Victor Okereke. "Fungal organisms associated with common tropical weeds in Choba Rivers State Nigeria." *Sustainability, Agri, Food and Environmental Research* 12, no. 2 (2024).
- [99] Te Yu, Qiong Wu, Jiaming Wang, Bin Liang, Xusheng Wang, Xinzhu Shang, Physicochemical properties of tiger nut (*Cyperus esculentus* L) polysaccharides and their interaction with proteins in beverages, *Food Chemistry: X*, Volume 19, (2023).
- [100] Echendu, Jane, Monday Godwin-Egein, Udensi Ekea Udensi, Kuromiayebaye Digtemie, and Victor Okereke. "Fungal organisms associated with common tropical

weeds in Choba Rivers State Nigeria." Sustainability, Agri, Food and Environmental Research 12, no. 2 (2024).

- [101] Yu, Yali & Lu, Xiaoyu & Zhang, Tiehua & Zhao, Changhui & Guan, Shiyao & Pu, Yiling & Gao, Feng. Tiger Nut (*Cyperus esculentus* L.): Nutrition, Processing, Function and Applications. *Foods*. 11. 601. (2022).
- [102] Allai, Farhana Mehraj, ZR Azaz Ahmad Azad, Nisar Ahmad Mir, and Khalid Gul. "Recent advances in non-thermal processing technologies for enhancing shelf life and improving food safety." *Applied Food Research* 3, no. 1 (2023).
- [103] Mohammed, Toungos & Babayola, Muazu. Tiger nut (*Cyperus esculentus*): A Supper Food but Neglected by Researchers. 7. 1-7. (2019).
- [104] Zhang, Yiming, and Shangde Sun. "Tiger nut (*Cyperus esculentus* L.) oil: A review of bioactive compounds, extraction technologies, potential hazards and applications." *Food chemistry: X* (2023).
- [105] Ohoke, Francis & Nwokonkwo, Dorathy. Production, Chemical Properties and Sensory evaluation of Wine from blends of Gaper (*Vitis vinifera*) fruit, Pawpaw(*Carica papaya*) fruit and Tiger nut (*Cyperus esculentus*)tuber. *International Journal of ChemTech Research*. 12. 17-27. (2019).
- [106] Mohammed, Toungos & Babayola, Muazu. Tiger nut (*Cyperus esculentus*): A Supper Food but Neglected by Researchers. 7. 1-7. (2019).
- [107] Edo, Great Iruoghene, Favour Ogheneoruese Onoharigho, Agatha Ngukuran Jikah, Gift Onyinyechi Oloni, Princess Oghenekenno Samuel, Opiti Ajiri Rapheal, Ovie Ikpekoru et al. "*Cyperus esculentus* (tiger nut): An insight into its bioactive compounds, biological activities, nutritional and health benefits." *Food Chemistry Advances* 3 (2023).
- [108] Aydar, Elif Feyza, Sena Tutuncu, and Beraat Ozcelik. "Plant-based milk substitutes: Bioactive compounds, conventional and novel processes, bioavailability studies, and health effects." *Journal of Functional Foods* 70 (2020): 103975.
- [109] Jonas J.G. da Costa Neto, Taísa L.M. Gomes, Thaís F. Justo, Karen S. Pereira, Priscilla F.F. Amaral, Maria H.M. Rocha Leão, Gizele C. Fontes Sant'Ana, Microencapsulation of tiger nut milk by lyophilization: Morphological characteristics, shelf life and microbiological stability, *Food Chemistry*, Volume 284, (2019) 133-139.

- [110] Putnik, Predrag, Branimir Pavlić, Branislav Šojić, Sandra Zavadlav, Irena Žuntar, Leona Kao, Dora Kitonić, and Danijela Bursać Kovačević. "Innovative hurdle technologies for the preservation of functional fruit juices." *Foods* 9, no. 6 (2020): 699.
- [111] da Costa Neto J.J.G., Gomes T.L.M., Justo T.F., Pereira K.S., Amaral P.F.F., Leão M.H.M.R., Sant'Ana G.C.F. Microencapsulation of tiger nut milk by lyophilization: Morphological characteristics, shelf life and microbiological stability. *Food Chem.* (2019); 284:133–139.
- [112] Bursać Kovačević, Danijela, Irena Žuntar, and Predrag Putnik. "Preservation of functional fruit juices using hurdle technology." In *3rd International Congress on Food Safety and Quality: Food, Health and Climate Changes*, (2020). pp. 34-34.
- [113] Roselló-Soto, Elena, Francisco J. Barba, Jose M. Lorenzo, Paulo ES Munekata, Belén Gómez, and Juan Carlos Moltó. "Phenolic profile of oils obtained from “horchata” by-products assisted by supercritical-CO₂ and its relationship with antioxidant and lipid oxidation parameters: Triple TOF-LC-MS-MS characterization." *Food chemistry* 274 (2019): 865-871.
- [114] Allai, Farhana Mehraj, ZR Azaz Ahmad Azad, Nisar Ahmad Mir, and Khalid Gul. "Recent advances in non-thermal processing technologies for enhancing shelf life and improving food safety." *Applied Food Research* 3, no. 1 (2023).
- [115] Onyimba, I. A., M. S. Chomini, M. O. Job, A. I. Njoku, J. A. Onoja, D. C. Isaac, I. C. Isaac, and A. C. Ngene. "Evaluation of the Suitability of Tigernut Milk and Tigernut-Cow Composite Milks for Yoghurt Production". *European Journal of Biology and Biotechnology* 3, no. 2 (2022): 38–44.
- [116] Lachowicz, S., Oszmiański, J., Wilczyńska, M., Zaguła, G., Saletnik, B., & Puchalski, C. Impact Mineralization of Chokeberry and Cranberry Fruit Juices Using a New Functional Additive on the Protection of Bioactive Compounds and Antioxidative Properties. *Molecules* (Basel, Switzerland), 25(3), 659. (2020).
- [117] Qin, Yuxin, Christopher Pillidge, Bernie Harrison, and Benu Adhikari. "Pathways in formulating foods for the elderly." *Food Research International* (2024): 114324.
- [118] Zhang, Yu, Weiting Fu, Siyao Chen, Hongshan Liang, Jing Li, Yan Li, and Bin Li. "Pickering emulsions stabilized by homogenized ball-milled eggshell particles in combination with sodium alginate." *International Journal of Biological Macromolecules* 229 (2023): 1044-1053.

- [119] Gbylik-Sikorska, Małgorzata, Anna Gajda, Ewelina Nowacka-Kozak, Beata Łebkowska-Wieruszewska, and Andrzej Posyniak. "Multi-class procedure for analysis of 50 antibacterial compounds in eggshells using ultra-high-performance liquid chromatography–tandem mass spectrometry." *Molecules* 26, no. 5 (2021).
- [120] Paździor, Magdalena. "Consumer Segmentation Using Cluster Analysis as A Source Of Data To Improve Product Quality." *Scientific Papers of Silesian University Of Technology. Organization & Management/Zeszyty Naukowe Politechniki Slaskiej. Seria Organizacji I Zarzadzanie* 188 (2023).
- [121] Ülkü, Sultan & Ünlü, Nimet. "Could Chicken Eggshell Powder Be The Solution in Dentistry?" (2023).
- [122] Awogbemi, Omojola, D. V. V. Kallon, and Victor Sunday Aigbodion. "Pathways for sustainable utilization of waste chicken eggshell." *Journal of Renewable Materials*, 10 (8) (2022): 2217-2246.
- [123] Lewko, L., J. Krawczyk, and J. Calik. "Effect of genotype and some shell quality traits on lysozyme content and activity in the albumen of eggs from hens under the biodiversity conservation program." *Poultry Science* 100, no. 3 (2021).
- [124] Abbas, Sheren & Fadhel, Sheren. "Inhibitory Effect and Antioxidant Activity of the Internal Membrane Decomposition of Egg Shells." (2023).
- [125] Arnold, M., Rajagukguk, Y. V., Sidor, A., Kulczyński, B., Brzozowska, A., Suliburska, J., Wawrzyniak, N., & Gramza-Michałowska, A. "Innovative Application of Chicken Eggshell Calcium to Improve the Functional Value of Gingerbread." *International journal of environmental research and public health*, 19(7), 4195. (2022).
- [126] Chang, Kian Aun, Sheryl Wee Min Low, Yih Heng Chia, Andrey Setyadi, Yun Ping Neo, and Lye Yee Chew. "Valorisation of chicken eggshell as a novel food ingredient in madeleine cake: an exploratory study amongst young adults." *British Food Journal* 125, no. 9 (2023): 3320-3333.
- [127] Kany, Shinwan, Jan Tilmann Vollrath, and Bornha Relja. "Cytokines in Inflammatory Disease" *International Journal of Molecular Sciences* 20, no. 23: 6008. (2019).
- [128] Ofshenko, Nadav, Eyal Bercovich, Tania Mashiach, Michal Weiler-Sagie, Daniela Militianu, and Eldad J. Dann. "Reduction of the Vertebral Bone Mineral Density in

Patients with Hodgkin Lymphoma Correlates with Their Age and the Treatment Regimen They Received" *Cancers* 14, no. 3: 495. (2022).

- [129] Creecy, A., Damrath, J. G., and Wallace, J. M. Control of Bone Matrix Properties by Osteocytes. *Front. Endocrinol.* 11, 578477. (2021).
- [130] Samanta, Sharmistha, Tanmay Sarkar, and Runu Chakraborty. "Multifunctional applications of natural colorants: Preservative, functional ingredient, and sports supplements." *Biocatalysis and Agricultural Biotechnology* 56 (2024): 103026.
- [131] Natarajan, Duraipandy, Zhitong Ye, Liping Wang, Linhu Ge, and Janak Lal Pathak. "Rare earth smart nanomaterials for bone tissue engineering and implantology: Advances, challenges, and prospects." *Bioengineering & Translational Medicine* 7, no. 1 (2022)
- [132] Zhang, Y.; Liu, Z.; Duan, L.; Ji, Y.; Yang, S.; Zhang, Y.; Li, H.; Wang, Y.; Wang, P.; Chen, J.; et al. Effect of Low-Dose Vitamin K2 Supplementation on Bone Mineral Density in Middle-Aged and Elderly Chinese: A Randomized Controlled Study. *Calcif. Tissue Int.* (2020) 106, 476–485.
- [133] Salehi, Bahare, Raziieh Sharifi-Rad, Farukh Sharopov, Jacek Namiesnik, Amir Roointan, Madhu Kamle, Pradeep Kumar, Natália Martins, and Javad Sharifi-Rad. "Beneficial effects and potential risks of tomato consumption for human health: An overview." *Nutrition* 62 (2019): 201-208.
- [134] Rinonapoli, Giuseppe, Valerio Pace, Carmelinda Ruggiero, Paolo Ceccarini, Michele Bisaccia, Luigi Meccariello, and Auro Caraffa. "Obesity and bone: a complex relationship." *International journal of molecular sciences* 22, no. 24 (2021): 13662.
- [135] Lin, Zhangyuan, Hongbo He, Min Wang, and Jieyu Liang. "MicroRNA-130a controls bone marrow mesenchymal stem cell differentiation towards the osteoblastic *and* adipogenic fate." *Cell proliferation* 52, no. 6 (2019).
- [136] Abdelshafy, Asem Mahmoud, Tarun Belwal, Ze Liang, Lei Wang, Dong Li, Zisheng Luo, and Li Li. "A comprehensive review on phenolic compounds from edible mushrooms: Occurrence, biological activity, application and future prospective." *Critical Reviews in Food Science and Nutrition* 62, no. 22 (2022): 6204-6224.

- [137] Brunetti Brunetti, G.; Storlino, G.; Oranger, A.; Colaianni, G.; Faienza, M.F.; Ingravallo, G.; Di Comite, M.; Reseland, J.E.; Celi, M.; Tarantino, U.; et al. LIGHT/TNFSF14 regulates estrogen deficiency-induced bone loss. *J. Pathol.* (2020) 250, 440–451.
- [138] Salari, Nader, Hooman Ghasemi, Loghman Mohammadi, Mohammad Hasan Behzadi, Elham Rabieenia, Shamarina Shohaimi, and Masoud Mohammadi. "The global prevalence of osteoporosis in the world: a comprehensive systematic review and meta-analysis." *Journal of orthopaedic surgery and research* 16 (2021): 1-20.
- [139] Milanović, Zoran, Nedim Čović, Eva Wulff Helge, Peter Krstrup, and Magni Mohr. "Recreational football and bone health: A systematic review and meta-analysis." *Sports Medicine* 52, no. 12 (2022): 3021-3037.
- [140] United Nations. *World Population Ageing 2019: Highlights*; United Nations: New York, NY, USA, (2019).
- [141] Timmis, Adam, Panos Vardas, Nick Townsend, Aleksandra Torbica, Hugo Katus, Delphine De Smedt, Chris P. Gale et al. "European Society of Cardiology: cardiovascular disease statistics 2021." *European heart journal* 43, no. 8 (2022): 716-799.
- [142] Lin, Kun-Mo, Chien-Lin Lu, Kuo-Chin Hung, Pei-Chen Wu, Chi-Feng Pan, Chih-Jen Wu, Ren-Si Syu, Jin-Shuen Chen, Po-Jen Hsiao, and Kuo-Cheng Lu. "The paradoxical role of uric acid in osteoporosis." *Nutrients* 11, no. 9 (2019): 2111.
- [143] Rossiello, Francesca, Diana Jurk, João F. Passos, and Fabrizio d'Adda di Fagagna. "Telomere dysfunction in ageing and age-related diseases." *Nature cell biology* 24, no. 2 (2022): 135-147.
- [144] Rino, Yasushi, Toru Aoyama, Yosuke Atsumi, Takanobu Yamada, and Norio Yukawa. "Metabolic bone disorders after gastrectomy: inevitable or preventable?." *Surgery today* (2022): 1-7
- [145] Martiniakova, Monika, Martina Babikova, Vladimira Mondockova, Jana Blahova, Veronika Kovacova, and Radoslav Omelka. "The role of macronutrients, micronutrients and flavonoid polyphenols in the prevention and treatment of osteoporosis." *Nutrients* 14, no. 3 (2022): 523.

- [146] Neves, Maria Isabel Landim, Eric Keven Silva, and Maria Angela A. Meireles. "Natural blue food colorants: Consumer acceptance, current alternatives, trends, challenges, and future strategies." *Trends in Food Science & Technology* 112 (2021): 163-173.
- [147] Aibar-Almazán, Agustín, Ana Voltres-Martínez, Yolanda Castellote-Caballero, Diego Fernando Afanador-Restrepo, María del Carmen Carcelén-Fraile, and Elena López-Ruiz. "Current status of the diagnosis and management of osteoporosis." *International journal of molecular sciences* 23, no. 16 (2022): 9465.
- [148] FAO. *The State of Food and Agriculture: Moving Forward on Food Loss and Waste Reduction*; Food and Agriculture Organization of the United Nations: Rome, Italy, (2019).
- [149] Tang, Yu, Sathian Dananjayan, Chaojun Hou, Qiwei Guo, Shaoming Luo, and Yong He. "A survey on the 5G network and its impact on agriculture: Challenges and opportunities." *Computers and Electronics in Agriculture* 180 (2021).
- [150] Sharma, Hari Bhakta, Kumar Raja Vanapalli, VR Shankar Cheela, Ved Prakash Ranjan, Amit Kumar Jaglan, Brajesh Dubey, Sudha Goel, and Jayanta Bhattacharya. "Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic." *Resources, conservation and recycling* 162 (2020).
- [151] Ben-Daya, Mohamed, Elkafi Hassini, and Zied Bahroun. "Internet of things and supply chain management: a literature review." *International journal of production research* 57, no. 15-16 (2019): 4719-4742.
- [152] Ślusarczyk, B., and E. Machowska. "Food Waste in the World and in Poland." (2019): 91-100.
- [153] Przezbórska-Skobiej, Lucyna, and Paulina Luiza Wiza. "Food waste in households in Poland—Attitudes of young and older consumers towards the phenomenon of food waste as demonstrated by students and lecturers of PULS." *Sustainability* 13, no. 7 (2021): 3601.
- [154] Waheed, M.; Yousaf, M.; Shehzad, A.; Inam-Ur-Raheem, M.; Khan, M.K.I.; Khan, M.R.; Ahmad, N.; Abdullah; Aadil, R.M. Channelling Eggshell Waste to Valuable and Utilizable Products: A Comprehensive Review. *Trends Food Sci. Technol.* (2020), 106, 78–90.

- [155] Khan, Faima Atta, Kashif Ameer, Muhammad Affan Qaiser, Imran Pasha, Qaiser Mahmood, Faqir Muhammad Anjum, Ayesha Riaz, and Rai Muhammad Amir. "Development and analysis of bread fortified with calcium extracted from chicken eggshells of Pakistani market." *Food Science and Technology* 41, no. suppl 1 (2020): 14-20.
- [156] Ejimofor, M. I., I. G. Ezemagu, V. I. Ugonabo, P. C. Nnaji, V. C. Anadebe, C. Diyoke, and M. C. Menkiti. "Adsorption kinetics, mechanistic, isotherm and thermodynamics study of petroleum produced water coagulation using novel *Egeria radiata* shell extract (ERSE)." *Journal of the Indian Chemical Society* 99, no. 3 (2022).
- [157] Nag, Moupriya, Dibyajit Lahiri, Ankita Dey, Tanmay Sarkar, Siddhartha Pati, Sanket Joshi, Hamidun Bunawan et al. "Seafood discards: a potent source of enzymes and biomacromolecules with nutritional and nutraceutical significance." *Frontiers in Nutrition* 9 (2022).
- [158] Camilleri, Mark Anthony. "European environment policy for the circular economy: Implications for business and industry stakeholders." *Sustainable Development* 28, no. 6 (2020): 1804-1812.
- [159] Xhelili, A.; Strube, R.; Grossi, F.; Zvěřinová, I.; Taylor, T.; Martinez-Juarez, P.; Quiroga, S.; Suárez, C.; Gjorgjev, D. A Technological Scenario for a Healthier, More Equitable and Sustainable Europe in 2040: Citizen Perceptions and Policy Implications. *Int. J. Environ. Res. Public Health*. (2020) 17, 231.
- [160] Lorenc, R.; Głuszko, P.; Franek, E.; Jabłoński, M.; Jaworski, M.; Kalinka-Warzocha, E.; Karczmarewicz, E.; Kostka, T.; Księżopolska-Orłowska, K.; Marcinowska-Suchowierska, E.; et al. Guidelines for the Diagnosis and Management of Osteoporosis in Poland. Update 2017. *Endokrynol. Pol.* (2017), 68, 604–609.
- [161] Waheed, Mariam, Masood Sadiq Butt, Aamir Shehzad, Noranizan Mohd Adzahan, Muhammad Asim Shabbir, Hafiz Ansar Rasul Suleria, and Rana Muhammad Aadil. "Eggshell calcium: A cheap alternative to expensive supplements." *Trends in Food Science & Technology* 91 (2019): 219-230.
- [162] Palacios, Cristina, Gabriela Cormick, G. Justus Hofmeyr, Maria Nieves Garcia-Casal, Juan Pablo Peña-Rosas, and Ana Pilar Betrán. "Calcium-fortified foods in public health programs: considerations for implementation." *Annals of the New York Academy of Sciences* 1485, no. 1 (2021): 3-21.

- [163] Zhou, Liping, Xiangyu Jiao, Songyang Liu, Mingda Hao, Siyang Cheng, Peixun Zhang, and Yongqiang Wen. "Functional DNA-based hydrogel intelligent materials for biomedical applications." *Journal of Materials Chemistry B* 8, no. 10 (2020): 1991-2009.
- [164] Ahmed, Tamer AE, Ling Wu, Manar Younes, and Maxwell Hincke. "Biotechnological applications of eggshell: recent advances." *Frontiers in Bioengineering and Biotechnology* 9 (2021)
- [165] Baláž, Matej, Elena V. Boldyreva, Dmitry Rybin, Stefan Pavlović, Daily Rodríguez- Padrón, Tihana Mudrinić, and Rafael Luque. "State-of-the-art of eggshell waste in materials science: recent advances in catalysis, pharmaceutical applications, and mechanochemistry." *Frontiers in Bioengineering and Biotechnology* 8 (2021)
- [166] Barbe, Alix, Namy Mellouk, Christelle Ramé, Jérémy Grandhayé, Karine Anger, Marine Chahnamian, Patrice Ganier et al. "A grape seed extract maternal dietary supplementation improves egg quality and reduces ovarian steroidogenesis without affecting fertility parameters in reproductive hens." *PLoS One* 15, no. 5 (2020)
- [167] Bhargava, Nitya, Rahul S. Mor, Kshitiz Kumar, and Vijay Singh Sharanagat. "Advances in application of ultrasound in food processing: A review." *Ultrasonics sonochemistry* 70 (2021)
- [168] Lizundia, Erlantz, and Dipan Kundu. "Advances in natural biopolymer-based electrolytes and separators for battery applications." *Advanced Functional Materials* 31, no. 3 (2021)
- [169] Baláž, Matej, Elena V. Boldyreva, Dmitry Rybin, Stefan Pavlović, Daily Rodríguez- Padrón, Tihana Mudrinić, and Rafael Luque. "State-of-the-art of eggshell waste in materials science: recent advances in catalysis, pharmaceutical applications, and mechanochemistry." *Frontiers in Bioengineering and Biotechnology* 8 (2021)
- [170] Lordelo, Madalena, Joana Cid, Cláudia MDS Cordovil, Susana P. Alves, Rui JB Bessa, and Inês Carolino. "A comparison between the quality of eggs from indigenous chicken breeds and that from commercial layers." *Poultry Science* 99, no. 3 (2020): 1768-1776.
- [171] Kulshreshtha, Garima, Liliana D'alba, Ian C. Dunn, Sophie Rehault-Godbert, Alejandro B. Rodriguez-Navarro, and Maxwell T. Hincke. "Properties, genetics and innate immune function of the cuticle in egg-laying species." *Frontiers in Immunology* 13 (2022).

