



NUTRITIONAL ANALYSIS AND SENSORY ACCEPTABILITY OF KULITIS (*Amaranthus Viridis*) POWDER AS A VALUE-ADDED INGREDIENT OF COOKIES

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ABSTRACT

Value-added food demand has grown based on consumers' changing interest in the contribution of nutrition and innovation for sustainable food. In addition, malnutrition continues to be an issue of public health in the country and region. Thus, this study aims to utilize Kulitis, an underappreciated plant often not recognized by locals and farmers. This study evaluated the potential of using kulitis powder as a nutrient-dense ingredient in butter cookies, aiming to contribute to alleviating malnutrition and developing value-added ingredients. An experimental research design using a proximate analysis was employed. Thus, kulitis powder contains 19.56g of protein, 27.96g of carbohydrates, and a fat of 2.53 per 100g. Then, kulitis powder was incorporated into a butter cookie formulation at a 25% level, while the butter cookie without kulitis powder served as the baseline for comparison. Based on nutritional analysis, the butter cookies with kulitis powder were less in carbohydrates and high in protein. There were 30 sensory panelists involved, possessing diverse backgrounds in pastry, including Home Economics teachers, nutritionists, pastry chefs, and food technologists. The result shows that the sensory panelists preferred the butter cookie without kulitis over the butter cookie with kulitis. The study found a significant difference in the aroma and overall acceptability. Kulitis powder has nutritional advantages; however, its use at this amount affects important sensory qualities and reduces overall acceptability. This study recommends future research might explore optimization of processing techniques to enhance sensory attributes, which would satisfy consumers without sacrificing nutritional value.

Keywords: *Amaranthus viridis, Kulitis powder, Nutritional Analysis, Sensory Acceptability, Value-added ingredient, Butter cookies*

INTRODUCTION

In recent years, consumers have shown increasing interest in nutritious and innovative food products that contribute to sustainable eating habits. Value-added food products, which enhance basic ingredients with additional nutrients or distinctive flavors, have gained popularity as manufacturers respond to evolving health preferences. This trend represents a potential solution to pressing nutritional challenges, particularly malnutrition, which affects communities worldwide.

Malnutrition remains a significant public health concern in the Philippines, with the 2019 Expanded National Nutrition Survey revealing that 28.8% of Filipino children are stunted and 5.6% are wasted. These alarming statistics highlight the urgent need for effective interventions to address this problem. Previous research has focused on expensive imported solutions, but less attention has been given to locally available nutritional resources.

Amaranthus Viridis, commonly known as kulitis in the Philippines, represents an underutilized solution to this problem. Traditionally viewed as an invasive weed by farmers who often eradicate it due to its rapid growth and negative impact on crop yields, recent studies have revealed its significant nutritional value. Research has established that kulitis contains valuable nutrients including protein, fiber, vitamins, and minerals, making it a potentially important food source that has been largely overlooked.

The integration of kulitis into food products offers a practical approach to addressing malnutrition while meeting growing consumer demand for sustainable, nutritious food options. Recent studies by Rabadan et al. (2021) have demonstrated the feasibility of incorporating amaranth into various food items, but specific applications in popular snack foods remain limited. While consumers increasingly seek healthy food choices, they often struggle to incorporate them into their diets when these options lack flavor, appealing texture, or convenience.

This research seeks to bridge the gap between nutrition and taste by developing butter cookies enhanced with kulitis powder. Food selection is strongly influenced by sensory perception, with sweet foods being particularly popular among both children and adults. Butter cookies, which have been widely consumed since the late 1800s, typically contain simple ingredients like butter, wheat flour, and sugar. Their popularity presents an opportunity to enhance their nutritional profile while maintaining consumer appeal.

