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# Zero-Waste Transformation: Functional Herbal Tea from Dragon Fruit Peel

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## Abstract

Food waste, such as fruit peels, is often discarded despite its nutritional potential. The study contributes to reducing food waste and aligns with the Sustainable Development Goals, particularly Zero Hunger and Good Health and Well-being. While tea is known for its health benefits, excessive consumption of traditional tea, which contains caffeine and additives, may cause side effects such as iron deficiency and insomnia. The objectives for this study are to develop a unique tea formulation using dragon fruit peel, evaluate its nutritional composition, and assess its acceptance among the Merlimau, Melaka community. The methodology involves cleaning, drying, grinding and blending dragon fruit peel with cinnamon. An organoleptic evaluation was conducted with 30 respondents, who rated taste, smell, texture, and colour using a 5-point Hedonic scale. Results showed an overall acceptance mean score of 3.93, with mean scores of 4.20 for texture, 3.27 for smell, 4.60 for colour, and 3.43 for taste. The nutritional analysis indicated that the dry tea blend contains, per 100 g, 0.7 g of crude protein, 80.5 g of carbohydrates, 0.4 g of fat, and 328 kcal of energy. However, the actual caloric intake from the brewed beverage is significantly lower. This study demonstrates a practical method for upcycling food waste into plant-based products with strong nutritional and commercial potential. In conclusion, the study supports sustainable practices and shows a high potential for commercialization of beverages as a nutritious, locally produced, and eco-friendly beverage.

**Keywords:** *dragon fruit peel, food waste, tea, organoleptic*

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## I. INTRODUCTION

Tea is widely consumed across cultures due to its perceived health benefits, including antioxidant properties and its role in daily hydration. Despite these benefits, excessive consumption of conventional tea products may pose health risks due to their high caffeine content and the presence of chemical compounds such as tannins and polyphenols, which can interfere with iron absorption and, when consumed frequently, potentially contribute to iron deficiency. These risks are more pronounced among individuals with existing nutritional deficiencies.

The peel of dragon fruit is usually thrown away as waste, despite the fruit's popularity due to its nutritional benefits and pleasing sensory qualities. According to scientific research, the peel of dragon fruit includes healthy bioactive substances such as antioxidants that can be used to create functional foods. This resource's underuse offers an opportunity for innovative product development that combines environmental sustainability with wellness promotion.

At the same time, food waste has become a primary worldwide concern. Despite their potential for reuse, large amounts of edible and nutritionally rich food by-products, especially fruit peels, are routinely thrown away. In addition, it's causing harm to the environment, and this practice jeopardises attempts to establish sustainable food systems. The Sustainable Development Goals (SDGs) from the United Nations (UN), especially SDG 2: Zero Hunger, and SDG 3: Good Health and Well-Being, are closely related to food waste.

This study creates Dragon Fruit Peel Herbal Tea as a functional beverage made from dragon fruit peel combined with natural ingredients. The product is free from added sugar, artificial colouring and preservatives. The innovation aims to reduce food waste, promote sustainable consumption habits and offer an alternative tea.

## II. LITERATURE REVIEW

Due to its antioxidant qualities and bioactive components, tea is one of the most popular drinks in the world and is frequently linked to a host of health

advantages [1]. Tea's polyphenols, catechins, and flavonoids have been shown to have anti-inflammatory and cardiovascular-protective properties [2]. But even with these advantages, drinking too much tea may have adverse health effects. Consuming too much tea can expose consumers to high concentrations of chemicals that, when consumed above permissible limits, may have adverse effects on the body [3]. Similarly, tea's tannins and polyphenols can hinder the gastrointestinal tract's ability to absorb iron, increasing the risk of iron deficiency anaemia, especially in people with nutritional vulnerabilities [4]. Concerns about frequent tea consumption and its potential to interfere with nutrient absorption because of tannins.

#### **A. Food Waste**

Food waste is a significant worldwide issue that impacts economic stability, food security, and environmental sustainability. An estimated one-third of the food produced worldwide is lost or wasted each year, according to the Food and Agriculture Organisation [5]. This issue directly impacts global hunger and sustainable development.

Reducing food waste is crucial to reaching SDG 2 (Zero Hunger) and SDG 3 (Good Health and Well-Being). Efficient resource use and innovative approaches to converting food waste into products of added value are necessary for sustainable food systems [6].

Although having high quantities of dietary fibre and bioactive substances, fruit peels contribute to a sizable amount of food waste [7]. According to Mirabella, Castellani, and Sala (2014), converting fruit waste into functional food ingredients is a potential strategy for sustainable production and for advancing circular economy principles. Researchers can address environmental issues and create economic opportunities simultaneously by turning food waste into unique food products [8].

#### **B. Functionality of Dragon Fruit Peel**

Dragon fruit is known for its nutritional content, which includes vitamins, minerals, dietary fibre and antioxidant chemicals [9]. Although the pulp is frequently eaten, the peel is commonly discarded, even though it contains high concentrations of flavonoids, betalains, and other phenolic compounds that support antioxidant activity.