- [172] Gautron, Joël, L. Stapane, N. Le Roy, Y. Nys, A. B. Rodriguez-Navarro, and M. T. Hincke. "Avian eggshell biomineralization: an update on its structure, mineralogy and protein tool kit." *BMC Molecular and Cell Biology* 22 (2021): 1-17.
- [173] Department of Physics. University of Illinois at Urbana-Champaign". Van.physics.illinois.edu "Q & A: Eggshells in Vinegar - What happened? (2007).
- [174] Girelli, Anna Maria, Maria Luisa Astolfi, and Francesca Romana Scuto. "Agro-industrial wastes as potential carriers for enzyme immobilization: A review." *Chemosphere* 244 (2020): 125368.
- [175] Wang, Ji, Yaoxin Zhang, Haiping Huai, Weiyu Hou, Yuan Qi, Yue Leng, Xiaoting Liu, Xiyan Wang, Dan Wu, and Weihong Min. "Purification, identification, chelation mechanism, and calcium absorption activity of a novel calcium-binding peptide from peanut (*Arachis hypogaea*) protein hydrolysate." *Journal of Agricultural and Food Chemistry* 71, no. 31 (2023): 11970-11981.
- [176] Girelli, Anna Maria, Maria Luisa Astolfi, and Francesca Romana Scuto. "Agro-industrial wastes as potential carriers for enzyme immobilization: A review." *Chemosphere* 244 (2020): 125368.
- [177] Wen, Rongxin, Yingying Hu, Lang Zhang, Yan Wang, Qian Chen, and Baohua Kong. "Effect of NaCl substitutes on lipid and protein oxidation and flavor development of Harbin dry sausage." *Meat Science* 156 (2019): 33-43
- [178] Mathew, Gincy Marina, Diksha Raina, Vivek Narisetty, Vinod Kumar, Saurabh Saran, Arivalagan Pugazhendi, Raveendran Sindhu, Ashok Pandey, and Parameswaran Binod. "Recent advances in biodiesel production: Challenges and solutions." *Science of the Total Environment* 794 (2021): 148751.
- [179] Shahnila., Arif Sana, Pasha Imran, Iftikhar Hira, Mehak Fakiha, and Sultana Razia. "Effects of eggshell powder supplementation on nutritional and sensory attributes of biscuits." *Czech J. Food Sci.* 40, no. 1 (2022): 26-32.
- [180] Mensah, Kenneth & Mahmoud, Hatem & Fujii, Manabu & Samy, Mahmoud & Hassan, Hassan. Dye removal using novel adsorbents synthesized from plastic waste and eggshell: mechanism, isotherms, kinetics, thermodynamics, regeneration, and water matrices. *Biomass Conversion and Biorefinery*. 14. (2022).

- [181] Fladerer JP, Grollitsch S. Eggshell membrane as promising supplement to maintain bone health: A systematic review. *Bone Rep.* (2024).
- [182] Owuamanam, Stephen, and Duncan Cree. "Progress of bio-calcium carbonate waste eggshell and seashell fillers in polymer composites: a review." *Journal of Composites Science* 4, no. 2 (2020): 70.
- [183] Prayitno, Agus & Suryanto, Edi & Setiyono, & Rusman, Rusman & Utami, Rista & Jamhari, Jamhari. Karakteristik Mikrostruktur dan Nilai Gizi Bakso Ayam yang Difortifikasi Kalsium Oksida dan Nanokalsium Laktat Kerabang Telur Ayam. (2020).653-663.
- [184] Torres-Mansilla A, Hincke M, Voltes A, López-Ruiz E, Baldión PA, Marchal JA, Álvarez-Lloret P, Gómez-Morales J. Eggshell Membrane as a Biomaterial for Bone Regeneration. *Polymers (Basel)*. (2023).
- [185] Matamala, Camila, Paula Garcia, Pedro Valencia, Alvaro Perez, Manuel Ruz, Leyla Sanhueza, Sergio Almonacid, Cristian Ramirez, Marlene Pinto, and Paula Jiménez. "Valorization of the Salmon Frame as a High-Calcium Ingredient in the Formulation of Nuggets: Evaluation of the Nutritional and Sensory Properties" *Foods* 13, no. 11: 1701. (2024).
- [186] Laohavisuti, Nongnuch & Seesanong, Somkiat & Chaiseeda, Kittichai & Boonmee, Wimonmat. Simple Recycling of Biowaste Eggshells to Various Calcium Phosphates for Specific Industries. (2021).
- [187] Maqsood, Sohail & Eddie, Lam & Ng, Hei & Afzal, Muhammad & Rehman, Safi & Ayyub, Muhammad. Eggshells from Different Countries of Origin and Their Sustainable Application as a Partial Replacement of Cement. (2023).
- [188] Niemann, A., Bäumer, S., & Nussbaum, M. Bioactive Peptides Derived from Eggshell Membrane: Extraction and Potential Applications. *Nutrients*, 13(1), (2021). 174.
- [189] Wang, C., & Zhang, Y. "Eggshells as an Eco-friendly Catalyst for Biodiesel Production: A Comprehensive Review." *Biomass and Bioenergy*, (2022). 155.
- [190] Crickmore, Tom S.; Sana, Haamidah Begum; Mitchell, Hannah; Clark, Molly; Bradshaw, Darren. "Toward sustainable syntheses of Ca-based MOFs". *Chemical Communications*. 57 (81): (2021). 10592–10595.

- [191] N A Mazlan, J M Sapari, K P Sambasevam, Synthesis and fabrication of polyaniline/eggshell composite in ammonia detection, *Journal of Metals, Materials and Minerals*, Vol 30, No. 2, 50-57 (2020).
- [192] Gonzalez-Garcia, S., & M. M. A Life Cycle Assessment of CO2 Emission Reduction Strategies in Cement Production. *Journal of Cleaner Production*, 385, 135678. (2023).
- [193] Ehsan, A., M. R. Rahman, A. M. M. Shakoor, and M. H. Anwar. "Performance of Rice Husk Ash as a Partial Cement Replacement in Concrete: A Review." *Construction and Building Materials* 335: (2022). 127299.
- [194] Kumar, S., V. K. Gupta, and R. K. Sharma. "Utilization of Agricultural Waste in Sustainable Construction: A Review." *Journal of Cleaner Production* 392: (2023). 135727.
- [195] Liu, Y., X. Zhang, and H. Wang. "Durability Performance of Concrete with Various Pozzolans: A Comprehensive Review." *Materials Today: Proceedings* 44: (2021). 3911-3916.
- [196] Khan, M. I., M. Ali, and A. Ullah. "High-Volume Fly Ash Concrete: A Review of its Properties and Applications." *Journal of Building Engineering* 29: (2020). 101108.
- [197] Jiang, Y., J. Y. Lee, and Z. F. Xu. "A Comprehensive Review of Ground Granulated Blast Furnace Slag for Sustainable Concrete Development." *Sustainable Materials and Technologies* 31: (2022).
- [198] Rashad, A. M. "Silica Fume in Cement-Based Materials: A Comprehensive Review." *Construction and Building Materials* 291: (2021).
- [199] Zhang, Y., J. Y. Li, and L. Zhao. "Effects of Limestone Powder on Concrete Properties: A Review of Recent Advances." *Journal of Cleaner Production* 335: (2022). 130179.
- [200] V. Jittin, A. K. S. Kumar, and R. P. S. Singh. Utilisation of rice husk ash for cleaner production of different construction products *J. Cleaner Prod.* (2020)
- [201] Li, Guojun, Hongjun Wang, Jun Zhang, and Zhiqiang Zhang. "Properties of Cement-Based Bricks with Oyster-Shells Ash." *Journal of Cleaner Production* 240 (2019)

- [202] Ahmad, Muhammad, Saeed A. Khan, Adeel Bukhari, and Muhammad A. Khan. "Eggshell and Coral Wastes as Low-Cost Sorbents for the Removal of Heavy Metals from Aqueous Solutions." *Journal of Hazardous Materials* 371 (2019): 192-199.
- [203] Bakhshi, Hamid, Mohammad R. A. Zarghami, and Mohammad Mahdavi. "Preparation and Evaluation of Hydrogel Composites Based on Starch-g-PNaMA/Eggshell Particles as Dye Biosorbent." *Desalination and Water Treatment* 171 (2019): 163-172.
- [204] Borah, Mukul J., Kiran P. Choudhury, J. S. B. Singh, and Deepak Kumar. "Transesterification of Waste Cooking Oil for Biodiesel Production Catalyzed by Zn Substituted Waste Eggshell Derived CaO Nanocatalyst." *Fuel* 258 (2019).
- [205] Daraei, Hossein, Farhad Mohammadi, and Mahshid Asghari. "Separation of Chromium from Water Samples Using Eggshell Powder as a Low-Cost Sorbent: Kinetic and Thermodynamic Studies." *Desalination and Water Treatment* 183 (2020): 173-183.
- [206] Farooq, Muhammad, Muhammad Sarfraz, and Qasim A. M. Alharbi. "Biodiesel Production from Date Seed Oil (*Phoenix dactylifera* L.) via Eggshell Derived Heterogeneous Catalyst." *Chemical Engineering Research and Design* 145 (2019): 155-165.
- [207] Foroutan, Reza, Behzad Shaterian, and Behnam Khazaei. "Eggshell Nano-Particle Potential for Methyl Violet and Mercury Ion Removal: Surface Study and Field Application." *Advanced Powder Technology* 30 (2019): 1987-1998.
- [208] Goli, Javad, Vahdat Jafari, and Sadegh Maleki. "Development of Heterogeneous Alkali Catalyst from Waste Chicken Eggshell for Biodiesel Production." *Renewable Energy* 135 (2019): 1033-1041.
- [209] Gupta, Abhishek R., Sanjeev Kumar, and Neha Sharma. "Waste Cooking Oil and Waste Chicken Eggshells Derived Solid Base Catalyst for the Biodiesel Production: Optimization and Kinetics." *Waste Management* 85 (2019): 93-102.
- [210] He, Sheng, Yiming Zheng, and Keke Zhang. "Investigation of CaO-Based Sorbents Derived from Eggshells and Red Mud for CO₂ Capture." *Journal of Alloys and Compounds* 785 (2019): 245-254.

- [211] Kamalanathan, P., Premkumar K., and Sathiyamurthy M. "Synthesis and Sintering of Hydroxyapatite Derived from Eggshells as a Calcium Precursor." *Ceramics International* 45 (2019): 12280-12289.
- [212] Li, Jun, Wei Zhang, and Yang Zhang. "Eggshell Membrane-Derived MgFe₂O₄ for Pharmaceutical Antibiotics Removal and Recovery from Water." *Chemical Engineering Research and Design* 137 (2018): 312-321.
- [213] Mansir, Nasir, John F. W. K. H. Ong, and Boon S. C. Y. Lim. "Synthesis and Application of Waste Eggshell Derived CaO Supported W-Mo Mixed Oxide Catalysts for FAME Production from Waste Cooking Oil: Effect of Stoichiometry." *Energy Conversion and Management* 186 (2019): 218-229
- [214] Mansir, Nasir, Suhaimi S., and Safiah O. "Modified Waste Eggshell Derived Bifunctional Catalyst for Biodiesel Production from High FFA Waste Cooking Oil: A Review." *Renewable and Sustainable Energy Reviews* 113 (2019): 109247.
- [215] Moodley, Ismail, Shenelle N. H. F. Ramjith, and Roy M. O. Abrahams. "Environmentally Sustainable Acid Mine Drainage Remediation: Research Developments with a Focus on Waste/By-Products." *Minerals Engineering* 139 (2019).
- [216] Muliwa, A. M., Bouhamidi, M., and Nguimkeu, E. P. "Performance Evaluation of Eggshell Waste Material for Remediation of Acid Mine Drainage from Coal Dump Leachate." *Minerals Engineering* 138 (2019): 76-86.
- [217] Niju, S., Kancharla, A. K., and Ali, M. S. "Modification of Eggshell and Its Application in Biodiesel Production." *Journal of Saudi Chemical Society* 23 (2019): 881-895.
- [218] Onwubu, Simon C., Ramesh Chinta, and Nisha Kumar. "Characterization and In Vitro Evaluation of an Acid Resistant Nanosized Dental Eggshell-Titanium Dioxide Material." *Advanced Powder Technology* 30 (2019): 982-993.
- [219] Onwubu, Simon C., Shukla V., and Krishna T. N. R. "Reducing the Surface Roughness of Dental Acrylic Resins by Using an Eggshell Abrasive Material." *The Journal of Prosthetic Dentistry* 122 (2019): 363-368.
- [220] Pandey, A., Kumar, N., and Srivastava, V. K. "Experimental Studies on Zeta Potential of Flocculants for Harvesting of Algae." *Journal of Environmental Management* 250 (2019).

- [221] Pettinato, Marco, Salvatore R. D., and Domenico D. L. "Eggshell: A Green Adsorbent for Heavy Metal Removal in an MBR System." *Ecotoxicology and Environmental Safety* 174 (2019): 264-272.
- [222] Piker, Ali, Sıdıka Akbulut, and Rezzan Temiz. "A Green and Low-Cost Room Temperature Biodiesel Production Method from Waste Oil Using Eggshells as Catalyst." *Fuel* 239 (2019): 569-578.
- [223] Ravindran, Rajesh, Raghuvanshi, and Vigneshwaran. "Exploitation of Food Industry Waste for High-Value Products." *Trends in Biotechnology* 37 (2019): 949-961.
- [224] Ray, Surendra, Karuna K., and Rani, R. "Chicken Eggshell Powder as Dietary Calcium Source in Chocolate Cakes." *The Pharma Innovation* 6 (2019).
- [225] Rania Salama, Nasser Abdelkader, Ahmed El-Sayed, Mohamed El-Sayed, and Tamer Elshafey. "Histomorphometric Evaluation of a Nano-Sized Eggshell-Containing Supplement as a Natural Alloplast: An Animal Study." *The Saudi Dental Journal* (2021).
- [226] Sanjay B. Chavan, R. K. A. Das, and K. S. P. B. Ghosh. "Synthesis of Biodiesel from *Jatropha Curcas* Oil Using Waste Eggshell and Study of Its Fuel Properties." *RSC Advances* (2020).
- [227] Ewa Kowalska, Jacek Kucharska-Gaca, J. Kuźniacka, and L. Lewko. "Egg Quality Depending on the Diet with Different Sources of Protein and Age of the Hens." *Scientific Reports* (2021).
- [228] A. S. Bashir, H. M. Ali, and K. M. A. Al-Dubai. "Characterization of Raw Eggshell Powder as a Good Bio-Filler." *Journal of Engineering Research and Technology* (2021)
- [229] M. I. M. Ali, A. B. M. A. Rahman, and S. R. M. Hasnain "Eggshells as a sustainable adsorbent for heavy metal removal from wastewater." *Journal of Environmental Management*. (2019).
- [230] Pedro Toro, Mauro P. K. V. D. Oliveira, and Letícia A. Ferreira. "Eggshell, a New Bio-Filler for Polypropylene Composites." *Materials Letters* (2021).

- [231] Grzegorz Lesniewski and Jacek Stangierski. "What's New in Chicken Egg Research and Technology for Human Health Promotion? - A Review." *Trends in Food Science & Technology* (2020).
- [232] Hyung-Jin Choi, W. J. Lee, and B. H. Ryu. "Heavy Metal Removal from Acid Mine Drainage by Calcined Eggshell and Microalgae Hybrid System." *Environmental Science and Pollution Research* (2020).
- [233] Muhammad Waheed, M. R. Khan, and A. Rehman. "Extraction of Calcium from Eggshell Waste; Importance and Food Applications." *Trends in Food Science & Technology* (2021).
- [234] T. A. A. Bakar, M. A. M. Z. Mansor, and M. A. M. Khairi. "Eggshell Coated Grey Cast Iron for Corrosion Applications." *Jurnal Teknologi* (2019).
- [235] Basem N. Alhussary, R. Z. Alharbi, and S. N. Alshahrani. "Preparation and Characterization of Natural Hydroxyapatite from Eggshell and Seashell and Its Effect on Bone Healing." *Journal of Applied Veterinary Sciences* (2020).
- [236] Nehal Balouch, R. L. A. Z. Alharbi, and A. Albar. "Experimental Study on Compressive Strength of Concrete by Partial Replacement of Cement with Eggshell Powder." *Technical Journal of University of Engineering and Technology* (2021).
- [237] Shamsuddeen A. Salaudeen, A. Adediran, M. Y. O. K. Olatunji, and I. B. Akande. "Eggshell as a Potential CO₂ Sorbent in the Calcium Looping Gasification of Biomass." *Waste Management* (2020).
- [238] Zhi Wei, Min Zhang, and Jizheng Yan. "Application of Waste Eggshell as Low-Cost Solid Catalyst for Biodiesel Production." *Bioresource Technology* (2021).
- [239] Bartter, Hayley Diffey, Y. H. O'Leary, Bernd Häsler, Wilson Maulaga, and Richard Alders. "Use of Chicken Eggshell to Improve Dietary Calcium Intake in Rural Sub-Saharan Africa." *Maternal & Child Nutrition* (2019).
- [240] Ganesh B. Bandhavya, R. S. Narayan, Anil K. Mohan. "An experimental study on partial replacement of cement with eggshell powder in concrete." *International Research Journal of Engineering and Technology* (2020).

- [241] David Barbara, Jiri Prochazka, Gabriela H. Matouskova. "Use of eggshells as a raw material for production of calcium preparations." *Czech Journal of Food Sciences* (2020).
- [242] Ahmad S. Bashir, W. H. Qazi, R. C. Thakur. "Characterization of raw eggshell powder (ESP) as a good bio-filler." *Journal of Engineering Research and Technology*. (2020).
- [243] Abhijit Borhade, T. K. Tiwari, B. K. Tiwari. "Calcined eggshell as a cost effective material for removal of dyes from aqueous solution." *Applied Water Science* (2019).
- [244] Shirish B. Chavan, Vijay A. Pawar, Balaji K. Joshi. "Synthesis of biodiesel from *Jatropha curcas* oil using waste eggshell and study of its fuel properties." *RSC Advances*. (2020).
- [245] Dong Chen, Li Zhang, Wei Li. "Removal of phosphate and hexavalent chromium from aqueous solutions by engineered waste eggshell." *RSC Advance* (2020).
- [246] Hye Jin Choi. "Effect of eggshells for the harvesting of microalgae species." *Biotechnology & Biotechnological Equipment*. (2019).
- [247] Hae-Jin Choi. "Efficiency of methyl-esterified eggshell membrane biomaterials for intensified microalgae harvesting." *Environmental Engineering Research* (2020).
- [248] Hae-Jin Choi, Ji-Hoon Park, Kyung-Jin Kim. "Heavy metal removal from acid mine drainage by calcined eggshell and microalgae hybrid system." *Environmental Science and Pollution Research* (2020).
- [249] Luciana R. Brun, Maria Lupo, Daniel A. Delorenzi, Vittorio E. Di Loreto, Alejandra Rigalli. "Chicken Eggshell as Suitable Calcium Source at Home." *International Journal of Food Science and Nutrition* (2019).
- [250] Jessica Bartter, Holly Diffey, Y. H. Yeung, Fiona O'Leary, B. Häsler, Wilfred Maulaga, Rachael Alders. "Use of Chicken Eggshell to Improve Dietary Calcium Intake in Rural Sub-Saharan Africa." *Maternal & Child Nutrition* (2019).
- [251] Grzegorz Lesniewski, Jan Stangierski. "What's New in Chicken Egg Research and Technology for Human Health Promotion?-A Review." *Trends in Food Science & Technology* (2019).

- [252] Roberts, J.R. Factors affecting egg internal quality and egg shell quality in laying hens. *J. Poult. Sci.* 2004, 41, 161–177. John R. Roberts. "Factors affecting egg internal quality and eggshell quality in laying hens." *Journal of Poultry Science* (2019).
- [253] Hendra Basri, M. Sulastri. "Physical Quality of the First Egg of Japanese Quail (*Coturnix japonica* L.) after Given Liquid Herbal Concoction." *Mangifera Education* (2019).
- [254] Elzbieta Kowalska, Justyna Kucharska-Gaca, Joanna Kuzniacka, Lucyna Lewko, Ewa Gornowicz, Jacek Biesek, Maciej Adamski. "Egg quality depending on the diet with different sources of protein and age of the hens." *Scientific Reports* (2021).
- [255] Susanna, L.; Grilli, G.; Ferrari, L.; Battelli, G.; Pozzo, S.; Galasso, I.; Russo, R.; Brasca, M.; Reggiani, R.; Ferrante, V. Effect of Different Percentage of *Camelina sativa* Cake in Laying Hens Diet: Performance, Welfare, and Eggshell Quality. *Animals* 2020, 10, 1396.
- [256] Yifan Zhu, Junping Wang, Xueming Ding, Shuping Bai, Shuqing Ren, Qi Zeng, Yanjun Xuan, Zhe Wang, Kaiyu Zhang. "Effect of different tea polyphenol products on egg production performance, egg quality and antioxidative status of laying hens." *Animal Feed Science and Technology* (2020).
- [257] N. Y. Al-awwal, U. L. Ali. "Proximate Analyses of Different Samples of Egg Shells Obtained from Sokoto Market in Nigeria." *International Journal of Scientific Research* (2020).
- [258] N. M. M. Hassan. "Chicken Eggshell Powder as Dietary Calcium Source in Biscuits." *World Journal of Dairy & Food Sciences* (2020).
- [259] Raheel Ali, Syed T. Hasan, Mohammed A. Alssiraj. "Effect of Chicken Eggshell Powder Fortification on the Chemical Physical and Rheological characteristics of the Bread." *Biochemical and Cellular Archives* (2019).
- [260] CakesSoumitra Ray, Ashok K. Barman, Pankaj K. Roy, Biplab K. Singh. "Chicken Eggshell Powder as an Alternative to Calcium Supplements in Young Adults." *International Journal of Nutritional Sciences* (2020).

- [261] Huawen Zhang, Xianjun Yu, Zheng Sun, Yu Wei, Weina Liu. "Effects of different levels of egg shell powder on performance and egg quality of laying hens." *Journal of Poultry Science* (2019).
- [262] Liana M. Slater, Abhinandan Roy, Alex C. A. Phillips, James P. Moore, Chris M. H. D. Zeeman. "The impact of dietary eggshell on the eggshell quality of the hybrid layers." *Animal Nutrition* (2020).
- [263] H. Y. Choi, Y. S. Seo, J. Y. Choi, J. H. Park. "Quality characteristics and antioxidant activity of cookies added with eggshell powder." *Journal of the Korean Society of Food Science and Nutrition* (2020).
- [264] Yifan Wu, Xin Wang, Ying Guo, Huanxiong Zhang. "Eggshell Powder as a Novel Ingredient for Cookies: Influence on Baking Quality and Sensory Characteristics." *Journal of Food Science* (2020).
- [265] Srivastava D, Singh D, Kumar P. "A review on the potential utilization of chicken eggshells in agriculture and food industry." *Journal of Cleaner Production* (2020).
- [266] K. K. Rajasekaran, R. R. Ramamoorthy, S. N. Karthikeyan. "Utilization of waste eggshells as a biocatalyst for biodiesel production." *Renewable Energy* (2020).
- [267] M. P. Betim, G. L. Q. Guerra, M. E. R. A. B. Leite. "Eggshells as a new resource for soil amelioration in the cultivation of lettuce (*Lactuca sativa* L.)." *Sustainability* (2020).
- [268] F. M. A. Ali, M. H. A. Arshad, S. Y. A. Ali. "Potential of chicken eggshell as a functional ingredient in food products." *Journal of Food Science and Technology* (2021).
- [269] J. W. Okwu, U. A. Okafor, E. O. Ogbonna. "Effects of eggshell powder on the chemical composition and sensory properties of wheat flour bread." *Journal of Culinary Science & Technology* (2021).

