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"Flourish and Nurturing Sustainable Innovation for a Prosperous Nation"

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Editorial Board

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Preface

In the name of Allah, the Almighty who gives us the enlightenment, the truth, the knowledge and with regards to Prophet Muhammad (peace be upon him) for guiding us to the straight path. We thank to Allah for giving us guidance and strength to write this e-book.

This e-book compiles the extended abstracts that submitted to Johor International Innovation Invention Competition and Symposium 2024 (JIIICaS2024), where JIIICaS2024 is a virtual platform for all creative minds to share and present their invention and innovation. Each abstract gives a brief background on the innovation or project.

We hope that this e-book will help the readers to get to know the innovation done by the students and get some ideas to develop future innovation products.

Foreword Rector

Assalamualaikum warahmatullahi Wabarakatuh, Salam Sejahtera, Salam Malaysia MADANI and Salam UiTM Dihatiku.

In the name of Allah, the Most Gracious, the Most Merciful.

It is a great honor to welcome you to the Johor International Innovation, Invention, Competition, and Symposium 2024 (JIIICaS 2024). This event connects various disciplines, focusing on education and engaging educators, students, researchers, and innovators from all walks of life.

Innovation is not just about ideas; it demands perseverance, creativity, and determination to turn those ideas into reality. The remarkable projects showcased today highlight the dedication and spirit of all participants. Initiatives like this not only explore new technologies but also cultivate skills and leadership among our youth. At Universiti Teknologi MARA (UiTM) Johor Branch, we are fully committed to fostering a dynamic culture of innovation, promoting the commercialization of new products, and encouraging meaningful collaborations with industry and society.

As we celebrate this event, I would like to extend my heartfelt gratitude to all sponsors, judges, the College of Computing, Informatics and Mathematics, UiTM Pasir Gudang Campus as the event organizer, as well as to the researchers and participants for their hard work in making this event a success. Let us continue striving for innovation and excellence. May the ideas presented today inspire us and lay the groundwork for future achievements.

Thank you.

Associate Professor Dr. Saunah Zainon
Rector
Universiti Teknologi MARA (UiTM)
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(A-SS040) TUFFAH-TREATS: Repurposing Wholesome Delights from Apple Peels

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ABSTRACT

In recent years, the global food industry has been grappling with the pervasive issue of food waste, where significant portions of edible biomass are discarded at various stages of production and consumption. This includes the disposal of nutrient-rich apple peels during apple product processing. Tuffah-Treats addresses this issue by repurposing apple peels into nutritious and sustainable snacks, aligning with ethical and wholesome (*Halalan Thayyiban*) food practices. Tuffah-Treats reduces food waste and environmental impact while promoting better health outcomes by transforming discarded apple peels into a healthy snack alternative. Apple peels, rich in dietary fibre, vitamins C and K, and antioxidants, offer benefits such as improved digestion, blood sugar regulation, and reduced risk of chronic diseases. These snacks, with their low-calorie, low-fat profile, provide health-conscious consumers with a balanced and nutritious option. The creation of Tuffah-Treats involves cleaning and preparing apple peels, infused with olive oil, sea salt, and cinnamon seasonings, then air-frying them to preserve their nutritional value. The choice of air frying is deliberate, as it significantly reduces the use of oil, thereby enhancing the health profile of the snack, and making the preparation process more energy-efficient. Additionally, Tuffah-Treats exemplifies sustainability by fostering responsible consumption and supporting a circular economy. This innovative approach not only enhances consumer wellness but also contributes to a more sustainable food ecosystem, which contributes to several Sustainable Development Goals (SDGs), including SDG 3 (Good Health and Well-being) by offering healthier snack options, SDG 12 (Responsible Consumption and Production) by reducing food waste, and SDG 13 (Climate Action) by minimising environmental impact through sustainable practices.

