EDUCATUM JSMT Vol. 12 Number 2 (2025)
ISSN 2289-7070 / e-ISSN 2462-2451(95-103)
https://ejournal.upsi.edu.my/index.php/EJSMT/index

Development and Evaluation of Ubod Cocos nucifera Balls as Plant-Based Meatball Alternatives

Raymund Catubig[1], Janine Suico[1], and Charess Goles[1]

[1]College of Teacher Education, Cebu Normal University, Philippines

**Corresponding author:* raymundcatubig05@gmail.com

Received: 23 November 2024; **Accepted:** 13 August 2025; **Published:** 16 December 2025

To cite this article (APA): Catubig, R., Suico, J., & Goles, C. (2025). Development and Evaluation of Ubod Cocos nucifera Balls as Plant-Based Meatball Alternatives. *EDUCATUM Journal of Science, Mathematics and Technology*, *12*(2), 95-103. https://doi.org/10.37134/ejsmt.vol12.2.9.2025

To link to this article: https://doi.org/10.37134/ejsmt.vol12.2.9.2025

Abstract

The consumption of meat has long been associated with various health and environmental concerns, prompting the exploration of alternative protein sources. The study aimed to formulate a plant-based ball using the heart of the coconut palm (ubod) as an alternative to meat. A quantitative research method and quasi-experimental research design were used in this study. The research environment was one of the state universities in Cebu City, Philippines with 38 respondents. The Sensory Evaluation Form and Hedonic Rating Scale were used as an instrument for data gathering. Among the four treatments, treatment 3 was chosen to undergo microbial analysis with the best measurement of 70% ubod and 30% flour. Thus, the results of the microbial analysis of the product were within the safe limit and safe for consumption. Four treatments of ubod ball were prepared and the results showed that the treatment 2 and treatment 3 ubod balls are acceptable and do not have significant differences in terms of its sensory characteristics and the overall acceptability. Among the four treatments, the control treatment was the most acceptable with a computed mean of 8.13 which means extremely-liked. The treatment 4 was the only moderately liked by the respondents with a computed mean of 6.76. Furthermore, a techno-guide on ubod ball was developed showcasing its microbial laboratory results, sensory characteristics results, objectives, recipe and costs. Therefore, it is concluded that there is a need to improve or revise the procedure made and amount of measurement in the ubod ball.

Keywords: formulation, ubod, cocos nucifera, ball, meatball

INTRODUCTION

Over the past 50 years, meat consumption has increased significantly while production has more than tripled. More than 340 million tons are produced globally each year but the production of meat has large environmental impacts increasing greenhouse gas emissions, agricultural land, and freshwater. A study conducted in the United States indicated that replacing conventional meat with plant-based proteins could reduce land use by approximately 24% [1-3]. Additionally, plant-based protein sources tend to emit fewer GHGs compared to conventional meat. Generally, proteins are the most important nutrients for humans and are present in animal products. However, the number of adherents to vegetarian and vegan diets has grown significantly, highlighting the need for alternatives to replace animal proteins [4-5]. Meat substitutes aim to imitate the nutritional value and sensory characteristics of meat regardless of how studies suggest differences in their composition. In the Philippines, meat was known to be high in price, and it has a high fat and cholesterol content which causes a lot of people to have high blood pressure cases.

A coconut heart of palm also known as ubod is a vegetable that is harvested from the core of a group of palm trees, including coconut, peach palm, açai palm, and palmetto [6-7]. Ubod is the most commonly added to salads, it can also be eaten on its own or used as a vegan meat replacement. However, the extensive uses and consumption of ubod does kill a coconut tree but there are those times when trees need to be thinned, or they fall over, or they have no choice but to remove them from the property. The coconut heart of palm is rich in essential vitamins and minerals [8-10]. It provides potassium for heart health, phosphorus for strong bones and teeth, and zinc to support the immune system and healing. It also contains vitamin B6, riboflavin, and folate, which are important for the immune system, nerve health, and protein breakdown. Meat, on the other hand, can be high in saturated fats and cholesterol, which may negatively affect heart health and overall well-being. Heart of palm offers a healthier, plant-based alternative with fewer health risks.

