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Exploring the Possibilities of Watermelon (*Citrullus Lanatus*) Rind in Making Pickles

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Abstract

Watermelon is one of the most consumed fruits while its rind takes up to 40% of its total weight that contributes to the agricultural waste. This research aims to develop a product that reduces the contribution of the rind to agricultural waste the pickled watermelon rind with its major objective of answering the questions regarding the contents, development process, nutritional contents, appropriate packaging materials and the acceptability of the developed product in terms of flavor, texture, taste, color, and packaging. The researchers used DDR or Design and Development Research. This study was conducted in Philippine Normal University South Luzon where expert criterion sampling was used to select the evaluators. The mixed method was the major research approach used in this study. For the evaluation the researchers used 4-point Likert scale, thus mean and analysis of variance were used to interpret and analyze the data. Researchers concluded that the use of watermelon rind in making pickles is acceptable as it receives a total of 3.617 mean score with a description of highly acceptable. Results show that watermelon rind can be used and developed into pickles which reduces its contribution to agricultural waste and opens opportunities to create new food products demonstrating its significance in both environmentally and economically, indicating the possibility of additional research and development.

Keywords: *Nutrients, Sustainability, Utilization, Residential, Composition, Design and Development Research, Watermelon (Citrullus lanatus)*

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I. INTRODUCTION

Watermelon (*Citrullus lanatus*) is commonly fruit consumed during summer or dry season in the world as it is composed of 92% water (Dubey et al., 2023). However, the rind has 40% total weight of the fruit and is always thrown away because it doesn't have a pleasant taste and contributes to the agricultural waste (Kataria & Kaur, 2023). Though it's consumed by people in the Southern United States, Shirvan et al. (2023) the rind remains underutilized and largely unfamiliar in the local context at the present time. There is a lack of local studies that explore the process of turning the watermelon rind into pickled product, also in terms of acceptability, and its possible contribution to sustainable food production and waste reduction.

According to Athanasiadis et al. (2023), the rind of watermelon has antioxidants, minerals, vitamins, and bioactive substances. Finding new ways to use the by-product of watermelon will be important to the growing interest for sustainable food practices and waste reduction.

Although the rind of the watermelon contains several nutrients and can have a high potential to be a source of appetizer, it is commonly treated as waste and left unused. This practice does not only contribute to the possible food loss but also overlooks the potential usage of the watermelon rind.

The study of Arivuchudar. (2023), the nutritional composition highlighted the composition in nutrition of watermelon rind, the moisture, carbohydrates, protein, vitamin, phytochemical and minerals. On the other hand, in the study of Dubey et al (2023), the peel of watermelon rind is rich in fiber and has the ability to be utilized as food products. Prior studies have explored the watermelon rind powder as cheap source substitute of wheat flour for manufacturers, in producing the baked product that contain ingredients that has a beneficial effects on human health and at low cost, El-Behairy et al. (2022) but few have examined watermelon rind acceptability in the household-level pickling.

The huge volume of fruit is in the rind but often disposed of, and contributes to the large amount of fruit waste. Watermelon rind is known to be a source of minerals carbohydrates, protein, vitamins, phytochemicals and moisture, (Arivuchudar, 2023). By addressing this problem the researcher tends to address how everyday practices, such as fruit consumption, can be useful to help in reducing waste and creating value-added products. The study is particularly relevant to local households, small food enterprises, and environmental advocates, making it a practical and socially impactful research area.

Based on the study of Dubey et al. (2023). There are still limited local studies that focus on household-level preparation in making a pickled watermelon rind and acceptability, reinforcing the idea that local studies are exploratory and limited. Many consumers are still unaware of the potential of the watermelon rind as another consumable part of the watermelon.The consumer's lack of awareness of its possible use highlights the need for further study. There is a clear gap in local studies that investigate the transformation of watermelon rind into pickled products

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This study is considered relevant to the local households or even for the environmental advocates as it provides another way of reducing food waste and turning it into a consumable one.

The purpose of this study is to make a pickled watermelon rind and to explore its acceptability in terms of the aroma, texture, taste, color, and packaging. Consequently, this research tends to demonstrate the potential transformation of food waste into useful, consumable, and nutritious food products.

