

Utilizing Pineapple Pomace in Snack Noodle Production: Quality Assessment and Textural Analysis

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Abstract

Snack noodles are used because they are quick to prepare, novel in texture and taste, and therefore suitable for the snacking industry. Pineapple pomace-based snack noodles were the focus of this research in a bid to enhance their nutritional and sustainability content. Commercial snack noodles were compared with 10%, 20%, 30%, and 40% pineapple pomace powder formulations on the basis of quality, texture, and acceptability to the consumer. This evaluation included major parameters of moisture, texture, and colour, quantified in terms of L*, a*, and b* values. Results showed sample difference with statistical significance ($p < 0.05$). Sensory evaluation was conducted to assess appearance, aroma, touch, flavour, and overall liking. The most preferred sample was Formulation 1, and it contained 1889 kJ of energy, 449 kcal, 16.2 g protein, 7.6 g fat, 176 g carbohydrate, and 11.4 g sodium per 100 grams. Pineapple pomace is an excellent source of healthier snack food. It contains nutrients like dietary fiber and antioxidants that benefit health. Pineapple pomace also reduces food waste through recycling byproducts. This encourages food sustainability during production and an environmentally friendly means of producing healthy snacks.

1. Introduction

The pineapple pomace snack noodle is made from the fibrous residue left after extracting juice from pineapple pomace. This residue is abundant and rich in nutrients, making it a great choice for boosting the nutritional value of food products [1]. The pomace contains varying amounts of protein, fat, carbohydrates, pH levels, and acidity, which are similar to those found in fresh pineapple fruit [2]. Research is focused on analysing the properties of pineapple pomace to determine if it is suitable for snack noodle production. Ready-to-eat snacks are becoming increasingly popular, as they provide convenient options for today's fast-paced lifestyle. Instant noodles, known for their high carbohydrate and fat content, often lack essential nutrients like fiber, vitamins, and minerals, leading to criticism for being unhealthy [3]. Frequent consumption of these noodles can contribute to malnutrition, nutrient-related diseases, and cardiometabolic disorders, including obesity, hypercholesterolemia, and metabolic syndrome [4]. Despite these concerns, the demand for instant noodles continues to rise, necessitating the development of healthier alternatives.

The purpose of this study is to examine the potential utilization of pineapple pomace in the production of snack noodles. The primary objective is to investigate the physical and chemical characteristics that can enhance the flavour and attractiveness of pineapple pomace snack noodles. The ultimate aim is to promote sustainable food solutions by transforming pineapple pomace, which is currently an underutilized agricultural by-product, into a valuable ingredient that bolsters the nutritional value and taste of snack noodles.

2. Methodology

2.1 Methods

2.1.1 Preparation of Pineapple Pomace and Development of Snack Noodle

The development of pineapple pomace followed the original recipes with a few modifications by Kazemi *et al* (2017). The ingredient that will be needed in making pineapple pomace powder which is pomace from *Ananas comosus* fruits as an optional ingredient. Fresh pineapple pomace was collected from the juicing process. Wet pomace will be oven-dried by using a food dehydrator for 24 hours to ensure minimal losses of nutrients, grind using a mixer grinder and then sieved with a sieve.

Four snack noodle formulations were prepared by increasing the amount of pineapple pomace powder for each formulation. The ingredients used were weighed separately by referring to the formulation from (Li *et al.*, 2020). The formulation was shown in Table 1. Dry and wet ingredients, including wheat flour, pineapple pomace powder, salt, and sodium bicarbonate, water and cooking oil were measured accurately for each formulation. The mixture is stirred until crumbly, then sheeted using a noodle machine roller with progressively wider gaps (2 and 4) to achieve a uniform dough. The sheets are cut into 2.0mm strands and trimmed to 5–10 cm lengths for consistency. The noodle was moulded into a round container around 7 grams. Then, the noodles were deep-fried in cooking oil at 140-160°C for 1-2 minutes. This can reduce moisture content of snack noodles from 30-50% to about 2-5% [5]. The products were stored in polyethylene bags (one per formulation) and placed at room temperature.