Keywords: Apple Peels, Food Waste, Halalan Thayyiban, Sustainable Snacks

1.0 INTRODUCTION

The global food industry faces significant food waste, with large quantities of edible biomass discarded during production and consumption. Approximately one-third of all food produced globally is lost or wasted, translating to about 1.3 billion tons annually. This waste occurs across various stages of the food supply chain, including production, processing, and consumption, leading to economic losses and environmental impacts, such as increased greenhouse gas emissions and resource depletion (United Nations, n.d; Goodwin, 2023). The food industry's waste has been extensively examined in the literature, with the suggestion of utilising it not only for organic fertilisation or animal feed but also as raw materials for innovative food items (Ayala-Zavala et al., 2010). Therefore, it is imperative to enhance the utilisation of fruits by fully exploiting their many species to generate novel food resources and reduce food wastage. Typically,

the outer parts of the fruit, such as the peels, contain a substantial quantity of biopolymers, bioactive compounds, and functional nutrients. Unfortunately, these components are often thrown away during processing, leading to a considerable loss of nutritional value. (Ayala-Zavala et al., 2010).

Concurrently, awareness of the need for sustainable and healthier food choices is increasing. Hence, numerous researchers are employing the fruit peel waste produced by agro-industries to create food products with enhanced value. By incorporating fruit peels, it is possible to create novel functional food products such as fruit bars. They could offer additional calories and vital nutrients, specifically protein, fats, fibre, vitamins, and minerals. (Gupta et al., 2023).

Fruit peel bars are delectable, dried fruit slabs that are delicious, chewy, rich in fibre, naturally low in fat, energy-dense, and possess health-enhancing benefits (Kumar et al., 2020; Gupta et al., 2023). They serve as a cost-effective and practical alternative to value-added natural bars produced through a complicated process using dried fruit peels and other materials (Gupta et al., 2023). The objective of the current investigation was to create apple peel as a nutritious and satisfying snack option.

Apple peels, rich in fibre, vitamins, and antioxidants, are often wasted despite their nutritional value. Hence, apple peel can be leveraged to create healthy and tasty snacks. Thus, Tuffah-Treats offers an innovative solution using apple peels to create new and healthy delights. Named from the Arabic word "*Tuffah*," meaning "apple," these treats align with *Halalan Thayyiban* principles, promoting ethical and sustainable food practices. Moreover, apples are nutritious, and their peels, high in dietary fibre and antioxidants, offer substantial health benefits (Hyson, 2011; Feretti et al., 2014). By repurposing apple peels, Tuffah-Treats provides a delicious, low-calorie snack while reducing food waste and supporting environmental sustainability. This approach not only addresses the issue of food waste but also adheres to Islamic values of responsible consumption and resourcefulness.

2.0 OBJECTIVES

The primary objective of this research is to develop a nutritious snack using apple skins and to evaluate its nutritional content and consumer acceptability. This involves preparing Tuffah Treats, conducting tests for fats, sugars, iodine, and proteins to ensure the snack's healthfulness, and performing a sensory evaluation to understand consumer preferences regarding taste, texture, appearance, and overall acceptability.

3.0 METHODOLOGY

3.1 Material

The materials used in this study include apple skins, spices and flavourings such as cinnamon and salt, and basic baking supplies like baking sheets. To enhance the crunchiness of the snacks, olive oil was evenly coated on the apple skin, and cornstarch was added to improve shelf life. Laboratory equipment for food tests included test tubes, reagents, and other standard lab tools. Additionally, materials for sensory evaluation, such as survey forms and scoring sheets, were utilised to collect participant feedback.

3.2 Method

The research methodology comprises the preparation of Tuffah Treats, conducting food tests to analyse their nutritional content, and performing sensory evaluations to assess their acceptability among consumers. This structured approach ensures that both the health benefits and consumer preferences of Tuffah Treats are comprehensively evaluated.