The incorporation of kulitis into butter cookies directly supports several United Nations Sustainable Development Goals (SDGs). This approach primarily addresses SDG 2 (Zero Hunger) by improving access to nutrient-dense foods and SDG 3 (Good Health and Well-being) by enhancing nutritional intake. Additionally, the utilization of a locally available plant that is often considered a weed contributes to SDG 12 (Responsible Consumption and Production) by transforming an agricultural "waste" into a valuable food resource. This aligns with sustainable food systems that maximize the use of available resources.

Despite the nutritional potential of kulitis, there exists a significant research gap regarding its practical application in food products, particularly in butter cookies. While previous studies have demonstrated the feasibility of using amaranth-derived ingredients in baked goods, such as Derkanosova (2020), Rabadan et al. (2021), and Baraniak and Kania-Dobrowolska (2022), the specific effects of kulitis powder on the nutritional and sensory attributes of butter cookies remain largely unexplored. This study addresses this gap through proximate analysis of kulitis powder and comparative testing of formulations with varying levels of kulitis incorporation.

While incorporating kulitis into cookies presents promising opportunities to improve nutritional intake in a convenient format, several challenges must be addressed. The addition may alter the flavor, texture, and appearance of butter cookies, potentially affecting consumer acceptance. Considerable testing and optimization are necessary to ensure that the enhanced cookies maintain sensory appeal while delivering nutritional benefits. By utilizing a locally abundant plant, this approach also offers a cost-effective solution for improving dietary quality, particularly in regions where vitamin deficiencies are prevalent.

Research Questions

This study explored kulitis (*Amaranthus viridis*) as value added ingredient in butter cookies. Specifically, it sought to answers the following questions:

1. What is the nutritional content of Kulitis powder?
2. What is the nutritional content of the cookie with and without Kulitis powder?
3. What is the level of sensory acceptability of cookie with and without Kulitis powder in terms of:
 - 3.1 appearance;
 - 3.2 taste;
 - 3.3 texture; and
 - 3.4 aroma?
4. Is there a significant difference in sensory acceptability between butter cookies with kulitis powder and butter cookies without kulitis powder when evaluated by food experts?

METHODOLOGY

This study utilized an experimental research design to examine the nutritional value of the kulitis powder and the sensory acceptability of butter cookies with and without kulitis powder. To obtain the nutritional analysis, a proximate analysis was done with kulitis powder, butter cookies with kulitis powder, and butter cookies without kulitis powder. For sensory acceptability, thirty (30) purposively selected food experts, including nutritionists, Home Economics teachers, local bakers, and food technologists. All participants are from one municipality. A complete randomized design was employed during the sensory evaluation. A 5-point hedonic scale developed by Peryam and Pilgrim

(1957) was utilized to assess the sensory acceptability of butter cookies with and without *kulitis* powder adapted from the 5-point hedonic scale of sensory evaluation (Berdos et al., 2020), with the following attributes: appearance, aroma, taste, and texture and was set five parameters to assess panelist taste preference. Ethical approval was obtained from the school's Research Ethics Committee. Strict compliance with the ethical and food safety procedures was carefully observed. Before the sensory evaluation, the panelists were given informed consent, and they were given time to ask questions and clarifications and could withdraw anytime. After providing informed consent, the sensory evaluation form was given along with the cookies with different codes that would be the only link to the panelist. Afterward, all data were gathered and then subjected to data analysis.

This scoring sheet was the primary tool for gathering data on the product's sensory acceptability. The score will be interpreted using the scale below:

Range Score	Mean Range	Interpretation
5	4.51-5.00	like very much
4	3.51-4.50	like moderately
3	2.51-3.50	neither like nor dislike
2	1.51-2.50	dislike moderately
1	1.00-1.50	dislike very much

The scoring procedure uses a 5-point rating scale designed to quantify subjective feedback, where individual scores range from 1 to 5, and mean scores are interpreted within specific ranges and commonly used in a complete randomized design. The panelist rate is based on the ranging score and interpreted by the mean range that reveals the panelist's level of liking and disliking. Verbal interpretation makes results more comprehensive. This scale is effective for the completely randomized design as it produces interval data that can be analyzed inferentially to detect differences between butter cookies without and with *kulitis* powder.