- [270] Munisami, F. M. Nasir, N. A. Ali, N. J. Mohd. "Eggshell powder as a source of calcium in the formulation of functional cookies." *International Journal of Food Science & Technology* (2021).
- [271] Choi, H. J. Kim, Y. S. Seo. "Enhancing the quality of muffins with eggshell powder." *Food Science & Nutrition* (2021).
- [272] J. S. Kim, H. J. Lee, S. H. Park. "Physicochemical properties and antioxidant activity of pasta made with eggshell powder." *Journal of Food Processing and Preservation* (2021).
- [273] H. B. Bahar, H. P. Sharif, N. A. Hamid. "The effect of chicken eggshell powder on the properties of chicken nuggets." *Journal of Food Processing and Preservation* (2021).
- [274] Okoh, O. K. Olatunji. "Bioactive compounds in chicken eggshell: A review." *Journal of Nutritional Science* (2021).
- [275] Polzonetti, V.; Pucciarelli, S.; Vincenzetti, S.; Polidori, P. Dietary Intake of Vitamin d from Dairy Products Reduces the Risk of Osteoporosis. *Nutrients* (2020), 1743.
- [276] Carlberg, Carsten. "Vitamin D and its target genes." *Nutrients* 14, no. 7 (2022): 1354.
- [277] van Schoor, Natasja, Renate de Jongh, and Paul Lips. "Worldwide vitamin D status." *Feldman and Pike's Vitamin D* (2024): 47-75.
- [278] Arnold, Marcellus, and Anna Gramza-Michałowska. "Enzymatic browning in apple products and its inhibition treatments: A comprehensive review." *Comprehensive Reviews in food science and food safety* 21, no. 6 (2022): 5038-5076.
- [279] ten Haaf, D.S.M.; Balvers, M.G.J.; Timmers, S.; Eijsvogels, T.M.H.; Hopman, M.T.E.; Klein Gunnewiek, J.M.T. Determinants of Vitamin D Status in Physically Active Elderly in the Netherlands. *Eur. J. Nutr.* (2019), 58, 3121–3128.
- [280] Giustina, Andrea, John P. Bilezikian, Robert A. Adler, Giuseppe Banfi, Daniel D. Bikle, Neil C. Binkley, Jens Bollerslev et al. "Consensus statement on Vitamin D

status assessment and supplementation: whys, whens, and hows." *Endocrine Reviews* (2024).

- [281] Köller, Marcus. "Sarcopenia—a geriatric pandemic: a narrative review." *Wiener Medizinische Wochenschrift* 173, no. 3 (2023): 97-103.
- [282] Bellanti, Francesco, Aurelio Lo Buglio, and Gianluigi Vendemiale. "Muscle delivery of mitochondria-targeted drugs for the treatment of sarcopenia: rationale and perspectives." *Pharmaceutics* 14, no. 12 (2022).
- [283] Roger, Claudio Marocchi, Geert Carmeliet, Daniel Bikle, John H. White, Bess Dawson-Hughes, Paul Lips et al. "Skeletal and extraskeletal actions of vitamin D: current evidence and outstanding questions." *Endocrine reviews* 40, no. 4 (2019): 1109-1151.
- [284] Manoj, Preethy, Rosemarie Derwin, and Sherly George. "What is the impact of daily oral supplementation of vitamin D3 (cholecalciferol) plus calcium on the incidence of hip fracture in older people? A systematic review and meta-analysis." *International Journal of Older People Nursing* 18, no. 1 (2023): e12492.
- [285] Fernandes, Jean-Michel, Joao Fernandes Araujo, Jorge Miguel Vieira, Ana Cristina Pinheiro, and Antonio Augusto Vicente. "Tackling older adults' malnutrition through the development of tailored food products." *Trends in Food Science & Technology* 115 (2021): 55-73.
- [286] EFSA Panel on Nutrition, Novel Foods and Food Allergens (NDA), Dominique Turck, Torsten Bohn, Jacqueline Castenmiller, Stefaan de Henauw, Karen Ildico Hirsch-Ernst, Helle Katrine Knutsen et al. "Scientific advice related to nutrient profiling for the development of harmonised mandatory front-of-pack nutrition labelling and the setting of nutrient profiles for restricting nutrition and health claims on foods." *EFSA Journal* 20, no. 4 (2022): e07259.
- [287] Derrien, Muriel, Anne-Sophie Alvarez, and Willem M. de Vos. "The gut microbiota in the first decade of life." *Trends in microbiology* 27, no. 12 (2019): 997-1010.
- [288] Mazziotta, Chiara, Mauro Tognon, Fernanda Martini, Elena Torreggiani, and John Charles Rotondo. "Probiotics mechanism of action on immune cells and beneficial effects on human health." *Cells* 12, no. 1 (2023): 184.
- [289] Marasco, Giovanni, Giovanna Grazia Cirotta, Benedetta Rossini, Lisa Lungaro, Anna Rita Di Biase, Antonio Colecchia, Umberto Volta, Roberto De Giorgio, Davide Festi,

and Giacomo Caio. "Probiotics, prebiotics and other dietary supplements for gut microbiota modulation in celiac disease patients." *Nutrients* 12, no. 9 (2020).

[290] Martiniakova, Monika, Martina Babikova, Vladimira Mondockova, Jana Blahova, Veronika Kovacova, and Radoslav Omelka. "The role of macronutrients, micronutrients and flavonoid polyphenols in the prevention and treatment of osteoporosis." *Nutrients* 14, no. 3 (2022): 523.

[291] Arora, S.K.; Patel, A.A. In Vivo Effect of Two Different Dietary Fiber Blends on the Milk Calcium Bioavailability. *J. Food Sci. Technol.* (2019), 56, 2126–2133.

[292] Zendeboodi, Fatemeh, Nasim Khorshidian, Amir M. Mortazavian, and Adriano G. da Cruz. "Probiotic: conceptualization from a new approach." *Current Opinion in Food Science* 32 (2020): 103-123.

[293] Wang, Zechun, Shiyao Chen, Shenglan Yang, Qun Luo, Yancheng Jin, Wei Xie, Lijun Zhang, and Qian Li. "Light-weight refractory high-entropy alloys: A comprehensive review." *Journal of Materials Science & Technology* 151 (2023): 41-65.

[294] Jansson, P.A.; Curiac, D.; Ahrén, I.L.; Hansson, F.; Niskanen, T.M.; Sjögren, K.; Ohlsson, C. Probiotic Treatment Using a Mix of Three *Lactobacillus* Strains for Lumbar Spine Bone Loss in Postmenopausal Women: A Randomised, Double-Blind, Placebo-Controlled, Multicentre Trial. *Lancet Rheumatol.* (2019), 1, 4–5.

Chapter Three

Materials and Methods

3.1 Procurement of raw Materials

Fresh fruits viz., watermelons (*Citrullus lanatus*), pineapples (*Ananas comosus*) banana (*Musa genus*) and tigernut (*Cyperus esculentus*) used in production of tigernut milk were procured from Oje Market Ibadan, Oyo state while egg shell was collected from a poultry farm and the egg shell powder was produced in Human nutrition and dietetics kitchen in Lead City university Ibadan, Oyo State.

3.1.1 Preparation and Processing

The fruit samples collected were fresh and mature, with no insect bites or organoleptic degradation. Fruits were thoroughly washed under tap water to eliminate visible dirt. Tiger nut milk was produced by washing the tiger nuts, blending and extraction of the milk from the paste, by pressing the liquid through a cheese cloth. The Fruits were peeled and cut into smaller pieces and processed individual into smoothies before the combining of each. This preparation and processing study was carried out as indicated at Human Nutrition and dietetics kitchen, Lead City University Ibadan, Oyo state.

Egg shell powder was produced from chicken egg shells which was washed and spread on a baking sheet. Baked at 180°C for 20 minutes to dry them out and grinded into fine powder with the use of a coffee or spice grinder.

3.1.2 Production of Watermelon Smoothie

Fresh watermelon smoothie was produced by washing in distilled water, cutting of flesh from rind and deseeding, cutting into smaller sizes and blend in a food processor.

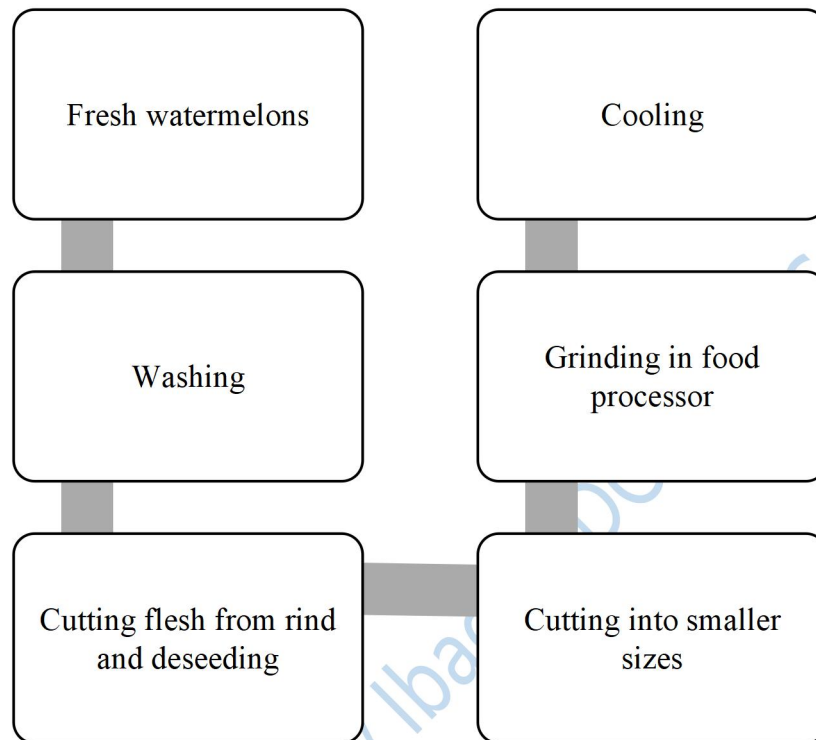


Figure 3.1: Flow chart for the production of watermelon smoothie
Source:¹

3.1.3 Production of Pineapple Smoothie

Fresh pineapple smoothie was produced by washing in distilled water, peeling, cutting into smaller sizes and blend in a food processor.

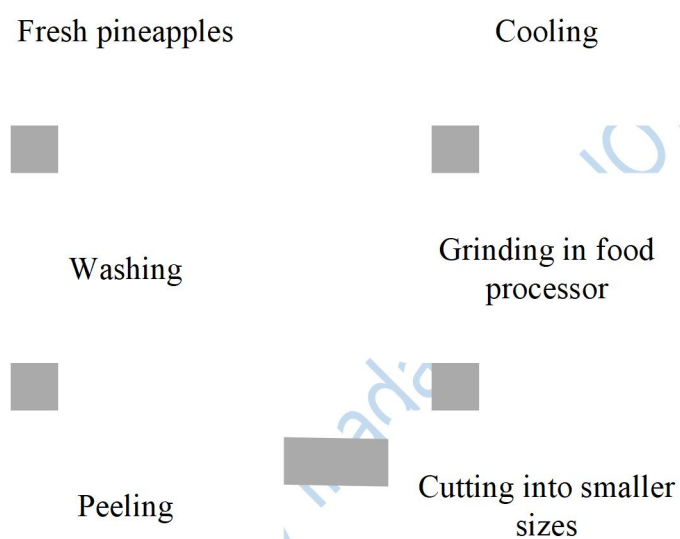


Figure 3.2: Flow chart for the production of pineapple smoothie
Source:²

3.1.4 Production of Banana Smoothie

Fresh bananas smoothie was produced by washing in distilled water, peeling, cutting into smaller sizes and blend in a food processor.

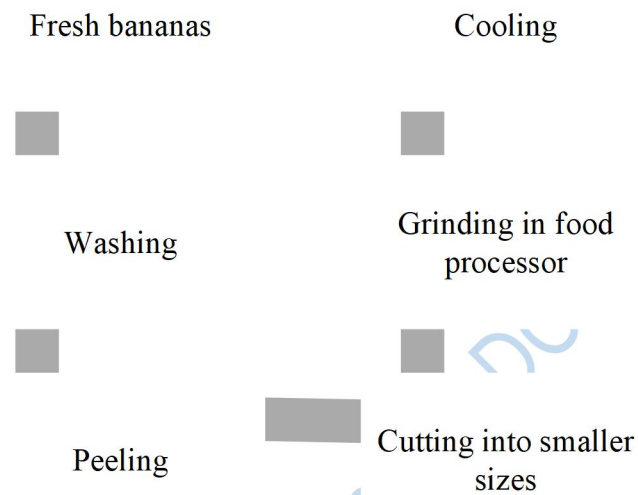


Figure 3.3: Flow chart for the production of banana smoothie
Source: ³

3.1.5 Production of Tigernut and Egg Shell Powders

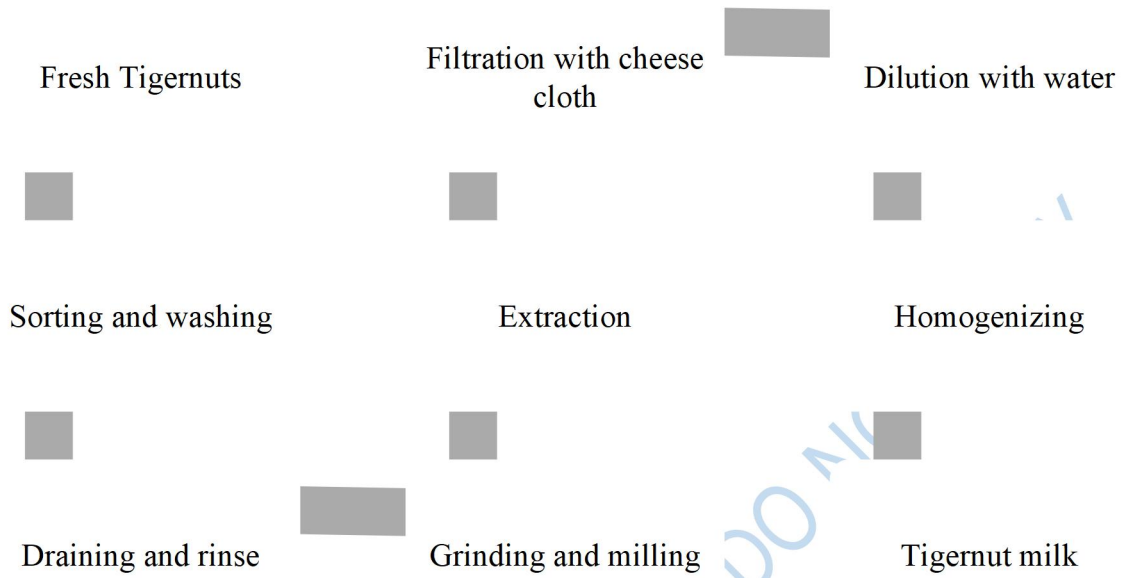


Figure 3.4: Flow chart for the production of tiger nut milk
Source: ⁴

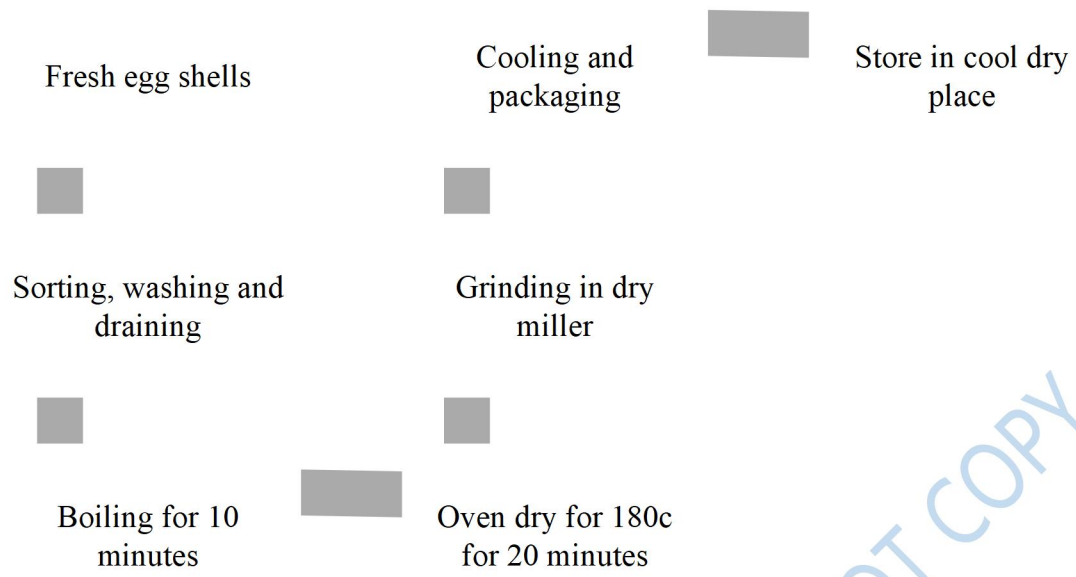


Figure 3.5: Flow chart for the production of eggshell powder

Source: ⁵

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Table 3.1 Proportions (%/100%) of ingredients in the tested formulations for Watermelon, Pineapple, Banana, Tiger nut milk and eggshell powder (Formulation A)

Table 3.1 shows the smoothies' mixing ratios. The smoothie sample 1 was created by blending 25%, 25%, 25%, 20%, and 5%. Watermelon, pineapple, and banana with tiger nut milk and eggshell powder. Sample 2 has the following ratio: 25%: 25%: 25%: 15%: 10%. Watermelon, pineapple, and banana with tiger nut milk and eggshell powder. Sample 3 included 25%: 25%: 25%: 10%: 15%. Watermelon, pineapple, and banana with tiger nut milk and eggshell powder. Sample 4 had 25%: 25%: 5%: 20%. Watermelon, pineapple, banana, tiger nut milk, and eggshell powder

Samples	Watermelon (%)	Pineapple (%)	Banana (%)	Tigernut Milk (%)	Eggshell Powder (%)
1	25	25	25	20	5
2	25	25	25	15	10
3	25	25	25	10	15
4	25	25	25	5	20

Table 3.2 Proportions (%/100%) of ingredients in the tested formulations for Watermelon, Pineapple, Banana, Tiger nut milk, animal milk and eggshell powder (Formulation B/ control)

Table 3.2, which functioned as the control, included identical proportions (25%: 25%: 25%: 25%). Watermelon: Pineapple: Banana with 25% Animal milk. An equal amount of the three fruits was chosen to assess the preferred combination of these fruits.

Sample	Watermelon (%)	Pineapple (%)	Banana (%)	Tiger nut Milk (%)	Eggshell Powder (%)	Animal milk (%)
5	25	25	25	0	0	25

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3.2 Methods

3.2.1 Phytochemical Analysis

In brief, approximately 0.25g of edible pieces from each sample were combined with 50 mL of solvent (water or 100% ethyl acetate) and standardised in a shaker (125 rpm) at 30°C for one hour. The extracts were vacuum filtered through JP41 filter paper to remove any residual parts, and the residues were extracted again with 50 mL of the same solvent and filtered under the same circumstances. The extracts were combined and concentrated under vacuum at 40°C, then stored at 70°C. The extractions were done in triplicate, the entire procedure was done in the dark and the extracts of the smoothie samples were evaluated for their phytochemical contents according to the standard processes of ^{6, 7, 8, 9}.

3.2.2 Minerals

The samples were ashed in the furnace and were digested according to AOAC, 2016 methods. Zinc, Sodium, Iron, Copper, Calcium, Phosphorus, Iron, Magnesium and Potassium contents were determined using the Flame- Atomic Absorption Spectrophotometry (Shimadzu AA-7000 series)⁶.

3.2.3 Vitamin determination

The vitamins (vitamin C, vitamin B6, vitamin B9, vitamin D, vitamin C and vitamin E) were analyzed according to the procedures of AOAC, 2016 methods ⁶.

3.2.4 Sensory Analysis

The smoothies' organoleptic properties were assessed using a 9-point hedonic scale ⁷. The test was employed to describe the intensity of smoothie samples; those who conducted sensory

evaluation on the samples were students of the Human Nutrition Dietetics Department, Lead City University Ibadan, Oyo State. 15 trained sensory panelists evaluated the prepared instant blended smoothies for taste, appearance, texture, aroma, and overall acceptability. The scale typically ranges from "dislike extremely" to "like extremely" Table water was presented to the panelists to rinse their mouth in-between sample testing.

3.2.5 Method of Data Analysis

The collected data were statistically analysed using IBM-SPSS version 23. The data was presented using descriptive statistics such as means and standard deviations.

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End notes

- [1] Wani, Sajad Ahmad, Jasmeet Kour, Raees-ul Haq, and Mohamed S. Elshikh, eds. *Fruits and Their Roles in Nutraceuticals and Functional Foods*. CRC Press, (2023).
- [2] Looi, Tze San. "Development of kombucha beverage derived from aquilaria malaccensis tea infused with pineapple and mint." PhD diss., UTAR, (2022).
- [3] Rombauer, Irma S., Marion Rombauer Becker, Ethan Becker, John Becker, and Megan Scott. *Joy of cooking: 2019 edition fully revised and updated*. Scribner, (2019).
- [4] Tong, S. C., L. F. Siow, T. K. Tang, and Y. Y. Lee. "Plant-based milk: unravel the changes of the antioxidant index during processing and storage—a review." *Critical Reviews in Food Science and Nutrition* 64, no. 14 (2024): 4603-4621.
- [5] Okpe, Promise Chinonso, Oladipo Folorunso, Victor Sunday Aigbodion, and Camillus Obayi. "Hydroxyapatite synthesis and characterization from waste animal bones and natural sources for biomedical applications." *Journal of Biomedical Materials Research Part B: Applied Biomaterials* 112, no. 7 (2024).
- [6] Bibi, Mamoona, Fayaz Asad, Sabrina Shahid, and Haseeba Kiramat. "Anatomical, histochemical and phytochemical screening of the vegetative parts of *Eichhornia crassipes*." *Journal of Pure and applied Agriculture* 8, no. 3 (2023).
- [7] Mansoori, Aadil, Nitesh Singh, Sharad Kumar Dubey, Tarun K. Thakur, Noam Alkan, Subha Narayan Das, and Anirudh Kumar. "Phytochemical characterization and assessment of crude extracts from *Lantana camara* L. for antioxidant and antimicrobial activity." *Frontiers in Agronomy* 2 (2020): 582268.
- [8] Ramírez-Telles, Mariana, Juan José Mora-Román, and Milena Fallas-Cartín. "Registro sanitario de medicamentos biológicos y biotecnológicos en América Latina." *Ars Pharmaceutica (Internet)* 62, no. 2 (2021): 131-143.
- [9] Tsong, Jia Ling, Lucky Poh Wah Goh, Jualang Azlan Gansau, and Siew-Eng How. "Review of *Nephelium lappaceum* and *Nephelium ramboutan-ake*: a high potential supplement." *Molecules* 26, no. 22 (2021).

- [10] Tsong, Jia Ling, Lucky Poh Wah Goh, Jualang Azlan Gansau, and Siew-Eng How. "Review of *Nephelium lappaceum* and *Nephelium ramboutan-ake*: a high potential supplement." *Molecules* 26, no. 22 (2021).
- [11] Ijarotimi, Oluwole Steve, Damilola Alex Fakayejo, and Timilehin David Oluwajuyitan. "Nutritional characteristics, glycaemic index and blood glucose lowering property of gluten-free composite flour from wheat (*Triticum aestivum*), soybean (*Glycine max*), oat-bran (*Avena sativa*) and rice-bran (*Oryza sativa*)." *Applied Food Research* 1, no. 2 (2021).

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Chapter Four Results

4.1. Micronutrient composition

The nutrient content of the samples of smoothies, for vitamin content, Sample 1 has the second highest amount of Vitamin B9, highest amount of Vitamin C, and the overall highest vitamin content. Sample 2 has the second highest amount of Vitamin C, and the overall second highest vitamin content. Sample 4 has the second highest amount of Vitamin B6, and the highest amounts of Vitamins D and E. Sample 5 has the highest amounts of Vitamins B6, 2B9, and E, and the second highest amount of Vitamin D.