3.3 Preparation of Tuffah Treats

The preparation process for Tuffah Treats begins with collecting apple skins from organic apples, ensuring they are thoroughly cleaned and free from pesticide residues. The apple skins are then spread evenly on a baking sheet and sprinkled with cinnamon and salt. To enhance the crunchiness of the snacks, olive oil was evenly coated on the apple skin, and cornstarch was added to improve shelf life. Olive oil contributes to a crunchier texture by creating a barrier that reduces moisture absorption during cooking, similar to its use in crispy potato skin chips (Drawbaugh, 2023). Cornstarch, on the other hand, aids in creating a crispy coating and extending shelf life by reducing moisture content (Kylene, n.d).

Moreover, recent studies indicate that cornstarch can also act as a carrier for antioxidant compounds, which suggests that it not only improves texture and shelf life but can also enhance the antioxidant properties of the product by delivering beneficial compounds (Garcia et al., 2020). This combination of olive oil and cornstarch thus proves effective in enhancing the quality and prolonging the shelf life of snacks. The apple skins were then air-fried until they achieved a crispy texture to promote a healthier preparation, as this method reduces the amount of oil required compared to traditional frying techniques. Once done, the apple skins are allowed to cool and stored in an airtight container to maintain their freshness and crispiness.

3.4 Food Tests

Four primary food tests were conducted to evaluate the nutritional content of Tuffah Treats: the fats test, sugars test, iodine test, and protein test. Each test was designed to identify the presence and concentration of specific nutrients. The indicators for these tests are shown in Table 1. The Tuffah Treats were analysed at the Ibnu Sina Laboratory, Universiti Islam Sultan Sharif Ali, Sinaut Campus, on July 6, 2024.

Table 1. Chemical Test for Nutrients and Results Indicator

Test	Indicator of Presence	Indicator of Absence
Ethanol Test (Fats)	Cloudy solution	Clear solution
Benedict's Test (Sugars)	Green (very low), Yellow (low), Orange (high), Red (very high)	Blue
Iodine Test (Starch)	Blue-black colour	Brown colour
Biuret Test (Proteins)	Violet or purple	Blue

3.5 Sensory Evaluation

A sensory evaluation was conducted with a panel of five participants to gauge the acceptability of Tuffah Treats. Each participant assessed the product using a 10-point

hedonic scale, where ratings ranged from “strongly dislike” (1) to “strongly like” (10). Feedback was collected on attributes such as colour, texture, flavour, appearance, and overall acceptance. This evaluation was essential for refining the product to better align with consumer preferences and plays a critical role in the ongoing research and development process, informing further improvements before bringing Tuffah Treats to market.

4.0 RESULTS

4.1 Tuffah Treats

The final product of Tuffah Treats is illustrated in Figure 1.

Figure 1. Tuffah Treats

4.2 Food Test Analysis of Tuffah Treats

4.2.1 Ethanol Test: Test for Fats

The fats test was conducted using ethanol to determine the presence of lipids in Tuffah Treats. A small sample of Tuffah Treats was crushed and placed in a test tube. 2 mL of ethanol was then added to the test tube, and the mixture was shaken thoroughly to ensure the extraction of any lipids present. The ethanol solution was observed for any changes after allowing the mixture to settle for 5 minutes. As shown in Figure 2, the solution remained clear, indicating a negative result, which means that Tuffah Treats contain no detectable fats (see Table 1).

The absence of fats in Tuffah Treats is significant for individuals monitoring their fat intake for weight management or health reasons. This aligns with the product's positioning as a healthy snack option and with the Thayyib aspect of Halalan Thayyiban, which emphasises the consumption of wholesome and health-promoting foods. While the test does not account for trace amounts of essential fatty acids, the lack of detectable fats supports the idea of Tuffah Treats as a beneficial choice for health-conscious consumers.