According to research, dragon fruit peel has potent antioxidant properties that may help reduce the risk of chronic diseases and oxidative stress [10]. Dragon fruit peel is a good option for functional food and

beverage applications due to its bioactive components.

Herbal infusions made from fruit have also been researched for their potential to improve health and sensory acceptability. Using natural herbs like cinnamon enhances the flavour profile and may offer additional health benefits, such as antibacterial and anti-inflammatory properties. Additionally, cinnamon enhances flavour and scent, thereby increasing consumer acceptance of herbal formulations [11].

Recent studies have emphasised the importance of food waste valorisation as part of sustainable food systems, particularly in reducing environmental impact and improving resource efficiency [12]. Additionally, the utilization of fruit by-products in functional beverage development has gained increasing attention due to their high antioxidant and polyphenol content [13].

#### **C. Organoleptic Evaluation**

The commercial viability of novel food and beverage products is mainly determined by organoleptic evaluation. Taste, smell, texture and colour are important factors to determine a product's acceptability by consumers and organoleptic evaluation evaluates these perceptions [14].

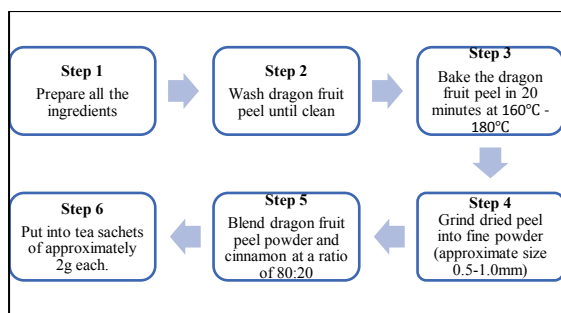
Due to its ease of use and consistency in evaluating customer preferences, the 5-point hedonic scale is frequently used in studies on food and beverage product creation [15]. Common statistical techniques for interpreting sensory evaluation data in small-scale product innovation studies include mean score analysis and percentage distribution.

### **III. RESEARCH METHODOLOGY**

This study adopted a quantitative research design to evaluate consumer acceptance and determine the nutritional composition of Dragon Fruit Peel Herbal Tea. The methodology comprised three main components, which are product formulation, organoleptic evaluation and nutritional fact analysis.

#### **A. Formulation of Dragon Fruit Peel Herbal Tea**

The ingredients used to produce Dragon Fruit Peel Herbal Tea include dragon fruit peel and cinnamon. Researchers have developed a formulation to produce Dragon Fruit Peel Herbal Tea, as shown in Figure 1.



**Figure 1: Process flow of making Dragon Fruit Peel Herbal Tea**

The process flow is to ensure systematic production and consistency in product quality, which is essential for potential commercialization.

### B. Organoleptic Evaluation of Dragon Fruit Peel Herbal Tea

Dragon Fruit Peel Herbal Tea requires organoleptic analysis or sensory evaluation. A hedonic scale ranging from 1 to 5 was used to assess the product's quality through sensory analysis. The respondents' response relates to their perception of the product's likeability, followed by their level of likeability. Respondents' acceptability was measured using a set of sensory evaluation questionnaires. The respondent was questioned about the smell, texture, colour and taste of Dragon Fruit Peel Herbal Tea. The sampling was limited to Merlimau, Melaka, and 30 respondents were selected at random for the sensory evaluation. The Statistical Package for the Social Sciences (SPSS) was used to analyze the questionnaire data, and the mean score was used to interpret the findings. Table 1 shows the interpretation of the mean value range based on Sekaran [16].

**Table 1. Mean value range interpretation**

Mean score	Interpretation	Level
1.00 to 2.33	Low	Weak
2.34 to 3.66	Medium	Moderate
3.67 to 5.00	High	Good

(Source: Sekaran, 2003)

### C. Determine the Nutritional Facts for Dragon Fruit Peel Herbal Tea

Dragon Fruit Peel Herbal Tea sample was submitted to Melaka Biotechnology Corporation for nutritional analysis. The Melaka Biotechnology Corporation used Gas Chromatography-Mass Spectrometry (GCMS). The analysis was conducted on the dry tea blend to determine the macronutrient content, including carbohydrates, protein, fat, and energy value.

## IV. RESULT AND DISCUSSION

The organoleptic evaluation's findings showed that Dragon Fruit Peel Herbal Tea was well-liked by respondents, with texture and colour receiving high mean ratings. The overall mean score reflected a positive reception, suggesting that consumers are receptive to herbal tea products developed from food waste when sensory quality is maintained.

### A. Organoleptic Evaluation of Dragon Fruit Peel Herbal Tea

The analysis of respondents' acceptance of Dragon Fruit Peel Herbal Tea is shown below. The four questions were designed to determine the sensory evaluation of Dragon Fruit Peel Herbal Tea in terms of smell, texture, colour, and taste. The result of the organoleptic assessment is shown in Table 2.