In terms of mineral content, Sample 3 has the highest amount of Potassium. Sample 4 has the second highest amounts of calcium, phosphorus, magnesium, sodium, copper, zinc, and iron, and the overall second highest mineral content. Sample 5 has the highest amount of all the minerals measured, and the overall highest mineral content.

Table 4.1 Nutrient Contents of Smoothies by Samples

SN	Parameter	$(\bar{x} \pm SD)$				
		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Vitamin Content						
1	Vitamin B6	0.43 ± 0.01	0.49 ± 0.01	0.58 ± 0.03	**0.63 ± 0.01	*0.83 ± 0.01
2	Vitamin B9	**0.52 ± 0.01	0.47 ± 0.02	0.48 ± 0.03	0.44 ± 0.02	*0.60 ± 0.03
3	Vitamin D	0.04 ± 0.00	0.05 ± 0.00	0.05 ± 0.00	*0.06 ± 0.00	**0.06 ± 0.01
4	Vitamin C	*14.88 ± 0.15	**12.97 ± 0.03	10.57 ± 0.42	8.73 ± 1.07	8.37 ± 0.19
5	Vitamin E	0.13 ± 0.00	0.13 ± 0.00	0.13 ± 0.00	*0.15 ± 0.00	*0.15 ± 0.00
	Average	*3.20 ± 0.04	**2.82 ± 0.01	2.36 ± 0.10	2.00 ± 0.22	2.00 ± 0.05
Mineral Content						
1	Potassium	592.38 ± 0.00	573.74 ± 8.07	**615.67 ± 8.07	592.38 ± 0.00	*750.79 ± 16.14
2	Calcium	610.76 ± 0.00	658.23 ± 0.00	1602.32 ± 0.00	**1739.45 ± 0.00	*2135.02 ± 0.00
3	Phosphorus	190.86 ± 0.00	205.70 ± 0.00	500.73 ± 0.00	**543.58 ± 0.00	*667.19 ± 0.00
4	Magnesium	128.31 ± 0.00	138.28 ± 0.00	336.62 ± 0.00	**365.43 ± 0.00	*448.53 ± 0.00
5	Sodium	244.30 ± 0.00	263.29 ± 0.00	640.93 ± 0.00	**695.78 ± 0.00	*854.01 ± 0.00
6	Copper	0.09 ± 0.00	0.10 ± 0.00	0.25 ± 0.00	**0.27 ± 0.00	*0.33 ± 0.00
7	Zinc	0.29 ± 0.00	0.31 ± 0.00	0.76 ± 0.00	**0.82 ± 0.00	*1.01 ± 0.00
8	Iron	0.68 ± 0.00	0.73 ± 0.00	1.78 ± 0.00	**1.94 ± 0.00	*2.38 ± 0.00
	Average	220.96 ± 0.00	230.05 ± 1.01	462.38 ± 1.01	**492.46 ± 0.00	*607.41 ± 2.02

Key: \bar{x} = mean, SD = standard deviation, * = highest value, ** = second highest value

Source: Laboratory Test (2023)

4.2 Phytochemicals composition

Sample 3 has second highest amount of flavonoid. Sample 4 has the second highest amount of total phenolic, total carotenoid, tannin, saponin, and terpenoid, and the second highest phytochemical content. Sample 5 has the highest amount of all the phytochemicals

Table 4.2 Phytochemicals composition by samples

$(\bar{x} \pm SD)$						
SN	Parameter	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Phytochemical Content						
1	Phenolic	0.41 ± 0.01	0.42 ± 0.05	0.42 ± 0.00	**0.45 ± 0.00	*0.57 ± 0.01
2	Flavonoid	5.04 ± 0.01	5.20 ± 0.01	**5.25 ± 0.05	5.19 ± 0.09	*6.25 ± 0.11
3	Carotenoid	0.14 ± 0.00	0.15 ± 0.02	0.08 ± 0.01	**0.17 ± 0.00	*0.37 ± 0.01
4	Tannin	0.13 ± 0.00	0.13 ± 0.00	0.59 ± 0.01	**0.62 ± 0.00	*0.71 ± 0.05
6	Saponin	0.02 ± 0.00	0.05 ± 0.00	0.08 ± 0.00	**0.11 ± 0.00	*0.16 ± 0.01
7	Terpenoid	0.77 ± 0.03	0.54 ± 0.00	1.15 ± 0.00	**1.74 ± 0.01	*1.91 ± 0.01
	Average	1.01 ± 0.01	1.03 ± 0.01	1.21 ± 0.01	**1.44 ± 0.02	*1.61 ± 0.03

Key: \bar{x} = mean, SD = standard deviation, * = highest value, ** = second highest value

Source: Laboratory Test

4.3 Sensory Properties and General Acceptability of Smoothies

Sample 1 has the second highest evaluation for all sensory indices, and the overall second highest sensory evaluation. Sample 4 has the second highest evaluation for texture alongside Sample 1. Sample 5 has the highest evaluation for all sensory indices, and the overall highest sensory evaluation. In terms of acceptability, Sample 5 was most acceptable by the panelists, with Sample 4 coming next.

Table 4.3 Sensory Properties and General Acceptability of Smoothies by Samples

SN	Parameter	$(\bar{x} \pm SD)$				
		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Sensory Evaluation						
1	Appearance	**8.33 ± 0.58	7.33 ± 1.53	7.67 ± 0.58	7.33 ± 0.58	*9.00 ± 0.00
2	Taste	**8.67 ± 0.58	7.67 ± 1.15	6.67 ± 0.58	7.00 ± 2.00	*9.00 ± 0.00
3	Texture	**7.67 ± 0.58	7.00 ± 0.00	6.33 ± 1.15	**7.67 ± 0.58	*9.00 ± 0.00
4	Aroma	**8.00 ± 0.00	8.00 ± 1.00	6.33 ± 1.15	8.00 ± 1.00	*9.00 ± 0.00
	Average	**8.17 ± 0.43	7.50 ± 0.92	6.75 ± 0.87	7.50 ± 1.04	*9.00 ± 0.00
General Acceptability		7.67 ± 0.58	8.00 ± 1.00	8.00 ± 1.00	**8.00 ± 0.00	*9.00 ± 0.00

Key: \bar{x} = mean, *SD* = standard deviation, * = highest value, ** = second highest value

Source: Laboratory Test (2023)

4.4 Discussions

The study compared the nutritional composition of smoothies made from watermelon, banana, pineapple, tiger nut milk, eggshell powder. The study achieved the following specific objectives produce smoothie from watermelon, pineapple, banana, tiger nut milk and egg shell powder; evaluate the micronutrients present in smoothie produced from watermelon, pineapple, banana, tiger nut milk and egg shell powder; evaluate the phytochemicals present in smoothie produced from watermelon, pineapple, banana, tiger nut milk and egg shell powder; conduct the sensory properties and general acceptability of the smoothie produced from watermelon, pineapple, banana, tiger nut milk and egg shell powder.

The findings show that the second and third objective show that smoothie made from 25% of Watermelon, pineapple, banana with 25% tiger nut milk and 5% egg shell powder (Sample 1) has the second highest amount of Vitamin B9, highest amount of Vitamin C, and the overall highest vitamin content. Smoothie made from 25% of watermelon, pineapple, banana with 15% tiger nut milk and 10% eggshell powder (Sample 2) has the second highest amount of Vitamin C, and the overall second highest vitamin content. Smoothie made from 25% watermelon, pineapple, banana with 10% tiger nut milk and 20% eggshell powder (Sample 4) has the second highest amount of Vitamin B6, and the highest amounts of Vitamins D and E. Smoothie made from 25% watermelon, pineapple, banana with 25% animal milk (Sample 5) has the highest amounts of Vitamins B6, B9, and E, and the second highest amount of Vitamin D.

This may imply that Sample 4 smoothie with the highest % of eggshell powder has the highest amount of Vitamin D which is vital in bone formation according to ¹ Adequate

calcium and vitamin D levels, either through food or calcium supplementation, are necessary for the prevention of hip fractures and osteoporosis.

Consumption of extra vitamin D does not reduce the risk of having bone fracture, this however does not suggest that individuals with vitamin D pills should discard them especially if recommended by their physicians especially in cases of mal-absorption or other bone related issues. It is important to note however that screening for levels of vitamin D in the blood should be reduced substantially as it often does not benefit majority of the population, rather it increases the cost of health care ².

In terms of mineral content, smoothie made from 25% watermelon, pineapple, and banana with 10% tiger nut milk and 15% eggshell powder (Sample 3) has the highest amount of Potassium. Smoothie made from 25% watermelon, pineapple, banana with 10% tiger nut milk and 20% eggshell powder (Sample 4) has the second highest amounts of calcium, phosphorus, magnesium, sodium, copper, zinc, and iron, and the overall second highest mineral content. Smoothie made from 25% watermelon, pineapple, banana with 25% animal milk (Sample 5) has the highest amount of all the minerals measured, and the overall highest mineral content. Sample 4 has the second highest amount of minerals which as the result of high amount of eggshell powder (20%) present in the sample, the findings showed that the calcium carbonate shell is being utilized in the treatment of calcium insufficiency in people and animals. A single eggshell weighs six grams and contains about 2.2g of calcium, while eggshell powder has been used to promote bone mineralization and growth ³.

Contrary to what was documented in an earlier report ⁴, higher values were obtained for mineral composition of smoothies produced from this study. Sample 3 (615.67 ± 8.07 ; 1602.32 ± 0.00) and sample 4 (592.38 ± 0.00 ; 1739.45 ± 0.00) had higher potassium and calcium, respectively. The values for potassium in this study were higher than 34.63 ± 0.01

mg/100 g reported in a previous study ⁵. This variation in the composition of minerals might be associated with the different methods applied by the researchers as well as the conditions under which the fruits were cultivated and or of storage.

In the same vein, Smoothie made from 25% watermelon, pineapple, and banana with 10% tiger nut milk and 15% eggshell powder (Sample 3) has second highest amount of flavonoid. Smoothie made from 25% watermelon, pineapple, and banana with 10% tigernut milk and 20% eggshell powder (Sample 4) the second highest amount of total phenolic, total carotenoid, tannin, saponin, and terpenoid, and the second highest phytochemical content. Smoothie made from 25% watermelon, pineapple, banana with 25% animal milk (Sample 5) has the highest amount of all the phytochemicals measured.

This can be explained in the light of Sample 3 and 4 has second highest amount of phytochemicals with sample 5 with the highest phytochemicals. Phytochemicals are recognized to exert some health benefits. Polyphenolic compounds such as flavonols and phenols for example are bioactive agents present in foods with anti-diabetic, -hypertensive and –inflammatory attributes.

These phytochemicals in plants have several kinds of therapeutic attributes ⁶ and may exhibit health protective capabilities through multiple means. One of these ways include as antioxidants, protecting the cells of the body against damaging effect of free radicals (eg. carotenoids and polyphenols) ⁷, anti-bactericidal activities, anti-malarial (eg. alkaloids), anti-viral and anti-tumoral (tannins) attributes^{8,9}

Values obtained for total polyphenol content in this study were far lower than 77.7mg and 68.3mg GAE/g reported ¹⁰ during the methanolic extract of the bark and leaf of *G. velutinus*, respectively. Perhaps, this could be due to the fact that the contents of polyphenols in the bark

and leaf of plants are more concentrated compared to fruits used in this study. The occurrence of these chemicals in the smoothies suggest that they possess nutraceutical properties¹¹

Findings in answer to the second objectives shows that Smoothie made from 25% of Watermelon, pineapple, banana with 25% tiger nut milk and 5% egg shell powder (Sample 1) has the second highest evaluation for all sensory indices, and the overall second highest sensory evaluation. Smoothie made 25% watermelon, pineapple, banana with 10% tiger nut milk and 20% eggshell powder from (Sample 4) has the second highest evaluation for texture alongside the smoothie made from 25% of Watermelon, pineapple, banana with 25% tiger nut milk and 5% egg shell powder (Sample 1). Smoothie made from 25% watermelon, pineapple, banana with 25% animal milk (Sample 5) has the highest evaluation for all sensory indices, and the overall highest sensory evaluation. In terms of acceptability, Smoothie made from 25% watermelon, pineapple, banana with 25% animal milk (Sample 5) was most acceptable by the panelists, with the smoothie made from 25% watermelon, pineapple, banana with 10% tiger nut milk and 20% eggshell powder from (Sample 4) coming next.

These findings agree with those of¹² which explained that the aim of conducting sensory evaluation is to measure the perception of consumers with respect to a product coupled with the behavioral, affectionate, and emotive reactions emanating from such perception. Smoothies produced were perceived as having moderate to high acceptability by the consumers with respect to all qualities monitored. Colour, flavor, texture and overall acceptability of these samples were not significantly different though the smoothies from the different samples have similar taste score, smoothie from sample 1 was tastier than the other smoothies evaluated. These suggest that having a uniform blend of fruits in a smoothie may yield an acceptable smoothie rather than trying to project the taste of an individual fruit over others. Therefore, trying to project the taste of tiger nut or eggshell powder than the other

fruits did not produce the envisaged outcome. It was reported in an earlier study that the calcium content of chocolate and wheat bread was improved with the use of powdered egg shell. The authors concluded that appearance and general acceptability was enhanced though aroma and taste were not influenced¹³.Result obtained in this study contradicts earlier research where smoothies sample 5 flavor were rated higher than other alternatives¹⁴

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Endnotes

- [1] Obeagu, Emmanuel Ifeanyi, Yahye Abdi Ahmed, Getrude Uzoma Obeagu, U. O. Bunu, O. P. C. Ugwu, and Esther U. Alum. "Biomarkers of breast cancer: Overview." *Int. J. Curr. Res. Biol. Med* 1 (2023): 8-16.
- [2] Girelli, Anna Maria, Maria Luisa Astolfi, and Francesca Romana Scuto. "Agro-industrial wastes as potential carriers for enzyme immobilization: A review." *Chemosphere* 244 (2020): 125368.
- [3] Wu, Wenmin, Lichao He, Yanhui Liang, Lili Yue, Weiming Peng, Guofeng Jin, and Meihu Ma. "Preparation process optimization of pig bone collagen peptide-calcium chelate using response surface methodology and its structural characterization and stability analysis." *Food Chemistry* 284 (2019): 80-89
- [4] Alake, O. T., D. O. Abraham, T. O. Akinola, O. O. Fatunmibi, T. O. Agboola, and S. I. Akua. "Production and Evaluation of Smoothies made from Various Fruits Sold in Lagos Market." *International Journal of Innovative Science and Research Technology* 7, no. 1 (2022): 642-646.
- [5] Pinto, Teresa, Alice Vilela, and Fernanda Cosme. "Chemical and sensory characteristics of fruit juice and fruit fermented beverages and their consumer acceptance." *Beverages* 8, no. 2 (2022): 33.
- [6] Adegbola, Peter Ifeoluwa, Adewale Adetutu, and Temitope Deborah Olaniyi. "Antioxidant activity of Amaranthus species from the Amaranthaceae family–A review." *South African Journal of Botany* 133 (2020): 111-117.
- [7] Delarue, J. Overview of sensory methods for the evaluation of nonfood products. *Non-food sensory practice*. (2022).
- [8] Bazrafshan, S., M. Mizani, Gh Pazuki, and Sh Shahriari. "Colorimetric and Sensory Properties of for Tube Feeding Formulated by Gelatin and Maltodextrin." *Journal of Food Biosciences and Technology* 13, no. Fall 2023 (2023): 49-62.
- [9] Onodugo, N. G., E. C. Agbo, C. M. Ikwumere, N. P. Onwubuya, I. M. Nnadi, E. P. Ezeja, and B. Chima. "Nutritional Composition and Sensory Properties of Smoothies Produced from Pineapple (*Ananus Comosus*), Watermelon (*Citrus Lanatus Thumb*) and Mango (*Mangifera Indica L*)." *Journal For Family & Society Research* 1, no. 2 (2022).

- [10] Sharma, A. M. I. T., and S. A. P. N. A. Tyagi. "Antimicrobial screening and phytochemical analysis of Citrus cultivars growing in vivo & in vitro." *J Phytologic Res* 32 (2019): 35-42
- [11] Delarue, J. Overview of sensory methods for the evaluation of nonfood products. *Non-food sensory practice*. (2022).
- [12] Waheed, Marium, Muhammad Yousaf, Aamir Shehzad, Muhammad Inam-Ur-Raheem, Muhammad Kashif Iqbal Khan, Moazzam Rafiq Khan, Naveed Ahmad, and Rana Muhammad Aadil. "Channelling eggshell waste to valuable and utilizable products: a comprehensive review." *Trends in Food Science & Technology* 106 (2020): 78-90.
- [13] Waheed, Marium, Masood Sadiq Butt, Aamir Shehzad, Noranizan Mohd Adzahan, Muhammad Asim Shabbir, Hafiz Ansar Rasul Suleria, and Rana Muhammad Aadil. "Eggshell calcium: A cheap alternative to expensive supplements." *Trends in Food Science & Technology* 91 (2019): 219-230.
- [14] O. T., D. O. Abraham, T. O. Akinola, O. O. Fatunmibi, T. O. Agboola, and S. I. Akua. "Production and Evaluation of Smoothies made from Various Fruits Sold in Lagos Market." *International Journal of Innovative Science and Research Technology* 7, no. 1 (2022): 642-646.

Conclusion

5.1 Summary of findings

This study has provided a reference point for the nutritional profile and sensory attributes of watermelon, pineapple, banana, plant-based milk and eggshell powder based smoothies. The result demonstrated that the smoothie sample 4 contained high calcium, phosphorus, magnesium, sodium, copper, zinc, and iron, vitamin B6, vitamin D and vitamin E an appreciable amount of vitamin B9 the second highest amount of total phenolic, total carotenoid, tannin, saponin, and terpenoid,

Sensory evaluation showed that the smoothies were well accepted by the panelists, indicating that they can be used to diversify diets. Consuming smoothie made with plant-based milk and eggshell powder can enhance the consumption of healthier and nutrition-rich drinks, thus aiding to ameliorate the growing incidence in deficiency of calcium and its resultant consequences on the populace.

5.2 Conclusion

This study has provided a reference point for the nutritional profile and sensory attributes of watermelon, pineapple, banana, plant-based milk and eggshell powder based smoothies. The result demonstrated that the smoothie sample 4 contained high calcium, phosphorus, magnesium, sodium, copper, zinc, and iron, vitamin B6, vitamin D and vitamin E an appreciable amount of vitamin B9 with highest amount of anthocyanin, the second highest amount of total phenolic, total carotenoid, tannin, saponin, and terpenoid,

Sensory evaluation showed that the smoothies were well accepted by the panelists, indicating that they can be used to diversify diets. Because potential pathogens can be removed from eggshells, we believe that eggshell use as a calcium supplement is safe and may help to

alleviate calcium deficiencies in low income communities, consuming smoothie made with plant-based milk and eggshell powder can enhance the consumption of healthier and nutrition-rich drinks, thus aiding to ameliorate the growing incidence in deficiency of calcium and its resultant consequences on the populace.

5.3 Recommendation

1. Promoting smoothies as a healthy alternative to commercial beverages is crucial as their popularity grows.
2. Smoothies with fruits, plant-based milk, and eggshell powder can help prevent calcium deficiencies and associated expenditures.
3. Industries can get large quantity of eggshell waste from poultries, process it and make it available in capsules and other ready made options.
4. Eggshell powder easy and safe processing methods in low income countries should be addressed in community advocacies.

5.4 Contribution to Knowledge

1. Promoting the use of poultry waste, chicken eggshell doesn't only increase the knowledge of people about the alternative ways to increase their calcium intake
2. The use of eggshell powder as a functional in the food industry, such as snacks for children can be incorporated without change texture is achievable at a regulated percentage
3. This higher production of egg generates a greater quantity of eggshell waste, which is normally discarded as garbage and ends up in landfills. Without going through proper treatment, this solid waste possesses significant environmental pollution due to its availability and chemical composition, with the study the important roles eggshell can play in our environment when fully utilized is highlighted

5.4 Suggested Area for Further Research

1. The use of eggshell as a means of promoting sustainable solution in our everyday life in African should be investigated further
2. Further applied study is needed to evaluate women of reproductive age's capacity to use eggshell and find any safety concerns.