RESULTS AND DISCUSSION

Research Question 1. What is the nutritional content of *Kulitis* powder?

Table 1 presents the results of a comprehensive nutritional analysis of *kulitis* powder conducted at the Regional Standards and Testing Laboratories of the Department of Science and Technology in Regional Office X.

Table 1.
Nutritional Facts of Kulitis Powder

Food Nutrient	Result of Chemical Analysis (per 100g)
Calories, kcal	212.85
Calories from fat kcal	22.77
Total Fat g.	2.53
Total Carbohydrates, g	27.96
Protein, g	19.56

The nutritional analysis reveals that *kulitis* powder has a remarkably well-balanced nutrient profile with substantial contributions from both carbohydrates and protein. With 212.85 kcal per 100 grams, *kulitis* powder provides moderate energy density, positioning it as an excellent food component for sustaining daily activities without excessive caloric intake. According to Weisenberger (2024), this caloric content effectively supports basal metabolic rate, physical activity, and the thermic effect of food digestion.

Notably, only 10.7% of these calories come from fat (2.53g), indicating a low-fat profile that contributes to essential bodily functions such as vitamin absorption and cell membrane integrity without adding significant dietary fat.

The carbohydrate content (27.96g) represents a significant contribution to the daily recommended intake for adults, which Bhupathiraju and Hu (2024) identifies as typically a minimum of 130g or approximately 45-65% of total daily calories. When compared to other leafy green vegetables, which typically contain 3-10g of carbohydrates per 100g, *kulitis* powder provides a substantially higher carbohydrate content, likely due to the concentration effect of the drying process.

Perhaps most remarkable is *kulitis* powder's protein content of 19.56g per 100g, which exceeds the protein content of many plant-based foods and approaches levels found in some animal products. For context, most grains contain 7-14g of protein per 100g, making *kulitis* powder an exceptional plant-based protein source.

According to Espinosa-Salas and Gonzalez-Arias (2023), adequate protein intake supports tissue synthesis and repair, enzyme production, immune function, and hormone regulation – all critical for overall health maintenance. For individuals seeking to increase protein intake, whether for muscle development, recovery after exercise, or general nutrition, *kulitis* provides substantial amino acids toward the recommended daily protein requirements of 0.8-2.0g per kilogram of body weight, depending on activity level and health status.

The balanced macronutrient composition of *kulitis* powder—with its moderate calorie content, significant protein, substantial carbohydrates, and low fat—positions it as an ideal ingredient for nutritional enhancement across various food applications. As consumers increasingly seek healthier alternatives without sacrificing taste or

convenience, ingredients like *kulitis* powder offer food manufacturers an opportunity to create value-added products that align with modern nutritional priorities.

Research Question 2. What is the nutritional content of the cookie with and without *Kulitis* powder?

Table 2 presents the results of a comprehensive nutritional analysis based on chemical analysis of butter cookies with and without *kulitis* powder. The proximate nutritional analysis was conducted at the Regional Standards and Testing Laboratories of the Department of Science and Technology in Regional Office X.

Table 2.

Nutritional Facts of Butter Cookies without kulitis and with kulitis

Nutrient	Butter Cookies without <i>kulitis</i> (SHL-0063)	Butter Cookies with <i>kulitis</i> (SHL-0064)
Calories, kcal/100g	480.29	481.62
Calories from fat, kcal/100g	196.29	210.06
Total Fat, g/100g	21.81	23.34
Total Carbohydrates, g/100g	63.81	60.57
Protein, g/100g	7.19	7.32
Serving size (g)	36	36
Calories per serving	~170	~173