Research Question:

1. What are the contents required in making pickled watermelon rind?
2. What is the development process needed to make pickled watermelon rind?
3. What is the nutritional content of the produced pickled watermelon rind?
4. What appropriate packaging material can be utilized in preparing pickled watermelon rind?
5. What is the acceptability level for the produced pickled watermelon rind in terms of:
    a. Aroma;
    b. Texture;
    c. Taste;
    d. Color;
    e. Packaging?

II. METHODOLOGY

Researchers used design and development research to develop the watermelon rind pickled. This research design is to develop the target food product because it aligns with that of the researcher in the development and evaluation of a research product. To provide the empirical basis in producing instructional and non-instructional products, tools, and new or improved development models the design and development research is used, (Aris et al., 2024).

The researchers must first prepare the necessary ingredients. After purchasing the watermelon from Lopez Quezon, this phase started from cutting the watermelon, scooping the flesh, scraping the rind using coconut scraper and then squeezing. Next is peeling the carrots and cutting them into flower shapes. Then, peel the ginger and slice into a julienne cut followed by removing the seeds of the bell pepper and slicing into thin pieces. The second phase is making the pickling syrup by combining the sugar, vinegar, ginger and black ground pepper into the casserole then cooking on low heat. The third phase was combining the rind and the pickling syrup where the *pasas* (raisins), carrots and bell pepper were soaked for 10 minutes. For the fourth phase is the transferring of the product into a jar and adding the decorations. And lastly the fifth phase was preparation of the packaging where the logo, nutrition facts and ingredients

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were attached. After the development process the researchers shall coordinate for the testing and evaluation of the developed product.

Brgy. Pamangpangin serves as a primary distribution point of a wide variety of watermelon, due to availability at low cost researchers choose these locations as primary source of watermelon in their study. For the evaluation of the developed food product, the researchers used expert criterion sampling, this purposive method selects participants according to the criteria to ensure focused and relevant research data, Teflpedia contributors. (n.d.). According to Edmonds and Kennedy (2017) this process includes the selection of participants that can meet the specific criterion, which should be related to the research objective. The criteria needed are consumers, future researchers or students, and subject matter experts or professors. The researchers selected participants with the total of 7fifty (50) coming from the identified evaluators. Complying with the study's objectives, the researchers developed a product evaluation tool to assess the pickled watermelon rind, using indicators derived from reviewed literature. The development process will involve identifying key evaluation criteria such as aroma, texture, taste, color, and packaging, which will be validated through the 4Rs technique. This topic provides comprehensive exploration about the topic, Teflpedia contributors. (n.d.). Validators of the tool are subject matter experts or professors to ensure content relevance, clarity, and reliability. It involves evaluation of the sensory attributes of food products- taste, aroma, texture, and appearance (Huang, 2024).

The data analysis involves the use of mix methods, the combination of quantitative and qualitative approaches, for flexible study design and producing more comprehensive results (CWA Authors, n.d.). The researchers used qualitative data in question 1,2 and 4, and quantitative data in questions 3 and 5 questions when analyzing for the research questions. According to Tenny et al. (2022), Qualitative data explore the experience and answer open ended questions without numerical data, thus according to Kantar (n.d), the quantitative data involve gathering the numerical data in producing statistical results. Meanwhile, for the acceptability evaluation, the researchers shall use Likert scale, (a survey tool that measures how strongly people agree or disagree with a statement, typically using a 4-point scale), according to McLeod (2025), Likert scale measures people's satisfaction by asking them to rate their level of agreement in the statements. For the interpretation of the result, researchers used mean and analysis of variance (ANOVA), according to Hayes, A. (n.d.), The ANOVA (analysis of variance) is a statistical method used to compare the three or more groups to determine if differences are significant or due to chance. Likewise, data shall be tallied using Microsoft Excel, In the presentation of Gettman, D. (2024), Microsoft Excel is useful for analyzing research data. It is also an accessible tool, despite some limitations it is easy to use and effective in managing visualizing the data.

The researchers uphold precise application of Informed Consent, Confidentiality, Non-disclosure agreement and Food Safety Standards protocols based on ethical standards. Before conducting the evaluation phase the consent form will be secured from the participant. Additionally, throughout the production the food safety protocols will be strictly applied during production to ensure the safety of the evaluators consuming the product. This involves the consumer's right in food safety. (Nguyen & Tran, 2024).

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III. RESULT and DISCUSSION

In the study, the part of watermelon openly discarded is the rind and has the contribution of agricultural waste (Kataria & Kaur, 2023). Thus, the researchers tried to develop the pickles using the watermelon rind by combining it with other materials to enhance flavor. It tries to make something new from underutilized products with nutrients and other beneficial content.