**Table 2: Mean score of respondents' acceptance level towards Dragon Fruit Peel Herbal Tea**

Characteristics	Mean value	Interpretation
Smell	3.27	Medium
Texture	4.20	High
Colour	4.60	High
Taste	3.43	Medium

According to Table 2, the mean acceptability level of respondents for Dragon Fruit Peel Herbal Tea is very high, with mean scores of 4.20 for texture and 4.60 for colour. Taste and smell achieved moderate acceptance levels, suggesting potential for further improvement. The overall findings indicate a positive level of respondent acceptance toward the product.

The favourable reaction to the tea further indicates that the sensory quality is not compromised when food waste, in this case dragon fruit peel, is turned into a functional beverage. Similar research has demonstrated that fruit peels and by-products, such as pitaya seeds and mango peel, retain antioxidants and bioactive compounds that can improve the sensory qualities and health benefits of the food items [7], [9], [10]. This is consistent with the broader concept of food valorisation, which is the process of turning food manufacturing waste into valuable goods without compromising customer acceptance [8].

Additionally, by reducing waste and encouraging ecologically conscious consumption, the potential of turning food waste into a widely recognised functional beverage supports sustainable food practices [5], [6]. The findings support the practical implementation of sustainable innovation in the food industry by indicating that using food by-products in beverage development not only adds nutritional and functional benefits but also satisfies consumer

expectations for taste, texture and visual appeal [1], [2].

Overall, the organoleptic results indicate that converting food waste into a beverage product does not substantially affect customer acceptability, suggesting that food waste transformation is feasible for developing functional beverages.

### B. Nutritional Facts of Dragon Fruit Peel Herbal Tea

The results of nutrition composition for Dragon Fruit Peel Herbal Tea, such as the amount of carbohydrate, fat, sugar and energy, were obtained using the Gas Chromatography–Mass Spectrometry (GCMS) at the Melaka Biotechnology Corporation. The analysis of the nutrition facts presented per 100g of dry tea blend is shown in Table 3.

**Table 3: Nutrition content for Dragon Fruit Peel Herbal Tea (per serving 100g)**

Test parameter	Unit	Result
Energy	kcal/ 100g	328
Total carbohydrate	g/ 100g	80.5
Protein	g/ 100g	0.7
Total fat	g/ 100g	0.4

(Melaka Institute of Biotechnology, 2024)

It is important to note that these values refer to the dry tea blend rather than the brewed beverage. Since the product is consumed as an infusion, the actual caloric and nutrient intake is significantly lower. Dragon Fruit Peel Herbal Tea has a moderate protein content, low fat content and high carbohydrate content. These ingredients work together to create an energy profile suitable for a functional beverage. The low-fat content makes the tea a light beverage choice that appeals to health-conscious consumers, while the moderate protein helps with satiety and nutritional balance [7], [9]. The tea's high carbohydrate content provides instant energy, making it a suitable option for people looking for both a functional energy source and a refreshing beverage. This makes the Dragon Fruit Peel Herbal Tea a viable substitute for traditional teas, offering valuable health benefits without caffeine. The use of fruit waste in the creation of functional drinks is enabled by its low-fat content and antioxidant potential, which align with consumer trends favouring light and healthful beverages [8], [5].

Overall, the tea's nutritional and bioactive value indicates that turning dragon fruit peel into a beverage not only makes sustainable use of food waste but also yields a healthy, suitable product for current dietary needs.

## V. CONCLUSION

The sustainability impact of this innovation is among its most important contributions. Effective use of food by-products is demonstrated by the use of dragon fruit peel, which is usually discarded as waste. In the food and hospitality industries, this strategy encourages circular-economy principles and waste-reduction initiatives.

Food waste management is nonetheless a major global issue and turning fruit peel into a product that can be supplied directly solves resource inefficiency. This study supports ethical production and consumption methods by valuing an underutilized material. Additionally, because the production method is straightforward, it may be implemented locally or on a small scale, which could encourage local entrepreneurship and reduce the environmental impact of disposing of organic waste.

Dragon Fruit Peel Herbal Tea's main innovation is its creative use of food waste as a functional ingredient in a drink. This product is naturally caffeine-free and made without added sugar, colourants, or preservatives, making it suitable for health-conscious consumers. This is compared to traditional tea products that rely on tea leaves and frequently contain caffeine, sugar and artificial additives. In conclusion, the study supports sustainable practices and demonstrates significant commercial potential as a nutritious, locally produced and eco-friendly beverage.

Future research should focus on improving sensory attributes, analysing shelf-life stability and evaluating consumer acceptance on a larger scale.

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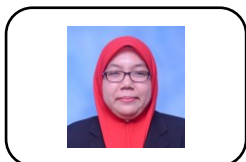
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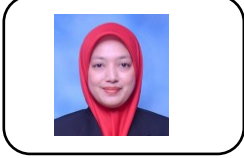
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