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Appendix A

Data Analysis Output

DESCRIPTIVES

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
VITAMIN_B6	1.00	3	.4333	.01155	.00667	.4046	.4620	.42	.44
	2.00	3	.4933	.00577	.00333	.4790	.5077	.49	.50
	3.00	3	.5833	.02887	.01667	.5116	.6550	.55	.60
	4.00	3	.6300	.01000	.00577	.6052	.6548	.62	.64
	5.00	3	.8300	.01000	.00577	.8052	.8548	.82	.84
	Total	15	.5940	.14181	.03662	.5155	.6725	.42	.84
VITAMIN_B9	1.00	3	.5233	.00577	.00333	.5090	.5377	.52	.53
	2.00	3	.4733	.02309	.01333	.4160	.5307	.46	.50
	3.00	3	.4800	.02646	.01528	.4143	.5457	.45	.50
	4.00	3	.4433	.02082	.01202	.3916	.4950	.42	.46
	5.00	3	.5967	.02517	.01453	.5342	.6592	.57	.62
	Total	15	.5033	.05802	.01498	.4712	.5355	.42	.62
VITAMIN_D	1.00	3	.0433	.00577	.00333	.0290	.0577	.04	.05

	2.00	3	.0500	.00000	.00000	.0500	.0500	.05	.05
	3.00	3	.0533	.00577	.00333	.0390	.0677	.05	.06
	4.00	3	.0567	.00577	.00333	.0423	.0710	.05	.06
	5.00	3	.0567	.00577	.00333	.0423	.0710	.05	.06
	Total	15	.0520	.00676	.00175	.0483	.0557	.04	.06
VITAMIN_C	1.00	3	14.8833	.15275	.08819	14.5039	15.2628	14.75	15.05
	2.00	3	12.9667	.02887	.01667	12.8950	13.0384	12.95	13.00
	3.00	3	10.5667	.41932	.24210	9.5250	11.6083	10.30	11.05
	4.00	3	8.7333	1.06927	.61734	6.0771	11.3895	7.80	9.90
	5.00	3	8.3667	.18930	.10929	7.8964	8.8369	8.15	8.50
	Total	15	11.1033	2.62165	.67691	9.6515	12.5552	7.80	15.05
VITAMIN_E	1.00	3	.1300	.00000	.00000	.1300	.1300	.13	.13
	2.00	3	.1300	.00000	.00000	.1300	.1300	.13	.13
	3.00	3	.1300	.00000	.00000	.1300	.1300	.13	.13
	4.00	3	.1433	.00577	.00333	.1290	.1577	.14	.15
	5.00	3	.1533	.00577	.00333	.1390	.1677	.15	.16

	T o t a l	15	.1373	.01033	.00267	.1316	.1431	.13	.16
POTASSIUM	1. 0 0	3	592.38	.000	.000	592.38	592.38	592	592
	2. 0 0	3	573.74	8.071	4.660	553.69	593.79	564	578
	3. 0 0	3	615.67	8.071	4.660	595.62	635.72	606	620
	4. 0 0	3	592.38	.000	.000	592.38	592.38	592	592
	5. 0 0	3	750.79	16.143	9.320	710.69	790.89	732	760
	T o t a l	15	624.99	66.965	17.290	587.91	662.08	564	760
	CALCIUM	1. 0 0	3	610.760 0	.00000	.00000	610.760 0	610.760 0	610.76
2. 0 0		3	658.230 0	.00000	.00000	658.230 0	658.230 0	658.23	658.23
3. 0 0		3	1602.32 00	.00000	.00000	1602.32 00	1602.32 00	1602.3 2	1602.3 2
4. 0 0		3	1739.45 00	.00000	.00000	1739.45 00	1739.45 00	1739.4 5	1739.4 5
5. 0 0		3	2135.02 00	.00000	.00000	2135.02 00	2135.02 00	2135.0 2	2135.0 2
T o t a l		15	1349.15 60	630.749 73	162.858 88	999.858 4	1698.45 36	610.76	2135.0 2
PHOSPHORUS		1. 0 0	3	190.860 0	.00000	.00000	190.860 0	190.860 0	190.86
	2. 0 0	3	205.700 0	.00000	.00000	205.700 0	205.700 0	205.70	205.70
	3. 0 0	3	500.730 0	.00000	.00000	500.730 0	500.730 0	500.73	500.73

	4. 0 0	3	543.580 0	.00000	.00000	543.580 0	543.580 0	543.58	543.58
	5. 0 0	3	667.190 0	.00000	.00000	667.190 0	667.190 0	667.19	667.19
	T o t a l	15	421.612 0	197.108 86	50.8932 9	312.456 8	530.767 2	190.86	667.19
MAGNESSIUM	1. 0 0	3	128.310 0	.00000	.00000	128.310 0	128.310 0	128.31	128.31
	2. 0 0	3	138.280 0	.00000	.00000	138.280 0	138.280 0	138.28	138.28
	3. 0 0	3	336.620 0	.00000	.00000	336.620 0	336.620 0	336.62	336.62
	4. 0 0	3	365.430 0	.00000	.00000	365.430 0	365.430 0	365.43	365.43
	5. 0 0	3	448.530 0	.00000	.00000	448.530 0	448.530 0	448.53	448.53
	T o t a l	15	283.434 0	132.510 31	34.2140 2	210.052 2	356.815 8	128.31	448.53
SODIUM	1. 0 0	3	244.300 0	.00000	.00000	244.300 0	244.300 0	244.30	244.30
	2. 0 0	3	263.290 0	.00000	.00000	263.290 0	263.290 0	263.29	263.29
	3. 0 0	3	640.930 0	.00000	.00000	640.930 0	640.930 0	640.93	640.93
	4. 0 0	3	695.780 0	.00000	.00000	695.780 0	695.780 0	695.78	695.78
	5. 0 0	3	854.010 0	.00000	.00000	854.010 0	854.010 0	854.01	854.01
	T o t a l	15	539.662 0	252.302 07	65.1441 1	399.941 8	679.382 2	244.30	854.01
COPPER	1. 0 0	3	.0900	.00000	.00000	.0900	.0900	.09	.09

	2. 0 0	3	.1000	.00000	.00000	.1000	.1000	.10	.10
	3. 0 0	3	.2500	.00000	.00000	.2500	.2500	.25	.25
	4. 0 0	3	.2700	.00000	.00000	.2700	.2700	.27	.27
	5. 0 0	3	.3300	.00000	.00000	.3300	.3300	.33	.33
	T o t a l	15	.2080	.09937	.02566	.1530	.2630	.09	.33
ZINC	1. 0 0	3	.2900	.00000	.00000	.2900	.2900	.29	.29
	2. 0 0	3	.3100	.00000	.00000	.3100	.3100	.31	.31
	3. 0 0	3	.7600	.00000	.00000	.7600	.7600	.76	.76
	4. 0 0	3	.8200	.00000	.00000	.8200	.8200	.82	.82
	5. 0 0	3	1.0100	.00000	.00000	1.0100	1.0100	1.01	1.01
	T o t a l	15	.6380	.29824	.07700	.4728	.8032	.29	1.01
IRON	1. 0 0	3	.6800	.00000	.00000	.6800	.6800	.68	.68
	2. 0 0	3	.7300	.00000	.00000	.7300	.7300	.73	.73
	3. 0 0	3	1.7800	.00000	.00000	1.7800	1.7800	1.78	1.78
	4. 0 0	3	1.9400	.00000	.00000	1.9400	1.9400	1.94	1.94
	5. 0 0	3	2.3800	.00000	.00000	2.3800	2.3800	2.38	2.38

	T o t a l	15	1.5020	.70382	.18173	1.1122	1.8918	.68	2.38
TOTAL_PHENOL IC	1. 0 0	3	.4100	.01000	.00577	.3852	.4348	.40	.42
	2. 0 0	3	.4200	.04359	.02517	.3117	.5283	.37	.45
	3. 0 0	3	.4200	.00000	.00000	.4200	.4200	.42	.42
	4. 0 0	3	.4467	.00577	.00333	.4323	.4610	.44	.45
	5. 0 0	3	.5733	.00577	.00333	.5590	.5877	.57	.58
	T o t a l	15	.4540	.06533	.01687	.4178	.4902	.37	.58
	FLAVONOID	1. 0 0	3	5.04	.012	.007	5.01	5.07	5
2. 0 0	3	5.20	.010	.006	5.18	5.22	5	5	
3. 0 0	3	5.25	.050	.029	5.13	5.37	5	5	
4. 0 0	3	5.19	.093	.054	4.96	5.42	5	5	
5. 0 0	3	6.25	.114	.066	5.97	6.54	6	6	
T o t a l	15	5.39	.457	.118	5.13	5.64	5	6	
TOTAL_CARRO TENOID	1. 0 0	3	.1400	.00000	.00000	.1400	.1400	.14	.14
	2. 0 0	3	.1533	.01528	.00882	.1154	.1913	.14	.17
	3. 0 0	3	.0733	.00577	.00333	.0590	.0877	.07	.08

	4.00	3	.1733	.00577	.00333	.1590	.1877	.17	.18
	5.00	3	.3667	.01155	.00667	.3380	.3954	.36	.38
	Total	15	.1813	.10232	.02642	.1247	.2380	.07	.38
TANNIN	1.00	3	.1300	.00000	.00000	.1300	.1300	.13	.13
	2.00	3	.1367	.00577	.00333	.1223	.1510	.13	.14
	3.00	3	.5933	.01155	.00667	.5646	.6220	.58	.60
	4.00	3	.6233	.00577	.00333	.6090	.6377	.62	.63
	5.00	3	.7067	.04933	.02848	.5841	.8292	.65	.74
	Total	15	.4380	.26107	.06741	.2934	.5826	.13	.74
SAPONIN	1.00	3	.0200	.00000	.00000	.0200	.0200	.02	.02
	2.00	3	.0567	.00577	.00333	.0423	.0710	.05	.06
	3.00	3	.0733	.00577	.00333	.0590	.0877	.07	.08
	4.00	3	.1100	.00000	.00000	.1100	.1100	.11	.11
	5.00	3	.1633	.01155	.00667	.1346	.1920	.15	.17
	Total	15	.0847	.05083	.01312	.0565	.1128	.02	.17
TERPENOID	1.00	3	.7667	.03215	.01856	.6868	.8465	.73	.79

	2. 0 0	3	.5400	.00000	.00000	.5400	.5400	.54	.54
	3. 0 0	3	1.1500	.00000	.00000	1.1500	1.1500	1.15	1.15
	4. 0 0	3	1.7433	.01155	.00667	1.7146	1.7720	1.73	1.75
	5. 0 0	3	1.9100	.01000	.00577	1.8852	1.9348	1.90	1.92
	T o t a l	15	1.2220	.55232	.14261	.9161	1.5279	.54	1.92
Appear	1. 0 0	3	8.3333	.57735	.33333	6.8991	9.7676	8.00	9.00
	2. 0 0	3	7.3333	1.52753	.88192	3.5388	11.1279	6.00	9.00
	3. 0 0	3	7.6667	.57735	.33333	6.2324	9.1009	7.00	8.00
	4. 0 0	3	7.3333	.57735	.33333	5.8991	8.7676	7.00	8.00
	5. 0 0	2	9.0000	.00000	.00000	9.0000	9.0000	9.00	9.00
	T o t a l	14	7.8571	.94926	.25370	7.3091	8.4052	6.00	9.00
Taste	1. 0 0	3	8.6667	.57735	.33333	7.2324	10.1009	8.00	9.00
	2. 0 0	3	7.6667	1.15470	.66667	4.7982	10.5351	7.00	9.00
	3. 0 0	3	6.6667	.57735	.33333	5.2324	8.1009	6.00	7.00
	4. 0 0	3	7.0000	2.00000	1.15470	2.0317	11.9683	5.00	9.00
	5. 0 0	2	9.0000	.00000	.00000	9.0000	9.0000	9.00	9.00

	T o t a l	14	7.7143	1.32599	.35438	6.9487	8.4799	5.00	9.00
Texture	1. 0 0	3	7.67	.577	.333	6.23	9.10	7	8
	2. 0 0	3	7.00	.000	.000	7.00	7.00	7	7
	3. 0 0	3	6.33	1.155	.667	3.46	9.20	5	7
	4. 0 0	3	7.67	.577	.333	6.23	9.10	7	8
	5. 0 0	2	9.00	.000	.000	9.00	9.00	9	9
	T o t a l	14	7.43	1.016	.272	6.84	8.02	5	9
	Aroma	1. 0 0	3	8.0000	.00000	.00000	8.0000	8.0000	8.00
2. 0 0	3	8.0000	1.00000	.57735	5.5159	10.4841	7.00	9.00	
3. 0 0	3	6.3333	1.15470	.66667	3.4649	9.2018	5.00	7.00	
4. 0 0	3	8.0000	1.00000	.57735	5.5159	10.4841	7.00	9.00	
5. 0 0	2	9.0000	.00000	.00000	9.0000	9.0000	9.00	9.00	
T o t a l	14	7.7857	1.12171	.29979	7.1381	8.4334	5.00	9.00	
Accept	1. 0 0	3	7.6667	.57735	.33333	6.2324	9.1009	7.00	8.00
	2. 0 0	3	8.0000	1.00000	.57735	5.5159	10.4841	7.00	9.00
	3. 0 0	3	8.0000	1.00000	.57735	5.5159	10.4841	7.00	9.00

	4.00	3	8.0000	.00000	.00000	8.0000	8.0000	8.00	8.00
	5.00	2	9.0000	.00000	.00000	9.0000	9.0000	9.00	9.00
	Total	14	8.0714	.73005	.19511	7.6499	8.4929	7.00	9.00
ALL VITAMINS	1.00	3	3.2033	.03512	.02028	3.1161	3.2906	3.17	3.24
	2.00	3	2.8233	.01155	.00667	2.7946	2.8520	2.81	2.83
	3.00	3	2.3633	.07506	.04333	2.1769	2.5498	2.32	2.45
	4.00	3	2.0000	.21284	.12288	1.4713	2.5287	1.81	2.23
	5.00	3	2.0000	.04359	.02517	1.8917	2.1083	1.95	2.03
	Total	15	2.4780	.49676	.12826	2.2029	2.7531	1.81	3.24
ALL MNERALS	1.00	3	220.9600	.00000	.00000	220.9600	220.9600	220.96	220.96
	2.00	3	230.0467	1.01036	.58333	227.5368	232.5565	228.88	230.63
	3.00	3	462.3800	1.00459	.58000	459.8845	464.8755	461.22	462.96
	4.00	3	492.4600	.00000	.00000	492.4600	492.4600	492.46	492.46
	5.00	3	607.4067	2.01495	1.16333	602.4012	612.4121	605.08	608.57
	Total	15	402.6507	157.91003	40.77219	315.2030	490.0983	220.96	608.57
ALL PHYTOCHEMICALS	1.00	3	1.01	.006	.003	.99	1.02	1	1

	2.00	3	1.03	.012	.007	1.00	1.06	1	1
	3.00	3	1.21	.015	.009	1.17	1.24	1	1
	4.00	3	1.44	.012	.007	1.41	1.47	1	1
	5.00	3	1.61	.010	.006	1.59	1.63	2	2
	Total	15	1.26	.242	.062	1.12	1.39	1	2
SENSORY ANALYSIS	1.00	3	8.1667	.14434	.08333	7.8081	8.5252	8.00	8.25
	2.00	3	7.5000	.86603	.50000	5.3487	9.6513	7.00	8.50
	3.00	3	6.7500	.66144	.38188	5.1069	8.3931	6.00	7.25
	4.00	3	7.5000	.90139	.52042	5.2608	9.7392	6.75	8.50
	5.00	3	6.0000	5.19615	3.00000	-6.9080	18.9080	.00	9.00
	Total	15	7.1833	2.17631	.56192	5.9781	8.3885	.00	9.00
ACCEPTABILITY	1.00	3	7.67	.577	.333	6.23	9.10	7	8
	2.00	3	8.00	1.000	.577	5.52	10.48	7	9
	3.00	3	8.00	1.000	.577	5.52	10.48	7	9
	4.00	3	8.00	.000	.000	8.00	8.00	8	8
	5.00	3	6.00	5.196	3.000	-6.91	18.91	0	9

	T o t a l	15	7.53	2.200	.568	6.32	8.75	0	9
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Lead City University Ibadan DO NOT COPY

Appendix B
Sensory Evaluation Form

Sensory Evaluation Form

Recipe Name:

Category:

Directions: Check one rating for each of the following: Appearance, Taste/Flavor, Texture/Consistency, Aroma/Smell, and Overall Acceptability

Rating Scale	Appearance	Taste/Flavor	Texture/ Consistency	Aroma/Smell	Overall Acceptability
9. Like Extremely					
8. Like Very Much					
7. Like Moderately					
6. Like Slightly					
5. Neither Like or Dislike					
4. Dislike Slightly					
3. Dislike Moderately					
2. Dislike Very Much					
1. Dislike Extremely					
Office Use Only					
Panelist Code:		Date:			

BIBLIOGRAPHY

Journals

1. Aadil Mansoori, Nitesh Singh, Sharad Kumar Dubey, Tarun K. Thakur, Noam Alkan, Subha Narayan Das, and Anirudh Kumar. "Phytochemical characterization and assessment of crude extracts from *Lantana camara* L. for antioxidant and antimicrobial activity." *Frontiers in Agronomy* 2 (2020): 582268.
2. Abbas, Sheren & Fadhel, Sheren. Inhibitory Effect and Antioxidant Activity of the Internal Membrane Decomposition of Egg Shells. (2023).
3. Abdelshafy, Asem Mahmoud, Muhammad T. Hossain, Abdelaziz A. H. Khedher, Meriem K. Kammoun, Ammar T. Ghabban, Mahmoud A. Elkhawad, and Ahmed A. M. Fadhl. "A comprehensive review on phenolic compounds from edible mushrooms: Occurrence, biological activity, application and future prospective." *Critical Reviews in Food Science and Nutrition* 62, no. 22 (2022): 6204-6224.
4. Abdullah AT, Mousheer ZT. Vitamin D Status in Epileptic Children on Valproic Acid; a Case-Control Study. *Arch Acad Emerg Med*. Feb 27; (2020) 8(1)
5. Ahmad, Muhammad, Saeed A. Khan, Adeel Bukhari, and Muhammad A. Khan. "Eggshell and Coral Wastes as Low-Cost Sorbents for the Removal of Heavy Metals from Aqueous Solutions." *Journal of Hazardous Materials* 371 (2019): 192-199.
6. Ahmed, Tamer A. E., H. N. A. El-Badry, M. A. Abou Taleb, M. M. El-Kader, and S. M. M. Abou Zaid. "Biotechnological applications of eggshell: recent advances." *Frontiers in Bioengineering and Biotechnology* 9 (2021).
7. Aibar-Almazán, Agustín, Fernando García-González, David P. Requejo, Javier R. Almarza, and Manuel J. López-García. "Current status of the diagnosis and management of osteoporosis." *International Journal of Molecular Sciences* 23, no. 16 (2022): 9465.

8. Aimi Azira, S.; Wan Zunairah, W.I.; Nor Afizah, M.; M.A.R., Nor-Khaizura; S., Radhiah; M.R., Ismail Fitry; Z.A., Nur Hanani. "Prevention of browning reaction in banana jam during storage by physical and chemical treatments." *Food Research* 5 (5): 55–62. (2021).
9. Akatwijuka, Osbert, Mohamed A-H. Gepreel, Ahmed Abdel-Mawgood, Mitsuo Yamamoto, Yukie Saito, and Ahmed H. Hassanin. "Overview of banana cellulosic fibers: agro-biomass potential, fiber extraction, properties, and sustainable applications." *Biomass Conversion and Biorefinery* 14, no. 6 (2024): 7449-7465.
10. Akinmoladun, A.C., Adetuyi, A.R., Komolafe, K., & Oguntibeju, O.M. Nutritional benefits, phytochemical constituents, ethnomedicinal uses and biological properties of Miracle fruit plant (*Synsepalum dulcificum* Shumach. & Thonn. Daniell). *Heliyon*, 6(12), (2020).
11. Alabi, Opeyemi Iyinoluwa. "Comparative Analysis and Proximate Composition Of Complementary Breakfast Cereal Produced From Composite Of Oats, Soybean And Dried Mixed Fruits (Apples, Bananas, Pawpaw)." *International Journal of Innovation in Science & Technology* 1, No. 1 (2023): 54-63.
12. Alake, O.T., Abraham, D.O., Akinola, T.O., Fatunmibi, O.O., Agboola, T.O., & Akua, S.I. Production and evaluation of smoothies made from various fruits sold in Lagos market. *International Journal of Innovative Science and Research Technology*, 7(1), 642-646, (2022).
13. Al-awwal, U. L. Ali. "Proximate Analyses of Different Samples of Egg Shells Obtained from Sokoto Market in Nigeria." *International Journal of Scientific Research* (2020).
14. Alhussary, Basem N., R. Z. Alharbi, and S. N. Alshahrani. "Preparation and Characterization of Natural Hydroxyapatite from Eggshell and Seashell and Its Effect on Bone Healing." *Journal of Applied Veterinary Sciences* (2020).
15. Ali, Abid, A. Rahman, and Syed R. M. Hasnain. "Eggshells as a Sustainable Adsorbent for Heavy Metal Removal from Wastewater." *Journal of Environmental Management* (2019).

16. Ali, Raheel, Khan, Muhammad F., Awan, Muhammad I., Hussain, Khalid, Yousaf, Shafique, and Khan, Imran. "Effect of Chicken Eggshell Powder Fortification on the Chemical Physical and Rheological Characteristics of the Bread." *Biochemical and Cellular Archives* (2019).
17. Alabi, Opeyemi Iyinoluwa. "Comparative Analysis And Proximate Composition Of Complementary Breakfast Cereal Produced From Composite Of Oats, Soybean And Dried Mixed Fruits (Apples, Bananas, Pawpaw)." *International Journal of Innovation in Science & Technology*, 1(1), 54-63. (2023)
18. Allai, Farhana Mehraj, ZR Azaz Ahmad Azad, Nisar Ahmad Mir, and Khalid Gul. Recent advances in non-thermal processing technologies for enhancing shelf life and improving food safety. *Applied Food Research* 3, no. 1 (2023).
19. Amit M. I. T. Sharma and Sanjeev A. P. N. A. Tyagi. "Antimicrobial screening and phytochemical analysis of Citrus cultivars growing in vivo & in vitro." *Journal of Phytologic Research* 32 (2019): 35-42.
20. Andrea Giustina, John P. Bilezikian, Robert A. Adler, Giuseppe Banfi, Daniel D. Bikle, Neil C. Binkley, Jens Bollerslev, et al. "Consensus statement on Vitamin D status assessment and supplementation: whys, whens, and hows." *Endocrine Reviews* (2024).
21. Anna Maria Girelli, Maria Luisa Astolfi, and Francesca Romana Scuto. "Agro-industrial wastes as potential carriers for enzyme immobilization: A review." *Chemosphere* 244 (2020): 125368.
22. Arnold, M., Rajagukguk, Y. V., Sidor, A., Kulczyński, B., Brzozowska, A., Suliburska, J., Wawrzyniak, N., & Gramza-Michałowska, A. Innovative Application of Chicken Eggshell Calcium to Improve the Functional Value of Gingerbread. *International journal of environmental research and public health*, 19(7), 4195. (2022).
23. Arnold, M., Rajagukguk, Y. V., Sidor, A., Kulczyński, B., Brzozowska, A., Suliburska, J., Wawrzyniak, N., & Gramza-Michałowska, A. Innovative Application of Chicken Eggshell Calcium to Improve the Functional Value of Gingerbread. *International journal of environmental research and public health*, 19(7), 4195. (2022).

24. Arogundade, O., Matthew, J., Akinyoola, O., Akin-Idowu, P., & Akinyemi, S.O.S. Phenotypic and Molecular Characterization of Mango Cultivars in Southwest Nigeria. *International Journal of Fruit Science*, 22, 151-159, (2022).
25. Atiase Y, Quarde A. A call to action for osteoporosis research in sub-saharan Africa. *Ghana Med J*. 2020; 54(1):58-67.
26. Awogbemi, Omojola, D. V. V. Kallon, and Victor Sunday Aigbodion. Pathways for sustainable utilization of waste chicken eggshell. *Journal of Renewable Materials*, 10 (8) (2022): 2217-2246.
27. Aydar, Elif Feyza, Sena Tutuncu, and Beraat Ozcelik. Plant-based milk substitutes: Bioactive compounds, conventional and novel processes, bioavailability studies, and health effects. *Journal of Functional Foods* 70 (2020): 103975.
28. Ayo, J.A., Ochefu, A., & Agbatutu, A. Effect of ripening on the Chemical Composition of Green locally Cultivated Banana Cultivars (*Musa spp.*) Peel. *Nigerian Annals of Pure and Applied Sciences*, 3(1), 52-66, (2020).
29. Bahar, H. B., Sharif, H. P., and Hamid, N. A. "The effect of chicken eggshell powder on the properties of chicken nuggets." *Journal of Food Processing and Preservation* (2021).
30. Bakar, T. A. A., M. A. M. Z. Mansor, and M. A. M. Khairi. "Eggshell Coated Grey Cast Iron for Corrosion Applications." *Jurnal Teknologi* (2019).
31. Bakhshi, Hamid, Mohammad R. A. Zarghami, and Mohammad Mahdavi. "Preparation and Evaluation of Hydrogel Composites Based on Starch-g-PNaMA/Eggshell Particles as Dye Biosorbent." *Desalination and Water Treatment* 171 (2019): 163-172.