The researchers conducted this study to encourage people to have healthy eating habits by making the meatball healthier and tastier by providing an alternative ingredient of ubod to provide a healthier alternative to conventional meatballs that have high fat and cholesterol content that can cause high blood pressure. Therefore, to lessen the cases of this problem, the researchers have to come up with a study that was carried out to formulate an ubod ball with an alternative ingredient in utilization of the nutrients found instead of meat. This can aid in the promotion of good eating habits most especially to school-aged children since they need nutrients for their health that can easily be found in ubod.

MATERIALS AND METHODS

Research design

This research study utilized a quantitative research design that encompasses a variety of methods observing systematic investigation of social phenomena by collecting numerical data that is to be analyzed through statistics [11]. Furthermore, a quasi-experimental design was used to find out the most acceptable treatment.

Research Environment

The locale of the study was one of the state universities in Cebu City, Philippines.

Research Respondents

The research participants were the Bachelor of Technology and Livelihood Education students in one of the state universities in Cebu City and the panels of experts who have skills in cooking or expertise in food laboratories in the field of Technology and Livelihood Education, Hotel and Restaurant Management, and Home Economics were chosen since they are knowledgeable in food sensory evaluation. A total of 38 respondents wherein 23 of them were the BTLEd students and 15 of them were the panels of experts evaluated on 4 different treatments. Each treatment was tested once by every respondent, resulting in 38 replicates per treatment. The order of treatments was randomized for each participant to minimize bias. This approach allowed for a thorough comparison of sensory characteristics such as appearance, flavor, color and shape.

Table 1. Inclusion Criteria for Students

A BTLEd students in Cebu City, Philippines
Male or female
18 years old and above

Table 2. Inclusion Criteria for Experts

Expertise in food laboratories
Male or female
At least 1 year of experience in cooking or baking.

Research Instrument

The research instrument was composed of two parts: (a) the sensory evaluation form was used to rate their perception level and (b) the hedonic rating scale was used to determine the overall acceptability for each treatment in the data-gathering process. The treatment 3 was subjected to microbial analysis to help determine the pathogens present in food thus making it safe for product testing. The first component of the questionnaire contains the senses evaluated by the respondents: (a) appearance, (b) flavor, (c) color, and (d) shape scorecard was used to determine these from one (1) to five (5) wherein they would rate according to their perception. The sensory characteristics were adapted from the study of Okuskhanova, et al. (2017) [**8**]. The second component is the 9-point hedonic rating scale, which was used to assess how well each treatment performed. The hedonic rating scale developed by David Peryam and colleagues for the purpose of measuring the food preferences.

Research Procedure

The process for this research study undergoes five phases: Product Development, Procurement Stage, Product Testing, and Product Evaluation. Upon knowing the chemical composition, nutritional value, and benefits of ubod for human health from a variety of studies, researchers aimed to develop a new product that ubod as the main ingredient. Therefore, the product was an ubod ball with the combination of ubod and flour. The researchers determined the source of ubod was then gathered the materials being used for experimentation. A general recipe of a meatball was used as a guide in ubod ball production. The researchers made a pre-experimental process, experimental period, preparation of four treatments, and the final recipe of four treatments. Furthermore, treatment 3 was chosen to undergo microbial analysis. Additionally, four treatments were evaluated through sensory characteristics and the level of acceptability. The researchers created a food brochure that details the nature of the study, its objectives, the components with a combination of meat and ubod balls, and its technique using the findings as their intended techno-guide.

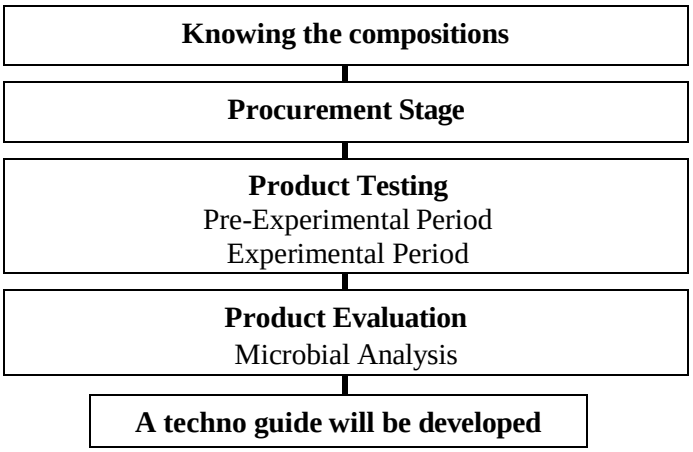

Figure 1. The process flowchart of the product development of ubod Balls.