Contents Required in Making a Watermelon Rind Pickle

To develop the pickled watermelon rind, the researchers identified the required contents, ingredients, including materials, in producing the watermelon rind pickle. Table 1 presents the finding of the study in preparing innovative pickles.

Table 1. *Contents Required in Making a Watermelon Rind Pickle*

Product	Ingredients
Watermelon rind pickle	Watermelon rind, white vinegar, brown cane sugar, ground black pepper, carrot, bell pepper, ginger, *pasas* (raisins)

Researchers developed the pickled watermelon rind. Aside from the main ingredients, the researchers also use Watermelon rind, white vinegar, brown cane sugar, pepper, carrot, bell pepper, ginger, *pasas* (raisins) to make the pickled watermelon rind.

According to FAO *(n.d.)*, pickles are a combination of fruit and vegetables and preserved by mixtures of acidity, with the addition of salt, and removing moisture and the addition of spices. In making pickles the acidity level of vinegar should be 5% at least, but not more than 7%, to ensure a safe making of pickles at home, or any pickle, Brunner (2025).

Development Process in Producing Pickled Watermelon Rind

Exploring the other uses of watermelon rind as it is usually discarded which contributes to due to unappealing taste. Thus, the process involves making watermelon pickles by utilizing the rind as it is usually discarded. This process includes the preparation of ingredients, transferring, making the solution and adding the syrup. Figure 1 showed the step by step process in making pickles.

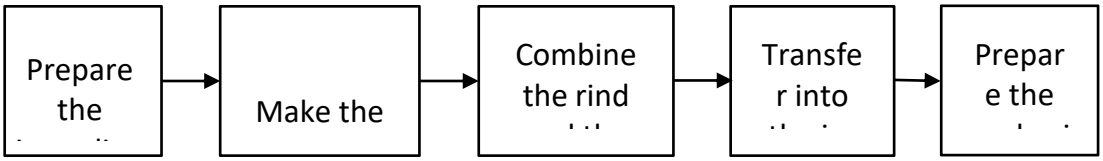

Figure 1. Development Process in Making Pickled Watermelon Rind

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There are four (4) main phases in the development of the watermelon rind pickled: (1) prepare the ingredients, (2) make the pickling syrup, (3) combine the rind and the pickling syrup, (4) transfer into the jar and (5) prepare the packaging.

Researchers conducted the first phase by preparing the ingredients. This phase started from cutting the watermelon, scooping the flesh, scraping the rind using coconut scraper and then squeezing. Next is to peel the carrots and cut them into flower shapes. Then, peel the ginger and slice into a julienne cut followed by removing the seeds of the bell pepper and slicing into thin pieces. The second phase was making the pickling syrup by combining the sugar, vinegar, ginger and black ground pepper into the casserole then cooking on low heat, wait until it is boiling and let it cool. The third phase was combining the rind and the pickling syrup where the *pasas* (raisins), carrots and bell pepper were soaked for 10 minutes and then those that will be used for decoration such as the flower shaped carrots and bell peppers were removed before combining the rind and the pickling syrup. The fourth phase was the transferring of the product into the jar and adding the decorations which are the flower shaped carrots and bell peppers. The last phase was the preparation of the packing where the logo, nutrition facts and ingredients were attached.

In the study of Shirvan et al. (2023), watermelon rind can be processed and developed into pickles which were consumed in the southern United States. This shows that there is a possibility that the watermelon rind can be used in making pickles.

Nutritional Content of the Produced Pickled Watermelon Rind

The Nutritional Content of the produced watermelon rind was computed through Very-well Fit website and submitted to the registered nutritionist for validation to ensure accuracy. The validation was done on February 12, 2026. During this process, the nutritionist reviewed the listed ingredients and the calculated nutritional value. Table to showed the nutritional content in producing watermelon rind

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Table 2. *Nutritional Content of the Produced Pickled Watermelon Rind*

Nutritional Content	Value	% Daily Value
Calories	296 kcal	
Total Carbs	73 g	27%
Total Sugar	66 g	
Fiber	2 g	7%
Fat	.4 g	
Protein	1.5 g	3%
Sodium	51 mg	2%
Potasium	420 mg	9%
Total fat	8 g	10%
Iron	1 mg	6%
Calcium	65 mg	5%

The nutritional contents of the watermelon rind pickles contain 150ml per serving, a total of 9 serving. Calories 296 kcal, Carbohydrates 73g, Sugar 66g, Fiber 2g, Fat 0.4g, Protein 1.5g, Sodium 51mg, Potassium 420mg, Iron 1mg, and Calcium, 65mg.