Figure 2. Results of Fats Test for Tuffah Treats

4.2.2 Benedict's Test: Test for Sugars

The sugars test was conducted using Benedict's reagent to detect reducing sugars in Tuffah Treats. Initially, a sample of Tuffah Treats was crushed and mixed with distilled water to create a solution. A portion of this solution was then placed in a test tube, and Benedict's reagent was added. The mixture was heated in a water bath for a few minutes. As shown in Figure 2, the solution turned green, indicating the presence of a deficient concentration of reducing sugars. This highlights that Tuffah Treats contain only a minimal sugar content, which is advantageous for consumers managing their blood sugar levels, such as people with diabetes, while reducing the risk of health issues like obesity.

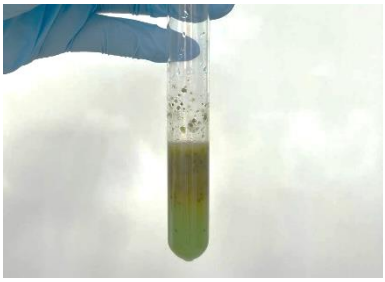

Figure 3. Results of Sugars Test for Tuffah Treats

4.2.3 Iodine Test: Test for Starch

The iodine test was conducted to detect the presence of starch in Tuffah Treats. A sample of the apple skin extract was mixed with an iodine solution. The solution turned brown upon mixing, indicating the absence of starch in Tuffah Treats, as shown in Figure 3. The brown colour observed confirms that Tuffah Treats do not contain starch, which supports the idea that they are a low-calorie snack.

Additionally, the lack of starch means that Tuffah Treats are less likely to contribute to rapid spikes in blood glucose levels, making them an appropriate choice for individuals managing their blood sugar levels. Refined carbohydrates and added sugars cause blood sugar spikes due to their high glycemic index and lack of fibre, vitamins, and minerals (Rowles, 2024). In contrast, foods high in fibre, such as non-starchy vegetables, whole grains, and legumes, help stabilise blood sugar levels by slowing

the digestion and absorption of carbohydrates (Mayo Clinic, 2023). Tuffah Treats can provide a healthier alternative for those monitoring their blood glucose by minimising the use of refined carbs and added sugars.

Figure 4. Results of Starch Test for Tuffah Treats

4.2.4 Biuret Test: Test for Protein

Finally, the protein test was conducted using the Biuret reagent to determine the presence of proteins in Tuffah Treats. The Biuret reagent, a copper sulfate and sodium hydroxide mixture, reacts with protein peptide bonds to form a complex. If proteins are present, the solution changes colour from blue to purple (Aryal, 2024). The Biuret reagent was mixed with the apple skin extract during the food test analysis, and the resulting solution was observed. As shown in Figure 4, the solution remained blue, indicating the absence of proteins in Tuffah Treats.

This finding is pertinent for those requiring a controlled protein intake, such as individuals with certain kidney conditions or those following specific dietary regimens. While the absence of protein may be a limitation for those seeking protein-rich snacks, it aligns well with the product's intended use as a low-calorie, low-fat, and low-sugar snack option. Tuffah Treats can be paired with other protein sources for consumers who need protein to create a balanced snack. This flexibility ensures that Tuffah Treats can fit into various dietary needs, adhering to the Halalan Thayyiban principle of wholesome consumption.

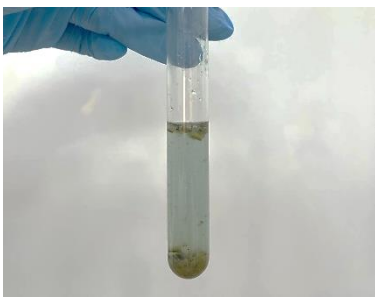

Figure 4. Results of Protein Test for Tuffah Treats

4.3 Sensory Analysis of Tuffah Treats

A sensory evaluation was conducted with a panel of five participants to assess Tuffah Treats regarding taste, texture, appearance, and overall acceptability. Participants

rated each attribute on a scale of 1 to 10, where 1 is the least favourable and 10 is the most favourable. The results, summarised in Table 2, indicate an overall positive reception of the product.