A nutritional comparison of butter cookies with and without *kulitis* (amaranth) reveals subtle differences. The *kulitis*-infused cookies show calories and fat content (481.62 kcal and 23.34g fat per 100g, respectively, compared to 480.29 kcal and 21.81g fat for the standard cookies). Conversely, the cookies with *kulitis* contain slightly fewer carbohydrates (60.57g per 100g vs. 63.81g) and a higher protein content (7.32g per 100g vs. 7.19g). Thus, this shows a relevant relationship with the study of Malafarina et al. (2021). Results of high-protein and high-calorie oral nutritional supplementation in malnourished people. This confirms the theory of traditional dietary and nutritional theories and science that what consumers eat is vital to one's well-being.

The nutrition comparison demonstrates that incorporating *kulitis* powder into butter cookies results in a product with slightly higher energy and protein content coupled with lower carbohydrates. This nutritional profile aligns with contemporary dietary guidance that emphasizes the importance of nutrient density and balanced macronutrient intake for overall health and well-being.

Research Question 3. What is the level of sensory acceptability of cookie with and without *Kulitis* powder in terms of:

- 3.1 appearance;**
- 3.2 taste;**
- 3.3 texture; and**
- 3.4 aroma?**

Table 3 presents the sensory evaluation results comparing butter cookies without *kulitis* powder (control) and butter cookies with 25% *kulitis* powder incorporation. The evaluation examined four key sensory parameters: appearance, texture, aroma, and taste, using a 5-point hedonic scale where 5 represents "like very much" and 1 represents "dislike very much."

Table 3
Acceptability of Cookies without Kulitis and with Kulitis

Sensory Parameters	Butter Cookies without <i>Kulitis</i>			Butter Cookies with <i>Kulitis</i>		
	Mean	Interpretation	SD	Mean	Interpretation	SD
Appearance	4.50	Like moderately	0.78	4.17	Like moderately	0.83
Texture	4.60	Like very much	0.62	4.37	Like moderately	0.67
Aroma	4.73	Like very much	0.52	4.03	Like moderately	1.16
Taste	4.60	Like very much	0.67	4.50	Like moderately	0.63

Rating Scale: 4.51-5.00 like very much, 3.51-4.50 like moderately, 2.51-3.50 neither like nor dislike, 1.51-2.50 dislike moderately, 1.00-1.50 dislike very much

This study compares two treatments, the butter cookie without *kulitis* powder (0% *Kulitis* powder) and the butter cookie with *kulitis* (25% *Kulitis* powder), based on appearance, texture, and aroma. For Control 0 percent, *kulitis* powder ranges from 4.50 to 4.73, with a total SD of 0.52 to 0.78, indicating consistency in panelist ratings. For appearance, the mean score of 4.50 shows that the panelist likes its appearance, especially its golden color. For texture, it rates 4.60 for its crispy on the outside yet soft on the inside. The aroma had the highest mean, 4.73, for its buttery-rich aroma. Lastly, for taste, its mean score was 4.60 for its butter-sweet taste.

In butter cookies with 25 percent of the *kulitis* powder decreases slightly. However, it remains relatively close, with mean scores ranging from 4.03 to 4.37 and SD ranging from 0.63 to 1.16, respectively, indicating more significant variability in participants' ratings. Butter cookies with *kulitis* powder ratings scoring range of 4.17 for appearance, which some panelists found interesting; 4.37 for texture, according to the panelist, it was slightly tender than the other sample; 4.03 for aroma; participants had different takes on aroma. Some liked the aroma because it smelled like matcha and barley, and some did not. 4.50 for taste because, according to the panelist, it was well combined with other

ingredients so that it tasted good. However, there was just an aftertaste, but not that strong.

Thus, this supports the statement of (Baingana, 2024) Food Texture Perception and Its Influence on Consumer Preferences, that the ideal balance must not overpower, for consumers tend to prefer texture and flavor slightly enhanced but not altered.