Data Analysis

This study utilized quantitative data analysis in which the researchers utilized the tables and graphs in presenting the summary of data tabulated and statistically treated using the Kruskal-Wallis test. The Kruskal–Wallis H-Test for Oneway Analysis of Variance (ANOVA) by Ranks is

often viewed as the nonparametric equivalent of the parametric Oneway Analysis of Variance (ANOVA). Both the Kruskal–Wallis Test often using ordinal data and Oneway ANOVA (typically using interval data) are used to determine if there are statistically significant differences for comparisons of three or more groups.

RESULTS AND DISCUSSION

Microbial Analysis of the Treatment

This research chose Treatment 3 to undergo microbial analysis with varying amounts of 70% ubod and 30% flour at Department of Science and Technology Region VII – Regional Laboratory Facility. Table showed the total plate counts of the treatment 3 as per examined in DOST–7.

Table 3. Microbial Analysis Result of Treatment 3

Parameter	Microbial Analysis Results	Remarks
E.coli Count	<1.0 x 10 cfu	Acceptable Limit
Enumeration of S. aureus	<1.0 x 10 cfu	Acceptable Limit
Salmonella Detection	negative	Acceptable Limit

According to the Food and Drug Administration Circular No. 2013-010 or "Revised Guidelines for the Assessment of Microbiological Quality of Processed Food, the acceptable limit for Aerobic Plate Count is:

n-(5) number of sample units selected from a lot of food to be examined, c=(2) maximum allowable number of marginally acceptable samples, m=(10) acceptable level of microorganism determined by a specified method; the values are generally based on levels that are achievable under GMP, M-(10) level which when exceeded in one or more samples would cause the lot to be rejected as this indicates potential health hazards or imminent spoilage. It can be gleaned from Table 4, the results of the microbial analysis of the product were within the safe limit and safe for consumption.

Sensory Characteristics of the Ubod Balls

The treatment 1 served as the control, consisting of meat-based treatments, while T2 through T4 represented experimental groups incorporating variations based on ubod. There were four sensory characteristics of an ubod ball. The appearance, flavor, color, and shape helped determine the quality and the most preference being guided in product development of the ubod balls. These sensory characteristics for each treatment were presented in the succeeding subsections.

Table 4. Sensory characteristics of the meatball

Characteristics	Mean (SD)	Description	Image
Appearance	4.29 (0.93)	Very acceptable	
Flavor	4.05 (1.09)	Acceptable	
Color	4.11 (0.98)	Acceptable	
Shape	4.13 (0.99)	Acceptable	

Legend: 1.00-1.80 (Unacceptable), 1.81-2.60 (Slightly acceptable), 2.61-3.40 (Moderately acceptable), 3.41-4.20 (Acceptable), 4.21-5.00 (Very acceptable)

The meatball with 70% meat and 30% flour was very acceptable in terms of appearance (=4.29, SD=0.93). The strong acceptability was indicated by its ratio of 70% meat to 30% filler of flour, which may have

resulted in the best quality meatballs. The breadcrumbs absorb the juices from the meat as it cooks, trapping them within the meatball.

Additionally, the meatball was acceptable in terms of flavor (=4.05, SD=1.09), color (=4.11, SD=0.98), and shape (=4.13, SD=0.99). This indicates that the majority of respondents expressed an acceptable preference in terms of flavor. Studies have demonstrated that the flavor modality which encompasses both aroma and taste—increases the feeling of fullness, stifles appetite, and lowers food consumption [2]. The color and shape of the control treatment was also acceptable by the respondents. It is described to have acceptable preference for the idea that color and shape can influence consumer perceptions of food taste, freshness, quality, and nutritional value. Thus, the color of the food is one of the most important sensory cues that consumers use to make decisions about what to eat. This can also influence consumer perceptions of food taste, freshness, quality, and nutritional value (Motoki et al., 2022).