32. Baláž, Matej, et al. "State-of-the-art of eggshell waste in materials science: recent advances in catalysis, pharmaceutical applications, and mechanochemistry." *Frontiers in Bioengineering and Biotechnology* 8 (2021).
33. Balouch, Nehal, R. L. A. Z. Alharbi, and A. Albar. "Experimental Study on Compressive Strength of Concrete by Partial Replacement of Cement with Eggshell Powder." *Technical Journal of University of Engineering and Technology* (2021).
34. Bandhavya, Ganesh B., R. S. Narayan, and Anil K. Mohan. "An Experimental Study on Partial Replacement of Cement with Eggshell Powder in Concrete." *International Research Journal of Engineering and Technology* (2020).
35. Barbara, David, Jiri Prochazka, and Gabriela H. Matouskova. "Use of Eggshells as a Raw Material for Production of Calcium Preparations." *Czech Journal of Food Sciences* (2020).
36. Barbe, Alix, et al. "A grape seed extract maternal dietary supplementation improves egg quality and reduces ovarian steroidogenesis without affecting fertility parameters in reproductive hens." *PLOS One* 15, no. 5 (2020).
37. Barron, A. Applications of microCT imaging to archaeobotanical research. *Journal of Archaeological Method and Theory*, 31(2), 557-592, (2024).
38. Bartter, Hayley Diffey, Y. H. O'Leary, Bernd Häslér, Wilson Maulaga, and Richard Alders. "Use of Chicken Eggshell to Improve Dietary Calcium Intake in Rural Sub-Saharan Africa." *Maternal & Child Nutrition* (2019).
39. Bashir, A. S., H. M. Ali, and K. M. A. Al-Dubai. "Characterization of Raw Eggshell Powder as a Good Bio-Filler." *Journal of Engineering Research and Technology* (2021).
40. Bashir, Ahmad S., W. H. Qazi, and R. C. Thakur. "Characterization of Raw Eggshell Powder (ESP) as a Good Bio-Filler." *Journal of Engineering Research and Technology* (2020).

41. Bazrafshan, S., M. Mizani, Gh Pazuki, and Sh Shahriari. "Colorimetric and Sensory Properties of for Tube Feeding Formulated by Gelatin and Maltodextrin." *Journal of Food Biosciences and Technology* 13, no. Fall 2023 (2023): 49-62.
42. Ben-Daya, Mohamed, Elkafi Hassini, and Zied Bahroun. "Internet of things and supply chain management: a literature review." *International Journal of Production Research* 57, no. 15-16 (2019): 4719-4742.
43. Bhargava, Nitya, et al. "Advances in application of ultrasound in food processing: A review." *Ultrasonics Sonochemistry* 70 (2021).
44. Borah, Mukul J., Kiran P. Choudhury, J.S.B. Singh, and Deepak Kumar. "Transesterification of Waste Cooking Oil for Biodiesel Production Catalyzed by Zn Substituted Waste Eggshell Derived CaO Nanocatalyst." *Fuel* 258 (2019).
45. Borhade, Abhijit, T. K. Tiwari, and B. K. Tiwari. "Calcined Eggshell as a Cost Effective Material for Removal of Dyes from Aqueous Solution." *Applied Water Science* (2019).
46. Brunetti Brunetti, G., et al. "LIGHT/TNFSF14 regulates estrogen deficiency-induced bone loss." *J. Pathol.* (2020) 250, 440–451.
47. Carsten Carlberg. "Vitamin D and its target genes." *Nutrients* 14, no. 7 (2022): 1354.
48. Castro, Renata S. D.; Caetano, Laércio; Ferreira, Guilherme; Padilha, Pedro M.; Saeki, Margarida J.; Zara, Luiz F.; "Banana Peel Applied to the Solid Phase Extraction of Copper and Lead from River Water: Preconcentration of Metal Ions with a Fruit Waste." *Industrial & Engineering Chemistry Research* 50 (6): (2019).
49. Chang, Kian Aun, Sheryl Wee Min Low, Yih Heng Chia, Andrey Setyadi, Yun Ping Neo, and Lye Yee Chew. Valorisation of chicken eggshell as a novel food ingredient in

madeleine cake: an exploratory study amongst young adults. *British Food Journal* 125, no. 9 (2023): 3320-3333.

50. Chavan, Sanjay B., Das, Ramesh Kumar Arvind, and Ghosh, Kalyan Subhas Prasad Bhowmik. "Synthesis of biodiesel from *Jatropha curcas* oil using waste eggshell and study of its fuel properties." *RSC Advances* (2020).
51. Chavan, Shirish B., Vijay A. Pawar, and Balaji K. Joshi. "Synthesis of Biodiesel from *Jatropha Curcas* Oil Using Waste Eggshell and Study of Its Fuel Properties." *RSC Advances* (2020).
52. Chen, Dong, Li Zhang, and Wei Li. "Removal of Phosphate and Hexavalent Chromium from Aqueous Solutions by Engineered Waste Eggshell." *RSC Advances* (2020).
53. Chiara Mazziotta, Mauro Tognon, Fernanda Martini, Elena Torreggiani, and John Charles Rotondo. "Probiotics mechanism of action on immune cells and beneficial effects on human health." *Cells* 12, no. 1 (2023): 184.
54. Choi, Hyung-Jin, W. J. Lee, and B. H. Ryu. "Heavy Metal Removal from Acid Mine Drainage by Calcined Eggshell and Microalgae Hybrid System." *Environmental Science and Pollution Research* (2020).
55. Choi, H. Y., Kim, Y. S., and Seo, H. S. "Quality characteristics and antioxidant activity of cookies added with eggshell powder." *Journal of the Korean Society of Food Science and Nutrition* (2020).
56. Christakos S, Li S, De La Cruz J, Bikle DD. New developments in our understanding of vitamin metabolism, action, and treatment. *Metabolism*. (2019); 98:112-120.
57. Claudio Marcocci Roger, Geert Carmeliet, Daniel Bikle, John H. White, Bess Dawson-Hughes, Paul Lips, et al. "Skeletal and extraskeletal actions of vitamin D: current evidence and outstanding questions." *Endocrine Reviews* 40, no. 4 (2019): 1109-1151.

58. Cormick, Gabriela, and Jose M Belizán. Calcium Intake and Health. *Nutrients*, 11, no. 7: 1606. (2019).
59. Creecy, A., Damrath, J. G., and Wallace, J. M. Control of Bone Matrix Properties by Osteocytes. *Front. Endocrinol.* 11, 578477. (2021).
60. Crickmore, Tom S.; Sana, Haamidah Begum; Mitchell, Hannah; Clark, Molly; Bradshaw, Darren. "Toward Sustainable Syntheses of Ca-based MOFs." *Chemical Communications* 57, no. 81 (2021): 10592–10595.
61. Cristina Palacios, Ana M. T. Castro, Elizabeth A. E. M. N. Ferreira, and Michael D. Holick. "Calcium-Fortified Foods in Public Health Programs: Considerations for Implementation." *Annals of the New York Academy of Sciences* 1485, no. 1 (2021): 3-21.
62. da Costa Neto J.J.G., Gomes T.L.M., Justo T.F., Pereira K.S., Amaral P.F.F., Leão M.H.M.R., Sant'Ana G.C.F. Microencapsulation of tiger nut milk by lyophilization: Morphological characteristics, shelf life and microbiological stability. *Food Chem.* (2019); 284:133–139.
63. Damota, Firew Deneke, Ketamaw Salelign Yazie, Babuskin Srinivasan, and Ballekallu Chinna Eeranna. "Evaluation of the effect of the operational parameter on unripe banana (*Musa cavendishii*) flour production: case study at Arba Minch." *International Journal of Food Engineering* 18, no. 2 (2022): 161-168.
64. Daraei, Hossein, Farhad Mohammadi, and Mahshid Asghari. "Separation of Chromium from Water Samples Using Eggshell Powder as a Low-Cost Sorbent: Kinetic and Thermodynamic Studies." *Desalination and Water Treatment* 183 (2020): 173-183.
65. De Villa, Bianca Denise M., Thea Mari M. Domingo, Rhema Jenica C. Ramirez, and Jame Monren T. Mercado. "Explicating the culinary heritage significance of Filipino kakanin using bibliometrics (1934–2018)." *International Journal of Gastronomy and Food Science* 28 (2022).

66. DeNotto, Michael. "Food and Drink in History." *The Charleston Advisor* 22, no. 3 (2021): 23-28.
67. Echendu, Jane, Monday Godwin-Egein, Udensi Ekea Udensi, Kuromiayebaye Digitemie, and Victor Okereke. "Fungal organisms associated with common tropical weeds in Choba Rivers State Nigeria." *Sustainability, Agri, Food and Environmental Research* 12, no. 2 (2024).
68. Echendu, Jane, Monday Godwin-Egein, Udensi Ekea Udensi, Kuromiayebaye Digitemie, and Victor Okereke. "Fungal organisms associated with common tropical weeds in Choba Rivers State Nigeria." *Sustainability, Agri, Food and Environmental Research* 12, no. 2 (2024).
69. Edo, Great Iruoghene, Favour Ogheneoruese Onoharigho, Agatha Ngukuran Jikah, Gift Onyinyechi Oloni, Princess Oghenekeno Samuel, Opiti Ajiri Rapheal, Ovie Ikpekoru et al. *Cyperus esculentus* (tiger nut): An insight into its bioactive compounds, biological activities, nutritional and health benefits. *Food Chemistry Advances* 3 (2023).
70. EFSA Panel on Nutrition, Novel Foods and Food Allergens (NDA), Dominique Turck, Torsten Bohn, Jacqueline Castenmiller, Stefaan de Henauw, Karen Ildico Hirsch-Ernst, Helle Katrine Knutsen, et al. "Scientific advice related to nutrient profiling for the development of harmonised mandatory front-of-pack nutrition labelling and the setting of nutrient profiles for restricting nutrition and health claims on foods." *EFSA Journal* 20, no. 4 (2022): e07259.
71. Ehsan, A., M. R. Rahman, A. M. M. Shakoor, and M. H. Anwar. "Performance of Rice Husk Ash as a Partial Cement Replacement in Concrete: A Review." *Construction and Building Materials* 335 (2022): 127299.
72. Elzbieta Kowalska, Justyna Kucharska-Gaca, Joanna Kuzniacka, Lucyna Lewko, Ewa Gornowicz, Jacek Biesek, and Maciej Adamski. "Egg quality depending on the diet with different sources of protein and age of the hens." *Scientific Reports* (2021).

73. Emmanuel Ifeanyi Obeagu, Yahye Abdi Ahmed, Getrude Uzoma Obeagu, U. O. Bunu, O. P. C. Ugwu, and Esther U. Alum. "Biomarkers of breast cancer: Overview." *International Journal of Current Research in Biology and Medicine* 1 (2023): 8-16.
74. Farooq, Muhammad, Muhammad Sarfraz, and Qasim A. M. Alharbi. "Biodiesel Production from Date Seed Oil (*Phoenix dactylifera* L.) via Eggshell Derived Heterogeneous Catalyst." *Chemical Engineering Research and Design* 145 (2019): 155-165.
75. Fatemeh Zendeboodi, Nasim Khorshidian, Amir M. Mortazavian, and Adriano G. da Cruz. "Probiotic: conceptualization from a new approach." *Current Opinion in Food Science* 32 (2020): 103-123.
76. Faysal M. A. Ali, Mohammad H. A. Arshad, and Syed Y. A. Ali. "Potential of chicken eggshell as a functional ingredient in food products." *Journal of Food Science and Technology* (2021).
77. Fladerer, JP, and Grollitsch, S. "Eggshell membrane as promising supplement to maintain bone health: A systematic review." *Bone Reports* (2024).
78. Foroutan, Reza, Behzad Shaterian, and Behnam Khazaei. "Eggshell Nano-Particle Potential for Methyl Violet and Mercury Ion Removal: Surface Study and Field Application." *Advanced Powder Technology* 30 (2019): 1987-1998.
79. Francesco Bellanti, Aurelio Lo Buglio, Gianluigi Vendemiale. "Muscle delivery of mitochondria-targeted drugs for the treatment of sarcopenia: rationale and perspectives." *Pharmaceutics* 14, no. 12 (2022).
80. Fuentes, S., Gonzalez Viejo, C., Torrico, D.D., & Dunshea, F.R. Digital Integration and Automated Assessment of Eye-Tracking and Emotional Response Data Using the BioSensory App to Maximize Packaging Label Analysis. *Sensors* (Basel, Switzerland), 21(22), 7641, (2021).

81. Gautron, Joël, De Reviers, M.-M., and A. Huchet. "Avian Eggshell Biomineralization: An Update on Its Structure, Mineralogy and Protein Tool Kit." *BMC Molecular and Cell Biology* (2021). 1-17.
82. Gbarakoro, S.L., Adooh, L.S.K., & Akinfolarin, O.M. Effects of natural and artificial fruits ripening agent on the pH of selected fruits in Port Harcourt Nigeria. *Asia Journal of Science and Technology*, 12(2), 11535-11539, (2021).
83. Gbylik-Sikorska, Małgorzata, Anna Gajda, Ewelina Nowacka-Kozak, Beata Łebkowska-Wieruszewska, and Andrzej Posyniak. Multi-class procedure for analysis of 50 antibacterial compounds in eggshells using ultra-high-performance liquid chromatography–tandem mass spectrometry. *Molecules* 26, no. 5 (2021).
84. Ginsberg, Charles, Joachim H. IX Diagnosis and Management of Osteoporosis in Advanced Kidney Disease: A Review. *American Journal of Kidney Diseases*, Volume 79, Issue 3, 427–436. (2022).
85. Giovanni Marasco, Giovanna Grazia Ciota, Benedetta Rossini, Lisa Lungaro, Anna Rita Di Biase, Antonio Colecchia, Umberto Volta, Roberto De Giorgio, Davide Festi, and Giacomo Caio. "Probiotics, prebiotics and other dietary supplements for gut microbiota modulation in celiac disease patients." *Nutrients* 12, no. 9 (2020).
86. Girelli, Anna Maria, Del Nobile, M. A., and S. D'Auria. "Agro-Industrial Wastes as Potential Carriers for Enzyme Immobilization: A Review." *Chemosphere* (2020).
87. Glasser, N. J., Pollack, H. A., Ranney, M. L., & Betz, M. E. Economics and Public Health: Two Perspectives on Firearm Injury Prevention. *The ANNALS of the American Academy of Political and Social Science*, 704(1), 44-69. (2022).
88. Goli, Javad, Vahdat Jafari, and Sadegh Maleki. "Development of Heterogeneous Alkali Catalyst from Waste Chicken Eggshell for Biodiesel Production." *Renewable Energy* 135 (2019): 1033-1041.

89. Gonzalez-Garcia, S., & M. M. "A Life Cycle Assessment of CO₂ Emission Reduction Strategies in Cement Production." *Journal of Cleaner Production* 385 (2023): 135678.
90. Grzegorz Lesniewski, Jan Stangierski. "What's New in Chicken Egg Research and Technology for Human Health Promotion?-A Review." *Trends in Food Science & Technology* (2019).
91. Gu, I., Balogun, O., Brownmiller, C., Kang, H.W., & Lee, S.-O. Bioavailability of Citrulline in Watermelon Flesh, Rind, and Skin Using a Human Intestinal Epithelial Caco-2 Cell Model. *Applied Sciences*, 13, 4882, (2023).
92. Gumussoy, Maya, Chloe Macmillan, Stephanie Bryant, David F. Hunt, and Peter J. Rogers. Desire to eat and intake of 'insect' containing food is increased by a written passage: The potential role of familiarity in the amelioration of novel food disgust. *Appetite* 161 (2021).
93. Gupta, Abhishek R., Sanjeev Kumar, and Neha Sharma. "Waste Cooking Oil and Waste Chicken Eggshells Derived Solid Base Catalyst for the Biodiesel Production: Optimization and Kinetics." *Waste Management* 85 (2019): 93-102.
94. Hae-Jin Choi, Ji-Hoon Park, Kyung-Jin Kim. "Heavy metal removal from acid mine drainage by calcined eggshell and microalgae hybrid system." *Environmental Science and Pollution Research* (2020).
95. Hae-Jin Choi. "Efficiency of methyl-esterified eggshell membrane biomaterials for intensified microalgae harvesting." *Environmental Engineering Research* (2020).
96. He, Sheng, Yiming Zheng, and Keke Zhang. "Investigation of CaO-Based Sorbents Derived from Eggshells and Red Mud for CO₂ Capture." *Journal of Alloys and Compounds* 785 (2019): 245-254.
97. Hendra Basri, M. Sulastri. "Physical Quality of the First Egg of Japanese Quail (*Coturnix japonica* L.) after Given Liquid Herbal Concoction." *Mangifera Education* (2019).

98. Huawen Zhang et al. "Effects of different levels of egg shell powder on performance and egg quality of laying hens." *Journal of Poultry Science* (2019).
99. Hye Jin Choi, Y. S. Kim, Y. S. Seo. "Enhancing the quality of muffins with eggshell powder." *Food Science & Nutrition* (2021).
100. Hye Jin Choi. "Effect of eggshells for the harvesting of microalgae species." *Biotechnology & Biotechnological Equipment* (2019).
101. Iftikhar, M.S., Cheema, H., Khan, A., DeLacy, I., & Basford, K. Genetic diversity assessment of cucumber landraces using molecular signatures. *BMC Genomics*, 25, (2024).
102. Irma S. Rombauer, Marion Rombauer Becker, Ethan Becker, John Becker, and Megan Scott. *Joy of Cooking: 2019 Edition Fully Revised and Updated*. Scribner (2019).
103. Iwuozor, Kingsley O., Taiwo Temitayo Micheal, Kehinde Temitope Micheal, Stephen Sunday Emmanuel, Ebuka Chizitere Emenike, and Adewale George Adeniyi. "Plant biomass-based composites in the maritime industry: A review." *Marine Structures* 96 (2024).
104. Jean Delarue. "Overview of sensory methods for the evaluation of nonfood products." *Non-food Sensory Practice* (2022).
105. Kim, J. S., Lee, H. J., and Park, S. H. "Physicochemical properties and antioxidant activity of pasta made with eggshell powder." *Journal of Food Processing and Preservation* (2021).
106. Kenneth Mensah, Enoch Y. Boakye, Richard K. B. Quaye, and Emmanuel A. G. Mensah. "Dye Removal Using Novel Adsorbents Synthesized from Plastic Waste and Eggshell: Mechanism, Isotherms, Kinetics, Thermodynamics, Regeneration, and Water Matrices." *Biomass Conversion and Biorefinery* 14 (2022).

107. Jean-Michel Fernandes, Joao Fernandes Araujo, Jorge Miguel Vieira, Ana Cristina Pinheiro, Antonio Augusto Vicente. "Tackling older adults' malnutrition through the development of tailored food products." *Trends in Food Science & Technology* 115 (2021): 55-73.
108. Jessica Bartter et al. "Use of Chicken Eggshell to Improve Dietary Calcium Intake in Rural Sub-Saharan Africa." *Maternal & Child Nutrition* (2019).
109. Jia Ling Tsong, Lucky Poh Wah Goh, Jualang Azlan Gansau, and Siew-Eng How. "Review of *Nephelium lappaceum* and *Nephelium ramboutan-ake*: a high potential supplement." *Molecules* 26, no. 22 (2021).
110. Jantapaso, Husanai, and Pimonsri Mittraparp-Arthorn. "Phytochemical composition and bioactivities of aqueous extract of rambutan (*Nephelium lappaceum* L. cv. Rong Rian) peel." *Antioxidants* 11, no. 5 (2022): 956.
111. Jansson, P. A., Curiaç, D., Ahrén, I. L., Hansson, F., Niskanen, T. M., Sjögren, K., Ohlsson, C. "Probiotic Treatment Using a Mix of Three *Lactobacillus* Strains for Lumbar Spine Bone Loss in Postmenopausal Women: A Randomised, Double-Blind, Placebo-Controlled, Multicentre Trial." *Lancet Rheumatology* (2019), 1, 4–5.
112. Jiang, Y., J.Y. Lee, and Z.F. Xu. "A Comprehensive Review of Ground Granulated Blast Furnace Slag for Sustainable Concrete Development." *Sustainable Materials and Technologies* 31 (2022).
113. Jittin, V., A.K.S. Kumar, and R.P.S. Singh. "Utilisation of Rice Husk Ash for Cleaner Production of Different Construction Products." *Journal of Cleaner Production* (2020).
114. Jiménez-Carrillo, Claudia Elizabeth, Piña-Ramos, Karen Miroslava, Meza-Arrayales, Carolina, Villaruel-Flores, Kathya Pamela, and García-Aguirre, Alejandro. "Latex Allergy." *Journal of Allergy and Clinical Immunology*, vol. 145, no. 1, 2020, pp. 123-130.

115. John W. Okwu, Uche A. Okafor, and Emeka O. Ogbonna. "Effects of eggshell powder on the chemical composition and sensory properties of wheat flour bread." *Journal of Culinary Science & Technology* (2021).
116. Jordana, C.N., Stapleton, S.C., Colee, J.C., Lee, S., Gao, Z., Ray, Z.T., Anrecio, L.R., Freed, D.J., & Zhao, X. How does watermelon grafting impact fruit yield and quality? A systematic review. *HortScience*, 58(8), 836-845, (2023).
117. Kabwama, S.N., Bahendeka, S.K., Wesonga, R. Low consumption of fruits and vegetables among adults in Uganda: findings from a countrywide cross-sectional survey. *Arch Public Health*. 77, 4 (2019).
118. Kalinke, I., & Kulozik, U. Enhancing Microwave Freeze Drying: Exploring Maximum Drying Temperature and Power Input for Improved Energy Efficiency and Uniformity. *Food and Bioprocess Technology*, 17, 5357-5371, (2024).
119. Kamalanathan, P., Premkumar K., and Sathiyamurthy M. "Synthesis and Sintering of Hydroxyapatite Derived from Eggshells as a Calcium Precursor." *Ceramics International* 45 (2019): 12280-12289.
120. Kany, Shinwan, Jan Tilmann Vollrath, and Borna Relja. Cytokines in Inflammatory Disease. *International Journal of Molecular Sciences* 20, no. 23: 6008. (2019).
121. Khan, M. I., M. Ali, and A. Ullah. "High-Volume Fly Ash Concrete: A Review of its Properties and Applications." *Journal of Building Engineering* 29 (2020): 101108.
122. Kowalska, Ewa, Jacek Kucharska-Gaca, J. Kuźniacka, and L. Lewko. "Egg Quality Depending on the Diet with Different Sources of Protein and Age of the Hens." *Scientific Reports* (2021).
123. Kontak, Julia C., Hilary A. T. Caldwell, Rena Kulczycki, Camille L. Hancock Friesen, and Sara F. L. Kirk. "Process and Experience of Youth Researchers within a Health Promoting Schools Study in Nova Scotia, Canada." *Health Promotion International* 38, no. 6 (2023).