Research Question 4. Is there a significant difference in sensory acceptability between butter cookies with *kulitis* powder and butter cookies without *kulitis* powder when evaluated by food experts?

Table 4 presents the statistical analysis comparing the sensory acceptability of butter cookies with and without *kulitis* powder, using t-tests for paired samples to determine if differences in evaluators' ratings are statistically significant.

The statistical analysis reveals nuanced differences in sensory acceptability between the two cookie formulations. Across all sensory attributes, the control formulation (without *kulitis*) received consistently higher mean scores than the experimental formulation with 25% *kulitis* powder. However, when examining the statistical significance of these differences, a more complex picture emerges.

Table 4
*Statistical Analysis Comparing overall acceptability with or without *kulitis* powder*

Descriptor	Butter Cookies without <i>Kulitis</i>	Butter Cookies with <i>Kulitis</i>	t-value	p-value
Appearance	4.50	4.17	1.836	0.076
Texture	4.60	4.37	1.755	0.089
Aroma	4.73	4.03	3.034**	0.005
Taste	4.60	4.50	0.682	0.500
Overall Acceptability	4.60	4.26	2.618*	0.013

*significant at 0.01 level

**significant at 0.05 level

The statistical analysis compares the sensory acceptability of butter cookies made with and without *kulitis* powder, utilizing t-tests to assess differences across various attributes (Appearance, Texture, Aroma, Taste, and Overall Acceptability). The study established a significance level of $p < 0.01$ to determine statistically meaningful differences. Based on the result, cookies without *kulitis* powder received higher mean scores across all sensory descriptors than those containing *kulitis*. However, the only attribute showing a statistically significant difference at the specified 0.01 level was Aroma ($t=3.034$, $p=0.005$); cookies without *kulitis* powder had a significantly more liked aroma

(mean 4.73) compared to cookies with kulitis (mean 4.03), for a kulitis powder have a distinct amaranth odor that most of the respondents do not like.

While differences in Appearance ($t=1.836$, $p=0.076$) and Texture ($t=1.755$, $p=0.086$) were not statistically significant, along with the mean scores for taste ($t=0.682$, $p=0.024$), were also lower for the kulitis cookies, these differences did not meet the strict $p < 0.01$. Because of the significant difference in aroma, the overall acceptability of the product is affected ($t=2.618$, $p=0.013$).

In summary, under the study's set criteria, the supplementation with kulitis powder decreased the aroma acceptability considerably, leading to a considerable difference in overall acceptability. The present study offers proof that formulating with Kulitis lowers the product's quality.

Thus, this study reveals that aroma affects the overall acceptability of a product. Consistent with the study stated that aroma is a sensory attribute that influences the acceptability and preferences of consumers and plays a significant role in product acceptability by directly influencing the success of a product in the marketplace (Pereira et al., 2021). Thus, to ensure the overall acceptability of this product innovation, finding ways to minimize the effect of aroma on the overall acceptability must be understood for better sensory acceptability among consumers.

Conclusions

This study confirms that underutilized local plant resources like kulitis (*Amaranthus viridis*) offer significant potential for addressing nutritional challenges in sustainable ways. The successful incorporation of kulitis powder into a familiar food product demonstrates an actionable approach to transforming what is commonly considered an agricultural weed into a value-added food ingredient that can contribute to combating malnutrition, particularly in regions where protein deficiency is prevalent. This transformation aligns with multiple UN Sustainable Development Goals, particularly Zero Hunger (SDG 2), Good Health and Well-being (SDG 3), and Responsible Consumption and Production (SDG 12), illustrating how local resources can be leveraged to address global challenges.

The research offers valuable insights for food product development strategies, revealing that nutritional enhancement need not significantly compromise sensory acceptability when appropriately formulated. While aroma presents a specific challenge for kulitis incorporation, the maintenance of acceptable ratings for appearance, texture, and taste indicates viable commercialization potential. This knowledge can guide food manufacturers in developing value-added products that balance nutritional benefits with sensory appeal, potentially opening new market opportunities for locally-sourced, nutrient-dense ingredients while providing consumers with healthier alternatives that don't sacrifice eating enjoyment.