Table 5. Sensory characteristics of the T2 ubod ball

Characteristics	Mean (SD)	Description	Image
Appearance	3.95 (0.80)	Acceptable	
Flavor	3.45 (0.89)	Acceptable	
Color	3.84 (0.92)	Acceptable	
Shape	3.53 (1.03)	Acceptable	

Legend: 1.00-1.80 (Unacceptable), 1.81-2.60 (Slightly acceptable), 2.61-3.40 (Moderately acceptable), 3.41-4.20 (Acceptable), 4.21-5.00 (Very acceptable)

The T2 ubod ball with 50% ubod and 50% flour is described to have acceptable appearance (=3.95, SD=0.80) and flavor (=3.45, SD=0.89). Appearance score of T2 is lower than T1. This implies that the Ubod has a different contribution compared to meat when cooked. Recipes where the ubod is stewed or cooked for a longer period of time, so that it softens and absorbs the flavors of the dish. In regards to flavor, respondents are more likely still to prefer meat than an ubod ball without knowing the benefits of vegetable ubod. Consumers can rate overall palatability without being consciously aware of all food ingredients, especially those present at near-threshold levels which are characteristic for individuals (Szymandera et at., 2020).

Moreover, the T2 ubod ball was characterized to have acceptable color (=3.84, SD=0.92) and shape (=3.53, SD=1.03). Combination of ingredients with egg can be the basis of a good quality ubod ball, specifically the color and shape. Deep-frying makes tastier by giving them a crispy texture, golden color, and delicious in flavor [6].

Table 6. Sensory characteristics of the T3 ubod ball

Characteristics	Mean (SD)	Description	Image
Appearance	3.82 (0.83)	Acceptable	
Flavor	4.00 (0.84)	Acceptable	
Color	3.84 (0.86)	Acceptable	
Shape	3.74 (0.92)	Acceptable	

Legend: 1.00-1.80 (Unacceptable), 1.81-2.60 (Slightly acceptable), 2.61-3.40 (Moderately acceptable), 3.41-4.20 (Acceptable), 4.21-5.00 (Very acceptable)

The T3 ubod ball with 70% ubod and 30% flour is described to have acceptable appearance (=3.82, SD=0.83) and flavor (=4.00, SD=0.84). This indicates an acceptable ubod ball due to its ratio of 70% ubod to 30% filler of flour may necessarily result as the best quality ubod ball in terms of appearance and flavor. Flour can add both flavor and texture to deep-fried dishes and cornstarch can add an incredibly crunchy texture to fried food (David Ross, 2011). The hearts of palm are fleshy, juicy, and slightly crunchy tender, but hearty enough to act as a meat substitute.

Furthermore, the T3 ubod ball is characterized to have acceptable color (=3.84, SD=0.86) and shape (=3.74, SD=0.92). It is described to have an acceptable preference for the idea that color and shape can influence consumer perceptions of food tasting. The beautiful and good colors can attract consumers' taste [5] and it is diversified based on its shapes and sizes.

Table 7. Sensory characteristics of the T4 ubod ball

Characteristics	Mean (SD)	Description	Image
Appearance	3.79 (0.81)	Acceptable	
Flavor	3.34 (1.10)	Moderately acceptable	
Color	3.71 (0.96)	Acceptable	
Shape	3.74 (1.06)	Acceptable	

Legend: 1.00-1.80 (Unacceptable), 1.81-2.60 (Slightly acceptable), 2.61-3.40 (Moderately acceptable), 3.41-4.20 (Acceptable), 4.21-5.00 (Very acceptable)

The T4 ubod ball with 90% ubod and 10% flour is described to have acceptable appearance (=3.79, SD=0.81). This implies that the research respondents' values of T4 are acceptable in terms of appearance because of its texture. Their texture is solid and crunchy but still delicate and easy to bite through. Another strategy to achieve desirable texture and flavor while also reducing meat consumption is by partially replacing animal protein with plant-derived extenders [4].

Similarly, the T4 ubod ball is characterized to have acceptable color (=3.71, SD=0.96) and shape (=3.74, SD=1.06). This implies that the color of the T4 ubod ball is the same as the control meatballs based on respondents' perception. These are formed into circles for resembling small balls [5].

However, the T4 ubod ball was also characterized to have moderately acceptable flavor (=3.34, SD=1.10). The ratio of T4 is 90% ubod, 10% flour. Sensory evaluation helps create meat alternatives that taste, feel, and look like real meat. It gives valuable data on things like taste, texture, and appearance, guiding how to make them better using different methods and ingredients.