The highest Nutritional content in the nutrition facts is potassium which contains 420mg. This is good for controlling blood pressure, proper heartbeat, proper muscle and nerve function. In Meta analysis randomized will conduct 32 eligible trials and it is found that potassium supplementation produces lowering the BP effects, especially in hypertension individuals (T. Filippini et al., 2020). Potassium is important to muscle and nerve function normal excitation, Potassium intake above 3500 mg/day (90 mmol/day) is associated with a reduced risk of stroke (Ulla Toft et al., 2024).

Products contain low fat content which contains only 0.4g. are positive in nutritional aspects. According to Brownstein (2021), the low-fat content is beneficial especially on those individuals who's on a diet.

Appropriate Packaging Material Utilized in Preparing Pickled Watermelon Rind

In preparing the watermelon rind pickles, Selection of the jar is the most complicated part as it can directly cause contamination, bubbling (activity caused by lactic acid bacteria), even loss of crispness. Thus, the researchers select the most appropriate packaging that would best preserve the product and ensure the fresh, tasty and food safety. The figure 2 Presented the choosing packaging material for pickled watermelon rind.

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Figure 2. The Appropriate Packaging Material Utilized in Preparing Pickled Watermelon Rind

The packaging used for watermelon rind pickles was a 150ml jar. Included in the packaging were the logo, list of ingredients, nutritional content as well as the expiration date.

Based on the study of Reddy (2023), glass can offer insulation and be resilient. It can help to preserve the freshness of goods while being stored and most glass used for food and drink containers may be simply recycled and reused. This shows that glass jars can be utilized as a packaging material for pickles which aims to preserve the freshness of the product while also having a recyclable and reusable packaging.

Acceptability Level of Watermelon Rind Pickle

To determine if the development of Watermelon Rind Pickle meets the criterion, the researchers conducted acceptability evaluation. In the process it was participated by several groups of evaluators namely: Subject matter expert or Course Professor, (2) Future Researchers or BTLE students, (3) Consumers. The evaluation process was done February 14-March 7, 2026. A project pitching was conducted on February 14, 2026, with various groups of respondents, while on remaining dates, the researchers visited the SMEs/CPs for individual evaluation of the product. There are a total of 50 Evaluators who participated in the evaluation using the validated evaluation tools. The Table 3 presented the level of acceptability in evaluation of the watermelon rind pickle

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Table 3. *Acceptability level Evaluation of the Watermelon Rind Pickle*

Criteria	**EVALUATOR**			**MS**	**QD**	**R**
	SME	*FRS*	*CON*			
Aroma	3.440	3.720	3.688	3.616	HA	3
Texture	3.480	3.610	3.784	3.625	HA	2
Taste	3.520	3.670	3.752	3.647	HA	1
Color	3.520	3.680	3.616	3.605	HA	4
Packaging	3.400	3.670	3.704	3.591	HA	5
Total	**3.472**	**3.670**	**3.709**	**3.617**	**HA**	

Legend:

SME - Subject Matter Expert/Course Professor
FRS - Future Researchers/BTLE Students
CON - Consumer
MS - Mean Score
QD - Qualitative Description
R - Rank

1.00 to 1.75 - Poorly Acceptable (PA)
1.76 to 2.50 - Fairly Acceptable (FA)
2.51 to 3.25 - Acceptable (A)
3.26 to 4.00 - Highly Acceptable (HA)

The criteria on taste received the highest evaluation rating with a total of 3.647 interpreted as highly acceptable. It is followed by the texture with a mean score of 3.625 described as (HA). Then, the aroma value of 3.616 is considered as (HA). After it is followed by the color value of 3.605 highly acceptable. Lastly, the packaging received a 3.591 mean score, with a qualitative description of highly acceptable. The total average in the mean score category is 3.617 known as highly acceptable.

The result of sensory evaluation shows that the taste received the highest rating which shows that the respondent preferred the taste over other criteria. In relation to this, according to the taste institute. (n.d), the one who decides to like or consume the product is the consumer, the taste is the most important thing to consider. Table 4 presented the Significance in acceptability rating of evaluators.