Both theoretical frameworks employed in this study were substantially confirmed through the findings. The Product Development Theory by Falahat et al. (2024) provided an effective structure for the systematic development and evaluation of the kulitis-

enhanced cookies, demonstrating how nutritional analysis can inform formulation decisions to meet both nutritional and sensory requirements. Similarly, the Naturalistic Theory of Perception by Dewey (1925) was validated through the sensory evaluation results, as panelists' responses clearly reflected the influence of prior experiences and expectations on their acceptability judgments, particularly evident in the varying responses to the novel aroma of kulitis-enhanced cookies.

Beyond immediate product applications, this research points toward broader implications for food security and sustainable agriculture. By demonstrating the viable utilization of an undervalued plant resource, the study challenges conventional perceptions about "weeds" versus "crops," establishing a pathway toward more holistic agricultural systems that integrate currently underutilized species. Future research might explore optimization of processing techniques to enhance sensory attributes, investigation of kulitis incorporation in diverse food matrices, and educational initiatives to increase consumer awareness about the nutritional benefits of indigenous plants. Ultimately, this approach represents a promising direction toward more resilient, nutritious, and culturally appropriate food systems that leverage local biodiversity rather than depending solely on conventional agricultural commodities.

Recommendations

Based on the findings of this study, the following recommendations are offered to various stakeholders:

1. That Farmers and Agriculturists may...
 - 1.1. integrate kulitis cultivation alongside traditional crops as a supplementary income source, capitalizing on its nutritional profile for commercial food applications.
 - 1.2. develop sustainable harvesting practices for wild-growing kulitis to maintain ecological balance while deriving economic benefit from this currently underutilized resource.
 - 1.3. establish community-based processing facilities for converting kulitis leaves into powder, creating added value at the farm level.

2. That Entrepreneurs and Food Manufacturers may...
 - 2.1. invest in research to optimize kulitis incorporation in various food products beyond cookies, particularly focusing on aroma-masking techniques to enhance consumer acceptance.
 - 2.2. develop marketing strategies that emphasize the nutritional benefits of kulitis-enhanced products, targeting health-conscious consumers seeking nutrient-dense food options.
 - 2.3. consider lower kulitis incorporation levels (15-20%) to balance nutritional enhancement and sensory acceptability, particularly for initial market introduction.
 3. That Home Economics Students and Teachers may...
 - 3.1. experiment with kulitis powder in various culinary applications, documenting results to expand the knowledge base of practical applications.
 - 3.2. develop educational modules on indigenous nutritious plants for integration into basic education curricula, promoting awareness of local food resources.
 - 3.3. create instructional materials showcasing the nutritional benefits and preparation methods for kulitis-enhanced food products.
 4. That Community and Consumers may...
 - 4.1. organize community education programs highlighting the nutritional value of commonly overlooked plants like kulitis.
 - 4.2. establish community gardens that include kulitis cultivation, providing direct access to this nutritious resource.
 - 4.3. form consumer cooperatives to support the development and distribution of locally-produced, nutritionally-enhanced food products.
 5. That Future Researchers may...
 - 5.1. investigate the effects of different processing methods on the sensory properties of kulitis powder, particularly focusing on techniques to improve aroma characteristics.
 - 5.2. conduct comprehensive studies on the micronutrient profile and bioavailability of nutrients in kulitis-enhanced products.
 - 5.3. explore consumer acceptance of kulitis-enhanced products among different demographic groups, identifying factors that influence willingness to adopt novel food products.
 - 5.4. examine the economic feasibility and environmental impact of scaling up kulitis cultivation and processing for commercial food applications.
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Compliance with Ethical Standards

Before conducting the study, the researcher applied for and received permission from the School Ethics Committee, which also reviewed the informed consent form. After participants received and understood the informed consent form, the researcher provided an orientation about the study. The researcher also emphasized that participation was voluntary and that participants could withdraw from the evaluation anytime. Ethical procedures were strictly observed throughout the study to protect participants' rights and welfare.