Level of Acceptability of the Ubod Balls

Table 8. Level of acceptability of the four treatments

Ball	Mean (SD)	Description
T1 Control (70% meat, 30% flour)	8.13 (0.84)	Like extremely
T2 (50% ubod, 50% flour)	7.34 (1.10)	Like very much
T3 (70% ubod, 30% flour)	7.34 (1.42)	Like very much
T4 (90% ubod, 10% flour)	6.76 (1.60)	Like moderately

Legend: 1.00-1.88 (Dislike extremely), 1.89-2.78 (Dislike very much), 2.79-3.67 (Dislike moderately), 3.68-4.59 (Dislike slightly), 4.60-5.45 (Neither like nor dislike), 5.46-6.34 (Like slightly), 6.35-7.23 (Like moderately), 7.24-8.12 (Like very much), 8.13-9.00 (Like extremely)

The respondents extremely liked the control meatball with 70% meat and 30% flour (=8.13, SD=0.84). The level of acceptability of control meatball revealed distinct differences in liking score hedonic rating perception among the three treatments. This suggests that the meatballs with a 70% meat to 30% flour filler ratio are highly acceptable and could perhaps yield the highest score of ball for all treatments. They are trying to understand how the taste, flavor, and palatability are working together to make a food objectively good.

Moreover, the respondents liked the T2 ubod ball (=7.34, SD=1.10) and T3 ubod ball (=7.34, SD=1.42). The T1 indicates the strong acceptability because of the combination of meat and flour that respondents chose over T2 and T3. The same results in the study of Fiorentini et. al., (2020), partial replacement of animal protein with plant protein provides the opportunity to improve the sustainability of meat products while also improving the nutritional profile of processed meat [4].

T4 ubod ball was only moderately liked by the respondents (=6.76, SD=1.60).This indicates that the mixture of 90% ubod and 10% flour was not a totally good combination based on the results. This treatment obtained the lowest score due to its measurement of only 10% flour while ubod contains high moisture content. Therefore, the amount of water strongly correlates with oil absorption [7]. Flour can be used as a decent binder but it can be even more useful in different parts of the process. Finding the right balance of ingredients can greatly improve how the texture of a product is perceived [4].

Comparison of Sensory Characteristics and Level of Acceptability of the four treatments

Table 9. Results of the Kruskal-Wallis test of sensory characteristics and level of acceptability.

Characteristics	X2 (p-value)	Significant post-hoc
Appearance	11.31* (.023)	Control > T3, T4
Flavor	16.42* (.003)	Control, T3 > T2, T4
Color	5.37 (.252)	None
Shape	8.77 (.067)	None
Level of Acceptability	19.87* (.001)	Control > T2, T4

* Significant at =.05

Only appearance (2=11.31, p=.023) and flavor (2=16.42, p=.003) were found to be significantly different among the control and ubod balls made. Specifically, the control meatball (70% meat, 30% flour) had a significantly better appearance than the T3 and T4 ubod balls. This implies the balance is important in measurement and overall acceptability among the other treatments. The same results in the study of Afzal et al., (2022), considering the means at the table, all the products treatments food quality as appetizing and extremely acceptable [1].

However, no significant differences in color (2=5.37, p=.252) and shape (2=8.77, p=.067) were observed among the control and ubod balls. These results suggest that the balls had comparable color and shape. Color is another important quality attribute of fried foods. Yu et. al., (2020), found that as we fry surimi products more and for longer times, they get darker. This happens because moisture evaporates, light reflection decreases, and brown colors form on the surface. All treatments have the same color and shape as what usually meatballs look like. Filipino meatballs are deep fried until golden brown and bolabola is literally "ball-shaped" that perfectly fits the round shape of the meatballs.

Lastly, in terms of level of acceptability, a significant difference exists between the control and ubod balls (2=19.87, p=.001). The control meatballs were more liked than the T2 and T4 ubod balls. This indicates that the control has a stronger overall acceptability than the rest of the ubod balls. This implies that meat is commonly thought to be the most frequently eaten and favored type of food specifically to teenage consumers. In the study of Afzal et al., (2022), meats are believed to be the most often consumed and preferred food, particularly among youths [1].

Techno-Guide for the Ubod Balls

This section presents the techno-guide being developed based on the findings of the study. The techno guide that the researchers have prepared gives an overview and background of ubod, was developed showcasing its nutritional benefits, treatments, ingredients, procedures, microbial laboratory results, sensory characteristics results, objectives, recipe, costs, as well as the purpose of this study. Techno-guide provides detailed information, visually showcases the product development and innovation. In this study the researcher formulates an ubod ball made of commonly available ingredients of ubod with flour which are cheaper and healthier than meat in ubod ball production.