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Table 4. *Significant Difference Among the Acceptability Rating of the Given by the Evaluators*

Source	DF	Sum of Square	Mean Square	F Statistic	P- value
Between Groups	2	0.1613	0.08065	28.7458	0.00002652
Within Groups	12	0.03367	0.002806		
Total	14	0.195	0.01393		

Test statistic F equals 28.745805, which is not in the 95% region of acceptance: [0: 3.8853]. The F stat results mean that the difference between the sample averages of some groups is big enough to be statistically significant. Using Turkey HSD, the researchers identified a difference among the set scores. The difference among the groups is based on the evaluator groups scores, consumers which were much higher than BTLE students and subject matter experts.

Researchers concluded that there is a difference between the number of consumers and the MSE and students/future researchers that is why there is difference in significance between the group. By the use of a Turkey test absolutely competent for this as it can control different error rates across many comparisons (K. T. Klasson et al., 2024). Same as Bonferroni's correction that states that the turkey test can provide the control in the false positive and high statistical power to all pairwise comparisons (Zweifach, A. 2025). Table 5 presented the significance among the criteria in the acceptability level. Table 5 showed the significance difference among the criteria in the acceptability rating.

Table 5. *Significant Difference Among the Criteria of the Acceptability Rating*

Source	DF	Sum of Square	Mean square	F Statistic	P-value
Between Groups	4	0.005324	0.0001331	0.07019	0.9896
Within Groups	10	0.1897	0.01897		
Total	14	0.195	0.01393		

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Test statistic F equals 0.0701856, which is in the 95% region of acceptance: [0 : 3.478]. In other words, the difference between the sample averages of all groups is not big enough to be statistically significant. Using the Tukey HSD, the researchers identified that there is no big difference among the evaluation scores given by the evaluator groups. It means that the scores given by the evaluators are similar.

Alignment of the acceptability rating is a criterion for product development. Consequently, in this paper attain this essential idea based on the acceptability rating and important various analysis. The statistics supporting this assertion, according to Fournier et al., (2020) criteria and direct inquiry are an essential instrument in AHRQ's contribution in resolution about application PCOR results.

In this data the acceptability rating research address accommodates standards. This approach will benefit its intended product development.

IV. CONCLUSION

The study explored the contents required in making pickled watermelon, the developmental process, and the nutritional content. Researchers also determine the appropriate packaging material to be utilized and assess the acceptability rating in terms of aroma, texture, taste, color, packaging.

Based on the result, the researchers concluded the idea that watermelon rind can be used to make pickles using a design and development research process. The development process required different ingredients such as vinegar, sugar, ginger, ground pepper, bell pepper and the watermelon rind. The development process includes, preparing the ingredients, making the pickling syrup, combining the rind and the pickling syrup, transferring into the jar, and preparing the packaging. Resulting the products that contain different nutritional components and other benefits. The acceptable packaging was glass jar, as glass can provide insulation and resilience, according to the survey, it received an acceptable rate of highly acceptable from subject matter experts, consumers, and future researchers or students, and the taste received a high acceptability rating shows that taste is the most important factor to consider.

Implication and Recommendations

This study has significance that demonstrates the watermelon rind, other uses, as it is usually discarded and contributes to waste. It can be developed into a nutritious product by using DDR or the design and development research process. The acceptability rating shows that it has a potential as a food product especially in taste, as it receives high acceptability ratings, it also shows the possibilities in further research, livelihood opportunities, and commercialization. In academics, it will serve as the basis for future studies on food preservation, nutritional enhancement, and in the environmental context. This research also helps those individuals' environmental advocates, as it can help in reducing waste. Overall, this study demonstrates the significance of watermelon rind pickle both environmentally and economically, indicating the possibility of additional research and development.

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However, this study was limited to non-commercial production and not for marketable use and this also limited to Fifty (50) respondents, 5 MSE, 20 Future researchers and 25 Consumer. Hence, the researchers recommended a more in-depth study. In addition, researchers recommend using different preservation methods to extend the shelf life of the product and use white sugar as stabilizer and color appeal, while also studying the vitamins and minerals to boost the nutrition of the pickled watermelon as it is a fruit-based product. Creating a new product shows that the students present that there is a great potential in creating a new food product that can help not only in expanding knowledge but also be used by the locals.

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