124. Kraak, Vivica I., and Katherine Consavage Stanley. A Systematic Scoping Review of Media Campaigns to Develop a Typology to Evaluate Their Collective Impact on Promoting Healthy Hydration Behaviors and Reducing Sugary Beverage Health Risks. *International Journal of Environmental Research and Public Health*, 18, no. 3: 1040. (2021).
125. Kulshreshtha, Garima, Shukla, S., and Suri, K. "Properties, Genetics and Innate Immune Function of the Cuticle in Egg-Laying Species." *Frontiers in Immunology* (2022).
126. Kumar K. Rajasekaran, Ramesh R. Ramamoorthy, and Sathiya N. Karthikeyan. "Utilization of waste eggshells as a biocatalyst for biodiesel production." *Renewable Energy* (2020).
127. Kumar, S., V.K. Gupta, and R.K. Sharma. "Utilization of Agricultural Waste in Sustainable Construction: A Review." *Journal of Cleaner Production* 392 (2023): 135727.
128. Lachowicz, S., Oszmiański, J., Wilczyńska, M., Zaguła, G., Saletnik, B., & Puchalski, C. Impact Mineralization of Chokeberry and Cranberry Fruit Juices Using a New Functional Additive on the Protection of Bioactive Compounds and Antioxidative Properties. *Molecules* (Basel, Switzerland), 25(3), 659. (2020).
129. Laohavisuti, Nongnuch, Seesanong, Somkiat, Chaiseeda, Kittichai, & Boonmee, Wimonmat. "Simple Recycling of Biowaste Eggshells to Various Calcium Phosphates for Specific Industries." *Materials* (2021).
130. Lesnierowski, Grzegorz, and Jacek Stangierski. "What's New in Chicken Egg Research and Technology for Human Health Promotion? - A Review." *Trends in Food Science & Technology* (2020).
131. Lewko, L., J. Krawczyk, and J. Calik. Effect of genotype and some shell quality traits on lysozyme content and activity in the albumen of eggs from hens under the biodiversity conservation program. *Poultry Science* 100, no. 3 (2021).

132. Li, Guojun, Hongjun Wang, Jun Zhang, and Zhiqiang Zhang. "Properties of Cement-Based Bricks with Oyster-Shell Ash." *Journal of Cleaner Production* 240 (2019).
133. Li, Jun, Wei Zhang, and Yang Zhang. "Eggshell Membrane-Derived MgFe₂O₄ for Pharmaceutical Antibiotics Removal and Recovery from Water." *Chemical Engineering Research and Design* 137 (2018): 312-321.
134. Liana M. Slater et al. "The impact of dietary eggshell on the eggshell quality of the hybrid layers." *Animal Nutrition* (2020).
135. Lin, Kun-Mo, et al. "The paradoxical role of uric acid in osteoporosis." *Nutrients* 11, no. 9 (2019): 2111.
136. Liu, Y., X. Zhang, and H. Wang. "Durability Performance of Concrete with Various Pozzolans: A Comprehensive Review." *Materials Today: Proceedings* 44 (2021): 3911-3916.
137. Lizundia, Erlantz, and Dipan Kundu. "Advances in natural biopolymer-based electrolytes and separators for battery applications." *Advanced Functional Materials* 31, no. 3 (2021).
138. Lončarević, N., Liu, U., Stefanaki, A., et al. Database of European vascular plants red lists as a contribution to more coherent plant conservation. *Scientific Data*, 11, 1138, (2024).
139. Lordelo, Madalena, et al. "A comparison between the quality of eggs from indigenous chicken breeds and that from commercial layers." *Poultry Science* 99, no. 3 (2020): 1768-1776.
140. Luciana R. Brun, Maria Lupo, Daniel A. Delorenzi, Vittorio E. Di Loreto, Alejandra Rigalli. "Chicken Eggshell as Suitable Calcium Source at Home." *International Journal of Food Science and Nutrition* (2019).

- ¹⁴¹. Madanhire T, Ó Breasail M, Kahari C, Kowo-Nyakoko F, Ebeling PR, Ferrand RA, Ward KA, Gregson CL. Prevalence of HIV-associated osteoporosis and fracture risk in midlife women: a cross-sectional study in Zimbabwe. *J Bone Miner Res.* 26; 39 (2024) (10):1464-1473.
- ¹⁴². Makinde, Oluwadamilola M., Kolawole I. Ayeni, Michael Sulyok, Rudolf Krska, Rasheed A. Adeleke, and Chibundu N. Ezekiel. "Microbiological safety of ready-to-eat foods in low-and middle-income countries: A comprehensive 10-year (2009 to 2018) review." *Comprehensive Reviews in Food Science and Food Safety* 19, no. 2 (2020): 703-732.
- ¹⁴³. Mamoon Bibi, Fayaz Asad, Sabrina Shahid, and Haseeba Kiramat. "Anatomical, histochemical and phytochemical screening of the vegetative parts of *Eichhornia crassipes*." *Journal of Pure and Applied Agriculture* 8, no. 3 (2023).
- ¹⁴⁴. Mansir, Nasir, John F. W. K. H. Ong, and Boon S. C. Y. Lim. "Synthesis and Application of Waste Eggshell Derived CaO Supported W-Mo Mixed Oxide Catalysts for FAME Production from Waste Cooking Oil: Effect of Stoichiometry." *Energy Conversion and Management* 186 (2019): 218-229.
- ¹⁴⁵. Mansir, Nasir, Suhaimi S., and Safiah O. "Modified Waste Eggshell Derived Bifunctional Catalyst for Biodiesel Production from High FFA Waste Cooking Oil: A Review." *Renewable and Sustainable Energy Reviews* 113 (2019): 109247.
- ¹⁴⁶. Maqsood, Sohail, Eddie, Lam, Ng, Hei, Afzal, Muhammad, Rehman, Safi, Ayyub, Muhammad. "Eggshells from Different Countries of Origin and Their Sustainable Application as a Partial Replacement of Cement." *Journal of Cleaner Production* (2023).
- ¹⁴⁷. Marcellus Arnold, Anna Gramza-Michałowska. "Enzymatic browning in apple products and its inhibition treatments: A comprehensive review." *Comprehensive Reviews in Food Science and Food Safety* 21, no. 6 (2022): 5038-5076.

148. Marcus Köller. "Sarcopenia—a geriatric pandemic: a narrative review." *Wiener Medizinische Wochenschrift* 173, no. 3 (2023): 97-103.
149. Mariana Ramírez-Telles, Juan José Mora-Román, and Milena Fallas-Cartín. "Registro sanitario de medicamentos biológicos y biotecnológicos en América Latina." *Ars Pharmaceutica (Internet)* 62, no. 2 (2021): 131-143.
150. Mário P. Betim, Gabriel L. Q. Guerra, and Maria E. R. A. B. Leite. "Eggshells as a new resource for soil amelioration in the cultivation of lettuce (*Lactuca sativa* L.)." *Sustainability* (2020).
151. Marium Waheed, Masood Sadiq Butt, Aamir Shehzad, Noranizan Mohd Adzahan, Muhammad Asim Shabbir, Hafiz Ansar Rasul Suleria, and Rana Muhammad Aadil. "Eggshell calcium: A cheap alternative to expensive supplements." *Trends in Food Science & Technology* 91 (2019): 219-230.
152. Marium Waheed, Muhammad Yousaf, Aamir Shehzad, Muhammad Inam-Ur-Raheem, Muhammad Kashif Iqbal Khan, Moazzam Rafiq Khan, Naveed Ahmad, and Rana Muhammad Aadil. "Channelling eggshell waste to valuable and utilizable products: a comprehensive review." *Trends in Food Science & Technology* 106 (2020): 78-90.
153. Martha S Field, Regan L Bailey, Patsy M Brannon, Jesse F Gregory, III, Alice H Lichtenstein, Ian J Saldanha, Barbara O Schneeman. Scanning the evidence: process and lessons learned from an evidence scan of riboflavin to inform decisions on updating the riboflavin dietary reference intakes. Volume 116, Issue 2, p. 299-302, August (2022).
154. Maseko, K.H., Regnier, T., Meiring, B., Wokadala, O.C., & Anyasi, T.A. Musa species variation, production, and the application of its processed flour: A review. *Scientia Horticulturae*, 325, (2024).
155. Michaëlsson, K., Baron, J.A., Byberg, L. et al. Declining hip fracture burden in Sweden 1998–2019 and consequences for projections through 2050. *Sci Rep.* 14, 706 (2024).

156. Mohammed, Toungos & Babayola, Muazu. "Tiger nut (*Cyperus esculentus*): A Super Food but Neglected by Researchers." 7. 1-7. (2019).
157. Monika Martiniakova, Martina Babikova, Vladimira Mondockova, Jana Blahova, Veronika Kovacova, and Radoslav Omelka. "The role of macronutrients, micronutrients and flavonoid polyphenols in the prevention and treatment of osteoporosis." *Nutrients* 14, no. 3 (2022): 523.
158. Monika Martiniakova, Jozef J. M. Kovalcik, Peter C. Valach, and Tomas J. Trizna. "The Role of Macronutrients, Micronutrients, and Flavonoid Polyphenols in the Prevention and Treatment of Osteoporosis." *Nutrients* 14, no. 3 (2022): 523.
159. Moodley, Ismail, Shenelle N. H. F. Ramjith, and Roy M. O. Abrahams. "Environmentally Sustainable Acid Mine Drainage Remediation: Research Developments with a Focus on Waste/By-Products." *Minerals Engineering* 139 (2019).
160. Muliwa, A. M., Bouhamidi, M., and Nguimkeu, E. P. "Performance Evaluation of Eggshell Waste Material for Remediation of Acid Mine Drainage from Coal Dump Leachate." *Minerals Engineering* 138 (2019): 76-86.
161. Mulia, A. M., H. S. Rahman, and M. K. Ibrahim. "Performance Evaluation of Eggshell Waste Material for Remediation of Acid Mine Drainage from Coal Dump Leachate." *Minerals Engineering* (2019).
162. Munisami, F. M. Nasir, N. A. Ali, N. J. Mohd. "Eggshell powder as a source of calcium in the formulation of functional cookies." *International Journal of Food Science & Technology* (2021).
163. Muriel Derrien, Anne-Sophie Alvarez, and Willem M. de Vos. "The gut microbiota in the first decade of life." *Trends in Microbiology* 27, no. 12 (2019): 997-1010.

164. N.A. Mazlan, J.M. Sapari, K.P. Sambasevam. "Synthesis and Fabrication of Polyaniline/Eggshell Composite in Ammonia Detection." *Journal of Metals, Materials and Minerals* 30, no. 2 (2020): 50-57.
165. Nabilah M. M. Hassan. "Chicken Eggshell Powder as Dietary Calcium Source in Biscuits." *World Journal of Dairy & Food Sciences* (2020).
166. Natarajan, Duraipandy, Zhitong Ye, Liping Wang, Linhu Ge, and Janak Lal Pathak. Rare earth smart nanomaterials for bone tissue engineering and implantology: Advances, challenges, and prospects. *Bioengineering & Translational Medicine* 7, no. 1 (2022).
167. Natasja van Schoor, Renate de Jongh, Paul Lips. "Worldwide vitamin D status." In *Feldman and Pike's Vitamin D* (2024): 47-75.
168. Neves, Maria Isabel Landim, et al. "Natural blue food colorants: Consumer acceptance, current alternatives, trends, challenges, and future strategies." *Trends in Food Science & Technology* 112 (2021): 163-173.
169. Nweze, Chibuzo, and Abdulganiyu, M. "Comparative Analysis of Vitamin C in Fresh Fruits Juice of *Malus domestica*, *Citrus sinensis*, *Ananas comosus*, and *Citrullus lanatus* by Iodometric Titration." (2019).
170. Niemann, A., Bäumer, S., & Nussbaum, M. "Bioactive Peptides Derived from Eggshell Membrane: Extraction and Potential Applications." *Nutrients* 13, no. 1 (2021).
171. Niju, S., Kancharla, A. K., and Ali, M. S. "Modification of Eggshell and Its Application in Biodiesel Production." *Journal of Saudi Chemical Society* 23 (2019): 881-895.
172. Nwankwo G. Onodugo, Emmanuel C. Agbo, Chinwe M. Ikwumere, Ndukwe P. Onwubuya, Ifeanyi M. Nnadi, Ezekiel P. Ezeja, and Chima B. "Nutritional Composition and Sensory Properties of Smoothies Produced from Pineapple (*Ananas*

- comosus), Watermelon (*Citrullus lanatus*), and Mango (*Mangifera indica*).¹⁷³ Journal for Family & Society Research 1, no. 2 (2022).
173. Ofshenko, Nadav, Eyal Bercovich, Tania Mashiach, Michal Weiler-Sagie, Daniela Militianu, and Eldad J. Dann. Reduction of the Vertebral Bone Mineral Density in Patients with Hodgkin Lymphoma Correlates with Their Age and the Treatment Regimen They Received. *Cancers* 14, no. 3: 495. (2022).
174. Ohoke, Francis & Nwokonkwo, Dorathy. "Production, Chemical Properties and Sensory Evaluation of Wine from Blends of Gaper (*Vitis vinifera*) Fruit, Pawpaw (*Carica papaya*) Fruit, and Tiger Nut (*Cyperus esculentus*) Tuber." *International Journal of ChemTech Research*, 12, 17-27 (2019)
175. Okoh, O. K. Olatunji. "Bioactive compounds in chicken eggshell: A review." *Journal of Nutritional Science* (2021).
176. Olaniyi T. Alake, Daniel O. Abraham, Tosin O. Akinola, Olawale O. Fatunmibi, Temitope O. Agboola, and Seye I. Akua. "Production and Evaluation of Smoothies made from Various Fruits Sold in Lagos Market." *International Journal of Innovative Science and Research Technology* 7, no. 1 (2022): 642-646.
177. Olaniyi T. Alake, Daniel O. Abraham, Tosin O. Akinola, Olawale O. Fatunmibi, Temitope O. Agboola, and Seye I. Akua. "Production and Evaluation of Smoothies made from Various Fruits Sold in Lagos Market." *International Journal of Innovative Science and Research Technology* 7, no. 1 (2022): 642-646.
178. Oluwole Steve Ijarotimi, Damilola Alex Fakayejo, and Timilehin David Oluwajuyitan. "Nutritional characteristics, glycaemic index and blood glucose lowering property of gluten-free composite flour from wheat (*Triticum aestivum*), soybean (*Glycine max*), oat-bran (*Avena sativa*) and rice-bran (*Oryza sativa*)." *Applied Food Research* 1, no. 2 (2021).
179. Onwubu, Simon C., Ramesh Chinta, and Nisha Kumar. "Characterization and In Vitro Evaluation of an Acid Resistant Nanosized Dental Eggshell-Titanium Dioxide Material." *Advanced Powder Technology* 30 (2019): 982-993.

180. Onwubu, Simon C., Shukla V., and Krishna T. N. R. "Reducing the Surface Roughness of Dental Acrylic Resins by Using an Eggshell Abrasive Material." *The Journal of Prosthetic Dentistry* 122 (2019): 363-368.
181. Onyimba, I. A., M. S. Chomini, M. O. Job, A. I. Njoku, J. A. Onoja, D. C. Isaac, I. C. Isaac, and A. C. Ngene. Evaluation of the Suitability of Tigernut Milk and Tigernut-Cow Composite Milks for Yoghurt Production. *European Journal of Biology and Biotechnology* 3, no. 2 (2022): 38–44.
182. Owuamanam, Stephen, and Duncan Cree. "Progress of bio-calcium carbonate waste eggshell and seashell fillers in polymer composites: a review." *Journal of Composites Science* 4, no. 2 (2020): 70.
183. Oyeyinka, B., Afolayan, A. Potentials of Musa Species Fruits against Oxidative Stress-Induced and Diet-Linked Chronic Diseases: In Vitro and In Vivo Implications of Micronutritional Factors and Dietary Secondary Metabolite Compounds. *Molecules*, 25, 5036, (2020).
184. Onodugo, N. G., E. C. Agbo, C. M. Ikwumere, N. P. Onwubuya, I. M. Nnadi, E. P. Ezeja, and B. Chima. "Nutritional Composition and Sensory Properties of Smoothies Produced from Pineapple (*Ananus Comosus*), Watermelon (*Citrus Lanatus Thumb*) and Mango (*Mangifera Indica L.*)" *Journal For Family & Society Research* 1, no. 2 (2022).
185. Pandey, A., Kumar, N., and Srivastava, V. K. "Experimental Studies on Zeta Potential of Flocculants for Harvesting of Algae." *Journal of Environmental Management* 250 (2019).
186. Park YB, Kim M, Nam HC, Jeon JW, Ha CW. Total knee arthroplasty and periprosthetic distal femoral fracture: looking beyond the osteoporosis to previous osteoporotic fracture. *Osteoporos Int.* (2024)
187. Paździor, Magdalena. Consumer Segmentation Using Cluster Analysis as A Source Of Data To Improve Product Quality. *Scientific Papers of Silesian University Of*

Technology. Organization & Management/Zeszyty Naukowe Politechniki Slaskiej. Seria Organizacji I Zarzadzanie 188 (2023).

188. Peter Ifeoluwa Adegbola, Adewale Adetutu, and Temitope Deborah Olaniyi. "Antioxidant activity of Amaranthus species from the Amaranthaceae family – A review." *South African Journal of Botany* 133 (2020): 111-117.
189. Pettinato, Marco, Salvatore R. D., and Domenico D. L. "Eggshell: A Green Adsorbent for Heavy Metal Removal in an MBR System." *Ecotoxicology and Environmental Safety* 174 (2019): 264-272.
190. Piker, Ali, Sıdıka Akbulut, and Rezzan Temiz. "A Green and Low-Cost Room Temperature Biodiesel Production Method from Waste Oil Using Eggshells as Catalyst." *Fuel* 239 (2019): 569-578.
191. Prayitno, Agus, et al. "Karakteristik Mikrostruktur dan Nilai Gizi Bakso Ayam yang Difortifikasi Kalsium Oksida dan Nanokalsium Laktat Kerabang Telur Ayam." (2020): 653-663.
192. Preethy Manoj, Rosemarie Derwin, Sherly George. "What is the impact of daily oral supplementation of vitamin D3 (cholecalciferol) plus calcium on the incidence of hip fracture in older people? A systematic review and meta-analysis." *International Journal of Older People Nursing* 18, no. 1 (2023).
193. Probojati, R.T., Listyorini, D., Sulisetijono, S., et al. Phylogeny and estimated genetic divergence times of banana cultivars (*Musa* spp.) from Java Island by maturase K (matK) genes. *Bulletin of the National Research Centre*, 45, 33, (2021).
194. Promise Chinonso Okpe, Oladipo Folorunso, Victor Sunday Aigbodion, and Camillus Obayi. "Hydroxyapatite synthesis and characterization from waste animal bones and natural sources for biomedical applications." *Journal of Biomedical Materials Research Part B: Applied Biomaterials* 112, no. 7 (2024).

- ^{195.} Putnik, Predrag, Branimir Pavlić, Branislav Šojić, Sandra Zavadlav, Irena Žuntar, Leona Kao, Dora Kitonić, and Danijela Bursać Kovačević. Innovative hurdle technologies for the preservation of functional fruit juices. *Foods* 9, no. 6 (2020): 699.
- ^{196.} Qin, Yuxin, Christopher Pillidge, Bernie Harrison, and Benu Adhikari. Pathways in formulating foods for the elderly. *Food Research International* (2024): 114324.
- ^{197.} Ranga, Leocardia, Noci, Francesco, Dermiki, Maria. Insect-Based Foods: A Preliminary Qualitative Study Exploring Factors Affecting Acceptance and New Product Development Ideas through Focus Groups. *Challenges*. 15. 40. (2024).
- ^{198.} Rashad, A.M. "Silica Fume in Cement-Based Materials: A Comprehensive Review." *Construction and Building Materials* 291 (2021).
- ^{199.} Ravi, Y., M. Elizabeth, and M. Shivashankar. "Raw and ripe banana powder for nutritional and economic sustainability." (2023): 157-160.
- ^{200.} Ravindran, Rajesh, Raghuvanshi, and Vigneshwaran. "Exploitation of Food Industry Waste for High-Value Products." *Trends in Biotechnology* 37 (2019): 949-961.
- ^{201.} Ray, Surendra, Karuna K., and Rani, R. "Chicken Eggshell Powder as Dietary Calcium Source in Chocolate Cakes." *The Pharma Innovation* 6 (2019).
- ^{202.} Ray, Soumitra, Debabrata Chowdhury, Rakesh Mandol, Ashok Ranjan, and Prabhat Sinha. "Chicken Eggshell Powder as an Alternative to Calcium Supplements in Young Adults." *International Journal of Nutritional Sciences* (2020).
- ^{203.} Renner, S.S., Wu, S., Pérez-Escobar, O.A., Silber, M.V., Fei, Z., Chomicki, G. A chromosome-level genome of a Kordofan melon illuminates the origin of domesticated watermelons. *Proceedings of the National Academy of Sciences*, 118 (23), (2021).

204. Rino, Yasushi, et al. "Metabolic bone disorders after gastrectomy: inevitable or preventable?" *Surgery Today* (2022): 1-7.
205. Rinonapoli, Giuseppe, Valerio Pace, Carmelinda Ruggiero, Paolo Ceccarini, Michele Bisaccia, Luigi Meccariello, and Auro Caraffa. Obesity and bone: a complex relationship. *International journal of molecular sciences* 22, no. 24 (2021): 13662.
206. Roberts, J.R. "Factors affecting egg internal quality and eggshell quality in laying hens." *Journal of Poultry Science* (2019).
207. Roselló-Soto, Elena, Francisco J. Barba, Jose M. Lorenzo, Paulo ES Munekata, Belén Gómez, and Juan Carlos Moltó. Phenolic profile of oils obtained from "horchata" by-products assisted by supercritical-CO₂ and its relationship with antioxidant and lipid oxidation parameters: Triple TOF-LC-MS-MS characterization. *Food Chemistry* 274 (2019): 865-871.
208. Rossiello, Francesca, et al. "Telomere dysfunction in ageing and age-related diseases." *Nature Cell Biology* 24, no. 2 (2022): 135-147.
209. Rotimi, D.E., & Asaleye, R.M. Impact of Watermelon (*Citrullus lanatus*) on Male Fertility. *JBRA Assisted Reproduction*, 27(4), 702, (2023).
210. Sajad Ahmad Wani, Jasmeet Kour, Raees-ul Haq, and Mohamed S. Elshikh, eds. *Fruits and Their Roles in Nutraceuticals and Functional Foods*. CRC Press (2023).
211. Salama, Rania, Nasser Abdelkader, Ahmed El-Sayed, Mohamed El-Sayed, and Tamer Elshafey. "Histomorphometric Evaluation of a Nano-Sized Eggshell-Containing Supplement as a Natural Alloplast: An Animal Study." *The Saudi Dental Journal* (2021).
212. Salari, Nader, et al. "The global prevalence of osteoporosis in the world: a comprehensive systematic review and meta-analysis." *Journal of Orthopaedic Surgery and Research* 16 (2021): 1-20.

213. Salaudeen, Shamsuddeen A., A. Adediran, M. Y. O. K. Olatunji, and I. B. Akande. "Eggshell as a Potential CO₂ Sorbent in the Calcium Looping Gasification of Biomass." *Waste Management* (2020).
214. Salehi, Bahare, Razieh Sharifi-Rad, Farukh Sharopov, Jacek Namiesnik, Amir Rooiantan, Madhu Kamle, Pradeep Kumar, Natália Martins, and Javad Sharifi-Rad. Beneficial effects and potential risks of tomato consumption for human health: An overview. *Nutrition* 62 (2019): 201-208.
215. Samanta, Sharmistha, Tanmay Sarkar, and Runu Chakraborty. Multifunctional applications of natural colorants: Preservative, functional ingredient, and sports supplements. *Biocatalysis and Agricultural Biotechnology* 56 (2024): 103026.
216. Sandeep K. Arora and Aayush A. Patel. "In Vivo Effect of Two Different Dietary Fiber Blends on the Milk Calcium Bioavailability." *Journal of Food Science and Technology* (2019), 56, 2126–2133.
217. Scott, G.J. A review of root, tuber and banana crops in developing countries: past, present and future. *International Journal of Food Science & Technology*, 56(3), 1093-1114, (2021).
218. Seyed Bazrafshan, Mohammad Mizani, Gholamreza Pazuki, and Shirin Shahriari. "Colorimetric and Sensory Properties of Tube Feeding Formulated by Gelatin and Maltodextrin." *Journal of Food Biosciences and Technology* 13, no. Fall (2023): 49-62.
219. Shahnaila, Ali, and Hussain, A. "Effects of Eggshell Powder Supplementation on Nutritional and Sensory Attributes of Biscuits." *Czech Journal of Food Sciences* (2022).
220. Sivamani, Kalaimani & Venkatesh, R & Tumbanatham, A & Green, Siva. A Rare Case of Extensive Brain Calcinosi and Features of Parkinsonism Secondary to Iatrogenic Hypoparathyroidism. *Journal of Clinical and Diagnostic Research*. (2019).