CONCLUSION

Results of the study showed that there is no significant difference of treatment 2 and treatment 3 in terms of color and shape on the quantity measurement of ubod and flour. Furthermore, treatment 3 got the highest value except the Control meatball. Moreover, with the results of the study conducted, it can be concluded that the recipe, specifically on the measurement of ingredients is found to be within a good proportion in development of ubod ball. Ubod can provide acceptable characteristics and overall acceptability. Treatment 1 got the highest score among the ubod balls. Furthermore, results of the microbial analysis of treatment were within acceptable safety limits. Consequently, it is concluded that there is a need to improve the procedure made and amount of measurement in the ubod ball. Based on the findings and conclusions, the researchers recommend purchasing fresh ubod with good quality, utilizing the innermost part of the coconut palm in making ubod balls. Researchers suggest chopping the ubod with a knife instead of blending it, squeezing it before mixing ingredients to reduce water content. Ubod can enhance meatball production as an additive and to improve flavor. Integrating ubod into meatball recipes offers a nutritious, plant-based alternative suitable for schools and households. Ubod is rich in dietary fiber, supporting heart health by helping to lower cholesterol levels. Incorporating it into meatballs can enhance their nutritional value, providing a healthier option for those seeking plant-based foods. Future studies could explore adding meat to enhance sensory characteristics, and emphasizing the importance of balance in measuring of flour and either meat or ubod in production.

DECLARATION OF INTEREST

There is no conflict of interest with this study.

ACKNOWLEDGEMENT

First to our God Almighty Father for His unwavering guidance and blessings throughout the entirety of this research project. To the individuals and organizations who contributed to this research. Special thanks to people behind for guidance, collaborators for their support, and our families, classmates, and friends for their encouragement. We are deeply grateful to our research respondents specifically the first year BTLEd and the panels of experts for their participation and invaluable contributions to this study. Lastly, we express our heartfelt thanks to our family for their unwavering encouragement, financial support, and understanding during the challenging phases of this research project.

REFERENCES

[1] Afzal, M., Dolor, P., Jamison, I., Sevelleno, K., & Valdez, A. (2022). Consumers' Acceptability of Vegan-meatball Varieties as Commercial Meatballs. ASEAN Journal of Economic and Economic Education, 1(2), 95-100.
[2] Bolhuis, D. P., and Forde, C. G. (2020). Application of food texture to moderate oral processing behaviors and energy intake. Trends in Food Science and Technology, 106, 445-456.
[3] Eshel G, Stainier P, Shepon A, Swaminathan A. Environmentally optimal, nutritionally sound, protein and energy conserving plant based alternatives to U.S. meat. Sci Rep. 2019;9:10345. doi: 10.1038/s41598-019-46590-1.
[4] Fiorentini, M., Kinchla, A. J., & Nolden, A. A. (2020). Role of sensory evaluation in consumer acceptance of plant-based meat analogs and meat extenders: A scoping review. Foods, 9(9), 1334.
[5] Hafid et. al., (2020). Organoleptic Characteristics of Chicken Meatballs that Using Gelatin as a Gelling Agent
[6] Jiang, H., Chen, W., Jia, Z., & Tao, F. (2020). Physiochemical properties of short-term frying oil for chicken wing and its oxidative stability in an oil-in-water emulsion. Food science & nutrition, 8(1), 668-674.
[7] Lumanlan, J.C.; Fernando, W.M.A.D.B.; Jayasena, V. Mechanisms of oil uptake during deep frying and applications of predrying and hydrocolloids in reducing fat content of chips. Int. J. Food Sci. Technol. 2020, 55, 1661–1670.
[8] Okuskhanova, E., Smolnikova, F., Kassymov, S., Zinina, O., Mustafayeva, A., (2017). Development of minced meatball composition for the population from unfavorable ecological regions. Annual Research & Review in Biology, 1-9.
[9] Romão, B., Botelho, R. B. A., Nakano, E. Y., Raposo, A., Han, H., Vega-Muñoz, A., ... & Zandonadi, R. P. (2022). Are vegan alternatives to meat products healthy? A study on nutrients and main ingredients of products commercialized in Brazil. Frontiers in Public Health, 10.
[10] Szymandera-Buszka, K., Jędrusek-Golińska, A., Waszkowiak, K., & Hęś, M. (2020). Sensory sensitivity to sour and bitter taste among people with Crohn's disease and folic acid supplementation. Journal of Sensory Studies, 35(1), e12550.
[11] Watson, R. (2015). Quantitative research. Nursing standard, 29(31).