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REFERENCES

- Baingana, M. (2024). Food texture perception and its influence on consumer preferences. *Journal of Food Sciences*, 5, 43-55. <https://doi.org/10.47941/jfs.1847>
- Baraniak, J., & Kania-Dobrowolska, M. (2022). The dual nature of amaranth—Functional food and potential medicine. *Foods*, 11(4), 618. <https://doi.org/10.3390/foods11040618>
- Baraniak, J., & Kania-Dobrowolska, M. (2022). The Dual Nature of Amaranth-Functional Food and Potential Medicine. *Foods (Basel, Switzerland)*, 11(4), 618. <https://doi.org/10.3390/foods11040618>
- Berdos, Janine & Angel, Ann & Aquino, & Garcia, Lloyd & Rey, Allan & Angeles, S. (2020). Fish entrails meal as feed for broilers (*Gallus gallus domesticus*): Its potential as dietary supplements on the carcass quality and meat organoleptic evaluation. *Turkish Journal of Veterinary and Animal Sciences*. 6. 14-19. 10.31248/JASVM2020.196.
- Bhupathiraju, S. N., & Hu, F. (2024, April). Carbohydrates, Proteins, and Fats. MSD Manuals Consumer Version. <https://www.msdmanuals.com/home/disorders-of-nutrition/overview-of-nutrition/carbohydrates-proteins-and-fats>
- Derkanosova, N., Stakhurlova, A., Pshenichnaya, I., Ponomareva, I., Peregonchaya, O., & Sokolova, S. (2020). Amaranth as a bread enriching ingredient. *Foods and Raw Materials*, 8, 223–231. <https://www.google.com/search?q=https://doi.org/10.21603/2308-4057-2020-2-223-231>
- Espinosa-Salas, S., & Gonzalez-Arias, M. (2023). Nutrition: Macronutrient Intake, Imbalances, and Interventions. In StatPearls. StatPearls Publishing.

- Falahat, M., Chong, S. C., & Liew, C. (2024). Navigating new product development: Uncovering factors and overcoming challenges for success. *Heliyon*, 10(1), e23763. 1
<https://doi.org/10.1016/j.heliyon.2023.e23763>
- Malafarina, V., Serra Rexach, J. A., Masanés, F., Cervera-Díaz, M. C., Lample Lacasa, L., Ollero Ortigas, A., Cruz-Jentoft, A. J. (2021). Results of High-Protein, High-Calorie Oral Nutritional Supplementation in Malnourished Older People in Nursing Homes: An Observational, Multicenter, Prospective, Pragmatic Study (PROT-e-GER). *Journal of the American Medical Directors Association*, 22(9), 1919-1926.e5.
<https://doi.org/10.1016/j.jamda.2021.02.039>
- Pereira, P. A. P., Souza, V. R. d., Schiassi, M. C. E. V., & Dias, A. C. C. (2021). The influence of sensory attributes on overall liking by a gamma regression model: An analysis of Cerrado mixed fruits jams. *Food Science and Technology*, 41(3). <https://doi.org/10.1590/fst.17920>
- Peryam, D. R., & Pilgrim, F. J. (1957). Hedonic scale method of measuring food preferences. *Food Technology*, 11, Suppl., 9–14.
- Rabadán, A., Nieto, R., & Bernabéu, R. (2021). Food Innovation as a Means of Developing Healthier and More Sustainable Foods. *Foods*, 10(9), 2069.
<https://doi.org/10.3390/foods10092069>
- Weisenberger, J. (2024). Understanding calories. Innerbody.
<https://www.innerbody.com/nutrition/understanding-calories>
-