221. Škegro, M., Putnik, P., Bursać Kovačević, D., Kovač, A. P., Salkić, L., Čanak, I., Frece, J., Zavadlav, S., & Ježek, D. Chemometric Comparison of High-Pressure Processing and Thermal Pasteurization: The Nutritive, Sensory, and Microbial Quality of Smoothies. *Foods* (Basel, Switzerland), 10(6), (2021). 1167.
222. Srivastava D, Singh D, Kumar P. "A review on the potential utilization of chicken eggshells in agriculture and food industry." *Journal of Cleaner Production* (2020).
223. Supplementation and Fractures in Adults: A Systematic Umbrella Review of Meta-Analyses of Controlled Trials. *The Journal of Clinical Endocrinology & Metabolism*, Volume 107, Issue 3, (2022), Pages 882–898.
224. Susanna L., Grilli G., Ferrari L., Battelli G., Pozzo S., Galasso I., Russo R., Brasca M., Reggiani R., and Ferrante V. "Effect of Different Percentage of *Camelina sativa* Cake in Laying Hens Diet: Performance, Welfare, and Eggshell Quality." *Animals* (2020).
225. Tan, L., He, R. & Zheng, X. Effect of vitamin D, calcium, or combined supplementation on fall prevention: a systematic review and updated network meta-analysis. *BMC Geriatr.* 24, 390 (2024).
226. Te Yu, Qiong Wu, Jiaming Wang, Bin Liang, Xusheng Wang, Xinzhu Shang. "Physicochemical properties of tiger nut (*Cyperus esculentus* L) polysaccharides and their interaction with proteins in beverages." *Food Chemistry: X*, Volume 19 (2023).
227. Ten Haaf, D. S. M., Balvers, M. G. J., Timmers, S., Eijsvogels, T. M. H., Hopman, M. T. E., and Klein Gunnewiek, J. M. T. "Determinants of Vitamin D Status in Physically Active Elderly in the Netherlands." *European Journal of Nutrition* 58 (2019): 3121–3128.
228. Teresa Pinto, Alice Vilela, and Fernanda Cosme. "Chemical and sensory characteristics of fruit juice and fruit fermented beverages and their consumer acceptance." *Beverages* 8, no. 2 (2022): 33.

229. Tchoukouang, Rose Daphnee, Alexandre R. Lima, Andreia C. Quintino, Nathana L. Cristofoli, and Margarida C. Vieira. "UV-C light: A promising preservation technology for vegetable-based non-solid food products." *Foods* 12, no. 17 (2023): 3227.
230. Timmis, A., Gale, C. P., Vlad, D., & Roffi, M. European Society of Cardiology: Cardiovascular disease statistics 2021. *European Heart Journal*, 43(8), (2022).S716-799.
231. Tong, S. C., Siow, L. F., Tang, T. K., and Lee, Y. Y. "Plant-based milk: Unravel the changes of the antioxidant index during processing and storage – a review." *Critical Reviews in Food Science and Nutrition* 64, no. 14 (2024): 4603-4621.
232. Toro, Pedro, Mauro P. K. V. D. Oliveira, and Leticia A. Ferreira. "Eggshell, a New Bio-Filler for Polypropylene Composites." *Materials Letters* (2021).
233. Torres-Mansilla, Ana, Jorge Alberto Arango, María José Vázquez, and Julio César Ochoa. "Eggshell Membrane as a Biomaterial for Bone Regeneration." *Polymers (Basel)* (2023).
234. Toungos, M. D., and M. Z. Babayola. "Tiger nut (*Cyperus esculentus*): A Super Food But Neglected By Researchers." *International Journal of Innovative Food* (2019).
235. Tze San Looi. "Development of kombucha beverage derived from *Aquilaria malaccensis* tea infused with pineapple and mint." PhD diss., Universiti Tunku Abdul Rahman (UTAR), (2022).
236. Ülkü, Sultan & Ünlü, Nimet. Could Chicken Eggshell Powder Be The Solution in Dentistry? (2023).
237. Valerio Polzonetti, Silvia Pucciarelli, Stefania Vincenzetti, Paolo Polidori. "Dietary Intake of Vitamin D from Dairy Products Reduces the Risk of Osteoporosis." *Nutrients* (2020).

238. Vitor-Aduloju, A.T., Nwanja, N.M., Ezegbe, C.C., Okocha, K.S., & Aduloju, T.A. Phytochemicals and vitamin properties of smoothie flavoured with mint leaves extract. *International Journal of Biochemical Research and Review*, 29(7), 24-30, (2020).
239. Waheed, Marium, et al. "Eggshell calcium: A cheap alternative to expensive supplements." *Trends in Food Science & Technology* 91 (2019): 219-230.
240. Waheed, Muhammad, M. R. Khan, and A. Rehman. "Extraction of Calcium from Eggshell Waste; Importance and Food Applications." *Trends in Food Science & Technology* (2021).
241. Wang, C., Zhang, Y. "Eggshells as an Eco-friendly Catalyst for Biodiesel Production: A Comprehensive Review." *Biomass and Bioenergy* (2022): 155.
242. Wang, Ji, Jianwei Zhang, Yuyuan Wang, Ruijuan Liu, and Bo Liu. "Purification, identification, chelation mechanism, and calcium absorption activity of a novel calcium-binding peptide from peanut (*Arachis hypogaea*) protein hydrolysate." *Journal of Agricultural and Food Chemistry* 71, no. 31 (2023): 11970-11981.
243. Wei, Zhi, Min Zhang, and Jizheng Yan. "Application of Waste Eggshell as Low-Cost Solid Catalyst for Biodiesel Production." *Bioresource Technology* (2021).
244. Wen, Rongxin, Zhang, C., and G. Wang. "Effect of NaCl Substitutes on Lipid and Protein Oxidation and Flavor Development of Harbin Dry Sausage." *Meat Science* (2019).
245. Wenmin Wu, Lichao He, Yanhui Liang, Lili Yue, Weiming Peng, Guofeng Jin, and Meihu Ma. "Preparation process optimization of pig bone collagen peptide-calcium chelate using response surface methodology and its structural characterization and stability analysis." *Food Chemistry* 284 (2019): 80-89.

246. Wingler, A., and B. Sandel. "Relationships of the Competitor, Stress Tolerator, Ruderal Functional Strategies of Grass Species with Lifespan, Photosynthetic Type, Naturalization and Climate." *AoB Plants* 15, no. 3 (2023).
247. Yi, H., Siu, Q. K. Y., Ngan, O. M. Y., & Chan, D. F. Y. Parents' experiences of screening, diagnosis, and intervention for children with autism spectrum disorder. *American Journal of Orthopsychiatry*, 90(3), (2020). 297–311.
248. Yifan Wu et al. "Eggshell Powder as a Novel Ingredient for Cookies: Influence on Baking Quality and Sensory Characteristics." *Journal of Food Science* (2020).
249. Yifan Zhu, Junping Wang, Xueming Ding, Shuping Bai, Shuqing Ren, Qi Zeng, Yanjun Xuan, Zhe Wang, and Kaiyu Zhang. "Effect of different tea polyphenol products on egg production performance, egg quality and antioxidative status of laying hens." *Animal Feed Science and Technology* (2020).
250. Yu, Yali, Lu, Xiaoyu, Zhang, Tiehua, Zhao, Changhui, Guan, Shiyao, Pu, Yiling, Gao, Feng. "Tiger Nut (*Cyperus esculentus* L.): Nutrition, Processing, Function and Applications." *Foods* 11. 601. (2022).
251. Zechun Wang, Shiyao Chen, Shenglan Yang, Qun Luo, Yancheng Jin, Wei Xie, Lijun Zhang, and Qian Li. "Light-weight refractory high-entropy alloys: A comprehensive review." *Journal of Materials Science & Technology* 151 (2023): 41-65.
252. Zhang, Y., J.Y. Li, and L. Zhao. "Effects of Limestone Powder on Concrete Properties: A Review of Recent Advances." *Journal of Cleaner Production* 335 (2022): 130179.
253. Zhang, Y.; Liu, Z.; Duan, L.; Ji, Y.; Yang, S.; Zhang, Y.; Li, H.; Wang, Y.; Wang, P.; Chen, J.; et al. Effect of Low-Dose Vitamin K2 Supplementation on Bone Mineral Density in Middle-Aged and Elderly Chinese: A Randomized Controlled Study. *Calcif. Tissue Int.* (2020) 106, 476–485.

254. Zhang, Yiming, and Shangde Sun. "Tiger nut (*Cyperus esculentus* L.) oil: A review of bioactive compounds, extraction technologies, potential hazards and applications." *Food Chemistry: X* (2023).
255. Zhang, Yu, Weiting Fu, Siyao Chen, Hongshan Liang, Jing Li, Yan Li, and Bin Li. Pickering emulsions stabilized by homogenized ball-milled eggshell particles in combination with sodium alginate. *International Journal of Biological Macromolecules* 229 (2023): 1044-1053.
256. Liping Zhou, Fei Chen, Xiuli Zhang, Xing Liu, Zhiyong Chen, and Zhongwei Hu. "Functional DNA-based hydrogel intelligent materials for biomedical applications." *Journal of Materials Chemistry B* 8, no. 10 (2020): 1991-2009.

Books

257. Rombauer, Irma S., Becker, Marion R., and Rombauer, Ethan. *Joy of Cooking: 2019 Edition Fully Revised and Updated*. Scribner, (2019).
258. Frame, Paul. "General information about K-40". Oak Ridge National Laboratory. (2019)
259. Korn, Leslie E. *Rhythms of Recovery: Integrative Medicine for PTSD and Complex Trauma*. Routledge, 2023.
260. Lewis, Susana; Lewis, Charles. *A Taste of Paradise*. Psy Press. (2012).18.
261. Lorenc, R., et al. "Guidelines for the Diagnosis and Management of Osteoporosis in Poland. Update 2017." *Endokrynol. Pol.* (2017), 68, 604–609.
262. Mansfield, Gary. "Banana equivalent dose". Internal Dosimetry, Lawrence Livermore National Laboratory, University of California. (2019)
263. Maria, Harrison, Meghan, Stallings, Virginia A. (eds.). *National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Food and Nutrition Board; Committee to Review the Dietary Reference Intakes for Sodium and*

- Potassium Oria. Dietary Reference Intakes for Sodium and Potassium. The National Academies Collection: Reports funded by National Institutes of Health. Washington, DC: National Academies Press (US). (2019)
264. Materials from Waste: Eggshells and Their Applications. Singh, R., and P. A. Kumar. Springer, (2022).
265. Paris, Harry S. Origin of the Dessert Watermelon. In *The Watermelon Genome*, pp. 1-16. Cham: Springer International Publishing, (2023).
266. Royal Botanic Gardens, Kew". Kew Science. "World Checklist of Selected Plant Families". (2021)
267. Samuel Ayofemi Olalekan, Adeyeye. Banana Drying Kinetics. *Banana Nutrition - Function and Processing Kinetics*. IntechOpen. (2020).
268. Sustainable Materials for Biodiesel Production. Smith, L. and McGregor, P. (Eds.), 1st Edition, Elsevier, (2021).
269. Utilization of Industrial By-Products in Green Construction: An Eggshell Perspective. Patel, A., and K. B. Ramesh. CRC Press, (2020).
270. Wani, Sajad Ahmad, ed. *Fruits and Their Roles in Nutraceuticals and Functional Foods*. CRC Press, 2023.

Research papers

271. Akabassi, Ghislain Comlan, Koffi Kibalou Palanga, Elie Antoine Padonou, Yao Dodzi Dagnon, Koffi Tozo, and Achille Ephrem Assogbadjo. "A global systematic review on biology, production constraints and uses of *Cyperus exculentus* L.(Neglected and Underutilized Crop Species): implications for valorization." (2021).
272. Devi, N. R., and Prakash, T. H. "A Comprehensive Study on the Use of Eggshell Powder as an Additive in Cementitious Materials." University of Engineering and Technology Research Report, 2021.

273. Echendu, Jane, Monday Godwin-Egein, Udensi Ekea Udensi, Kuromiayebaye Digitemie, and Victor Okereke. "Fungal organisms associated with common tropical weeds in Choba Rivers State Nigeria." *Sustainability, Agri, Food and Environmental Research*, 12(2) (2024).
274. "Eggshell Waste in Cement Production." *Sustainability Today* (2023).
275. Feys, Jeroen, Benny De Cauwer, Dirk Reheul, Clara Sciffer, Shana Clercx, and Sander Palmans. "Impact of electrocution on shoot and tuber vitality of yellow nutsedge (*Cyperus esculentus*)." *Agriculture*, 13(3), 696 (2023).
276. Grover, Neha. "Why South Indians Eat On Banana Leaves - Health Benefits And More". *NDTV*. (2024)
277. Khan, Muhammad, Siddique, Syed A., and Hashmi, Muhammad Z. "Development of Low-Cost Sorbents from Eggshells for Heavy Metal Removal." Report by the International Environmental Agency, 2019.
278. Neumann, Caryn E., Lori L. Parks, and Joel G. Parks. *Global Dishes: Favorite Meals from Around the World*. Bloomsbury Publishing USA. (2023).
279. Prayitno, Agus, Santoso, U., and Y. Supriyadi. "Karakteristik Mikrostruktur dan Nilai Gizi Bakso Ayam yang Difortifikasi Kalsium Oksida dan Nanokalsium Laktat Kerabang Telur Ayam." (2020).
280. Tsao, Kimberley. "Turon, maruya, bitso-bitso and banana cue make it to Taste Atlas's list of 100 most popular deep-fried desserts in the world". (2024).

Theses/Dissertations

281. Looi, Tze San. "Development of Kombucha Beverage Derived from *Aquilaria Malaccensis* Tea Infused with Pineapple and Mint." PhD diss., UTAR,(2022).

ARTICLES

282. Dietitians of Canada. "What you need to know about potassium". *EatRight Ontario*, (2019)

283. Food and Agriculture Organization of the United Nations. "Watermelon | Land & Water". Food and Agriculture Organization of the United Nations | Land & Water. Fao.org, (2023).
284. Harvard Heart Letter, Harvard Medical School. "Drink your fruits and vegetables?" (2018).
285. Jeff Olsen "Mayo Clinic Minute: Get smart about smoothies". (2017).
286. Kemper B. "Nut Milks Are Milk, Says Almost Every Culture Across the Globe". Smithsonian Magazine. (2020).
287. Khan, Faima Atta, et al. "Development and analysis of bread fortified with calcium extracted from chicken eggshells of Pakistani market." Food Science and Technology 41, no. suppl 1 (2020): 14-20.
288. Matejic, Vesna & Petrovic, Milos & Kurćubić, Vladimir & Petkovic, Marko & Miletic, Nemanja & Đurović, Igor. Comparison of Cow's Milk with Plant-Based Milk Alternatives: Selected Chemical and Physical Analysis. (2023).
289. Middle East Eye. "Watermelon: A slice of Palestinian resistance". 17 August (2022).
290. Nag, Moupriya, et al. "Seafood discards: a potent source of enzymes and biomacromolecules with nutritional and nutraceutical significance." Frontiers in Nutrition 9 (2022): therapeutic options." Revista alergía México, 69 (2022): 55-68.
291. "New Innovations in Eggshell Applications." *EcoScience Magazine* (2022).
292. NBC News. "How to build a better smoothie, according to a nutritionist". (2022).
293. Nweze, Chibuzo & Abdulganiyu, M & Erhabor, Osas. Comparative Analysis Of Vitamin C In Fresh Fruits Juice Of Malus Domestica, Citrus Sinensis, Ananas Comosus And Citrullus Lanatus By Iodometric Titration. (2019).

294. Oliver Franklin-Wallis. "White gold: the unstoppable rise of alternative milks". The Guardian. (2019).
295. Patil, L. "Eggshells as a Green Catalyst for Biodiesel Production." Green Chemistry Journal, vol. 5, no. 2, 2020.
296. Quang Duc Tran, Thi Hoa Huyen Nguyen, Cu Linh Le, Lan Van Hoang, Thi Quynh Chi Vu, Ngoc Quang Phan, Thi Thuy Bui. Sugar-sweetened beverages consumption increases the risk of metabolic syndrome and its components in adults: Consistent and robust evidence from an umbrella review. Clinical Nutrition ESPEN, Volume 57, (2023) Pages 655-664.
297. Rosenfeld, M. J. "Eggshell Waste: A Promising Source for Sustainable Water Purification." Environmental News Today, 2020.
298. Sharma, Hari Bhakta, et al. "Challenges, opportunities, and innovations for effective solid waste management during and post COVID-19 pandemic." Resources, Conservation and Recycling 162 (2020).
299. Sharon, Jeremy. "Activists use watermelons to protest police crackdown on Palestinian flags". The Times of Israel, (2023).
300. Tao, Jingjing. "Alert: Ultra-processed Food Is Overwhelming American's Diet." Journal of Agricultural Science, 14, no. 4 (2022).
301. The New York Times. "Why the Watermelon Emoji Is a Symbol of Support for Palestinians". (2023).
302. The Times of Israel "Activists use watermelons to protest police crackdown on Palestinian flags".. (2023).
303. Waheed, M., Yousaf, M., Shehzad, A., Inam-Ur-Raheem, M., Khan, M.K.I., Khan, M.R., Ahmad, N., Abdullah, Aadil, R.M. "Channelling Eggshell Waste to Valuable

and Utilizable Products: A Comprehensive Review." *Trends Food Sci. Technol.* (2020), 106, 78–90.

- ³⁰⁴. Williams, Patrick. "Roast Bream with Fried Plantain Fritters and Coconut Sauce." BBC. Retrieved March 12, 2024.

Conferences

- ³⁰⁵. Affecting Acceptance and New Product Development Ideas through Focus Groups. *Challenges* 15 (2024): 40.
- ³⁰⁶. Bursać Kovačević, Danijela, Irena Žuntar, and Predrag Putnik. Preservation of functional fruit juices using hurdle technology. In *3rd International Congress on Food Safety and Quality: Food, Health and Climate Changes*, (2020). pp. 34-34.
- ³⁰⁷. da Costa Neto J.J.G., Gomes T.L.M., Justo T.F., Pereira K.S., Amaral P.F.F., Leão M.H.M.R., Sant'Ana G.C.F. Microencapsulation of tiger nut milk by lyophilization: Morphological characteristics, shelf life and microbiological stability. In *Proceedings of the Food Chemistry Conference*, (2019), 133-139.
- ³⁰⁸. Delarue, J. "Overview of Sensory Methods for the Evaluation of Non-Food Products." *Non-Food Sensory Practice* (2022).
- ³⁰⁹. Isaev, S., T. Rajabov, G. Goziev, and A. Khojasov. "Effect of fertilizer application on the 'Bukhara-102' variety of cotton yield in salt-affected cotton fields of Uzbekistan." In *E3S Web of Conferences*, vol. 258, p. 03015. EDP Sciences. (2021).
- ³¹⁰. Iqbal, M., & Shah, S. R. Eggshell waste for water treatment: A sustainable approach. In *Proceedings of the 2019 International Conference on Environmental Sustainability and Renewable Energy*. Dubai, UAE. (2019).
- ³¹¹. Kadir, N., Othman, F., and S. M. S. Ali. "Utilization of Eggshell Powder in Concrete Mixes." In: *Proceedings of the 7th International Conference on Environmental Science and Technology*, Kuala Lumpur, Malaysia, (2020).
- ³¹². Przezbórska-Skobiej, Lucyna, and Paulina Luiza Wiza. "Food waste in households in Poland—Attitudes of young and older consumers towards the phenomenon of food waste as demonstrated by students and lecturers of PULS." *Sustainability* 13, no. 7 (2021): 3601.

313. Ślusarczyk, B., and E. Machowska. "Food Waste in the World and in Poland." (2019): 91-100.
314. Tang, Y., Wang, X., Liu, C., & Zhang, Z. A survey on the 5G network and its impact on agriculture: Challenges and opportunities. *Computers and Electronics in Agriculture*, 180, (2021).
315. Zidan, A., H. Al-Naggar, and H. S. M. Khalil. "Use of Eggshell in Concrete as Partial Replacement of Cement." In: *Proceedings of the 11th International Civil Engineering Conference*, Cairo, Egypt, (2019).
316. Van der Veen, Marijke. "Crop Prevalence and Surplus Production in Roman and Medieval Northeast England." (2023).

Internet sources

317. Dietitians of Canada. "What you need to know about potassium". EatRight Ontario, (2019).
318. FAO. "The State of Food and Agriculture: Moving Forward on Food Loss and Waste Reduction." Food and Agriculture Organization of the United Nations: Rome, Italy, (2019).
319. Food and Agriculture Organization of the United Nations. Watermelon | Land & Water. Fao.org. (2023).
320. FoodData Central, United States Department of Agriculture. (2023).
321. Pure Green Franchise. Benefits of drinking healthy smoothies. Retrieved from <https://puregreenfranchise.com/benefits-of-drinking-healthy-smoothies>. (2021).
322. United Nations. "World Population Ageing 2019: Highlights." United Nations: New York, NY, USA, (2019).

323. FoodData Central, United States Department of Agriculture. "Ranking of potassium content per 100 grams in common foods ("Foundation" only for search filter)". (2023)
324. Nace, Trevor. "Thailand Supermarket Ditches Plastic Packaging For Banana Leaves". *Forbes* (2019)
325. Tarantino, Olivia. "You're Eating Bananas Wrong—here's the Right Way". *Eat This Not That* (2021)
326. The San Diego Union-Tribune. "Banana leaves transform texture of chicken tamales". (2022)
327. Nazish, Noma. "What Are Tiger Nuts And Why Should You Eat Them?". *Forbes*. (2022)cts Labels". (2024)
328. United States Food and Drug Administration. Daily value on the nutrition and supplement facts labels. (2020).
329. Williams, Patrick. "Roast bream with fried plantain fritters and coconut sauce". BBC. Retrieved March 12, (2024)

Reports/Extensions

330. United States Food and Drug Administration. "Daily Value on the Nutrition and Supplement Facts Labels." FDA. (2024).
331. Darla Stoker, Carrie Durward. "Smoothies—Helpful or Harmful?" Nutrition Extension - Utah State University (2022).

Patents

332. Sigal, Abdulkadir Yussuf, Jesus Lopez Garcia, and Maria Valeria Theall. "Stuffed, flavored and packaged olives." U.S. Patent 10,842,181, (2020).

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