Table 2. Average Sensory Score of Tuffah Treats

Sensory Attribute	1st Judge	2nd Judge	3rd Judge	4th Judge	5th Judge	Avg.
Taste	8	7	9	9	8	8.2
Texture (Crispiness)	7	7	8	9	7	7.6
Appearance	7	8	8	7	7	7.4
Overall Acceptance	7	8	10	8	8	8.2

The taste of Tuffah Treats received consistently high ratings, ranging from 7 to 9. This suggests that the flavour, derived from the combination of organic apple peels, cinnamon, and salt, is highly appealing and meets consumer expectations. The positive feedback highlights the effectiveness of these ingredients in delivering a satisfying and enjoyable taste, aligning with findings that emphasise the importance of flavour in consumer acceptance of food products (Rai et al., 2023; Baker et al., 2024). Studies indicate that taste is a crucial determinant of consumer preferences, with consumers often unwilling to compromise on flavour, even for health benefits (Verbeke, 2006).

Similarly, texture scores ranged from 7 to 9, reflecting general satisfaction with the snack's mouthfeel. Adding olive oil and cornstarch is likely instrumental in achieving this positive texture. Olive oil enhances crunchiness, while cornstarch contributes to a desirable crispy coating. These components are essential for a pleasurable eating experience and are consistent with the high ratings observed. Research indicates that the texture of snacks significantly influences consumer preferences, emphasising the need for optimal texture in product development (Food Research Lab, 2022).

Appearance scores were also favourable, with participants rating the visual appeal between 7 and 8. This can be attributed to the air-frying process, which imparts a golden-brown colour, and the inclusion of spices, which enhance the snack’s visual attractiveness. Studies show that visual appeal plays a significant role in food choice, as consumers often rely on appearance to indicate quality (Schaub, 2015; Rai et al., 2023). Hence, a pleasing appearance is crucial for consumer acceptance, and these results indicate that Tuffah Treats are well-received in this regard.

Finally, the overall acceptability scores, which ranged from 7 to 10, reflect broad approval of Tuffah Treats. This high overall satisfaction level suggests that the combination of favourable taste, texture, and appearance aligns well with consumer preferences. The variation in scores, with one participant providing a perfect score of 10, highlights the potential for even greater consumer enthusiasm. Sensory evaluations are fundamental in understanding consumer preferences and guiding product development, as they provide insights into the attributes that drive acceptance (Food Research Lab, 2022). These positive feedbacks indicates that the selected ingredients and preparation methods effectively meet consumer expectations. Continued attention to these attributes will ensure the product’s success in the market.

5.0 CONCLUSION

The evaluation of Tuffah Treats highlights its distinctive integration of sustainability and health-conscious principles. By utilising apple peels, Tuffah Treats addresses the global issue of food waste. Besides, the positive results from the sensory evaluation, where Tuffah Treats received high scores for taste, texture, and appearance, show its success in combining environmental responsibility with consumer satisfaction. The product's low fat and minimal sugar content enhances its appeal to health-conscious consumers, aligning with the growing preference for nutritious and sustainable snacks (Hoek et al., 2017). Additionally, from a Halal perspective, the adherence to permissible ingredients and Islamic dietary laws further supports the product's market suitability. The food test results confirm that Tuffah Treats align with the Thayyib principle, offering a nutritious and health-promoting snack.

Overall, the innovative approach of Tuffah Treats exemplifies a triumphant delight of sustainability, health, nutrition, and consumer appeal. Its ability to transform food waste into a desirable product demonstrates its potential for significant market impact. As consumer awareness of the environmental effects of their food choices increases, products like Tuffah Treats, which emphasise sustainability and health, are expected to resonate strongly in the marketplace. Sensory evaluation studies support this, showing that appealing sensory attributes are crucial for consumer acceptance and purchasing decisions (Food Research Lab, 2022).

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