Table 1 The formulation samples of snack noodle

Ingredients	Formulation 1 (F1)	Formulation 2 (F2)	Formulation 3 (F3)	Formulation 4 (F4)	Formulation 5 (F5)
Wheat flour	65.10%	55.10%	45.10%	35.10%	25.10%
Pineapple pomace powder	-	10%	20%	30%	40%
Salt	1.70%	1.70%	1.70%	1.70%	1.70%
Sodium bicarbonate	1.70%	1.70%	1.70%	1.70%	1.70%
Water	30%	30%	30%	30%	30%
Cooking oil	1.50%	1.50%	1.50%	1.50%	1.50%

2.1.2 Cooking of Snack Noodle with Pineapple Pomace Powder

The snack noodle pieces were fried directly in a frying pan at a temperature between 184°C and 188°C for one minute. After frying, the noodles were strained to remove excess oil, allowed to cool, and then packed in polyethylene bags for further evaluation.

2.2 Physicochemical Properties

2.2.1 Colour Analysis

The colour of all four snack noodle samples containing pineapple pomace was analysed using the HunterLab ColourFlex model to measure specific colour values. These values include L* for lightness, a* for redness, and b* for yellowness. This evaluation helps in understanding the visual appearance of the noodles, as these colour parameters are key indicators of product quality and consumer appeal. The lightness (L*) reflects how bright or dark the noodles appear, while the redness (a*) and yellowness (b*) indicate the intensity of warm tones, which can be influenced by the addition of pineapple pomace [6].

2.2.2 Textural Profile Analysis (TPA)

The textural analysis utilized a TA. XT plus texture analyzer for compression tests on four formulations of snack noodle. Using HDP/3PB; Three Bend Rig probe, parameters such as hardness and fracturability were measured. Texture Profile Analysis (TPA) were compressed in triplicate using textural analyzer software for peak force determination [7].

2.2.3 Moisture Content

The moisture levels in the snack noodle were measured by using MX-50 A&D rapid moisture analyzer from Japan. Following the analyzer's instructions, 2-gram samples of dried snack noodles with pineapple pomace were tested at 160°C.

2.2.4 Sensory Evaluation

The study employed a 9-point Hedonic scale for sensory assessment, evaluating varying ratio percentage of snack noodle with pineapple pomace. The sensory evaluation, conducted by 40 panellists in Sensory Laboratory at Universiti Tun Hussein Onn Malaysia (UTHM), focused on attributes like appearance, aroma, texture, flavour, and overall acceptability.

2.2.5 Nutrient Analysis

Analysing the nutritional value is crucial for determining the balanced properties of essential energy, total fat, total carbohydrate, protein, and sodium. This information is vital for nutritional labelling on food products.

2.2.6 Statistical Analysis

The analysis for all four samples was carried out triplicates. The data from the analyses were expressed as mean and standard deviation. One-way analysis of variance (ANOVA) is performed using Minitab Software and Microsoft Excel to determine statistically significant differences between the 4 samples of snack noodle. The level of statistical were defined at $p < 0.05$ where the p value below or equal to 0.05 are regarded as significant.

3. Results and Discussion

3.1 Colour Evaluation

The colour analysis for all the formulations is outlined in Table 2 L^* , a^* , and b^* are some of the colour parameters assessed. The colour analysis of noodle snacks with pineapple pomace shows noticeable differences compared to regular noodles. Adding pineapple pomace reduced the lightness (L^*) and increased the redness (a^*) and yellowness (b^*) of the noodles, giving them a darker and more vibrant colour due to the natural pigments in the pomace. Regular noodles are typically lighter because they lack these pigments.

Among the formulations, Formulation 4 had the highest lightness (49.88 ± 1.07) and yellowness (16.66 ± 0.98), suggesting a brighter and more yellow appearance. This might be due to its higher moisture content, which reduces the visual effect of the darker pigments. In contrast, Formulation 3 had the lowest redness (7.52 ± 0.30), possibly because of differences in ingredient amounts or processing.

Formulations 1 and 2 showed similar lightness but small variations in red and yellow tones. These changes highlight how pineapple pomace and processing techniques influence the noodle colour. The richer colours in these formulations may appeal to consumers looking for visually attractive and natural snack options [8]

Table 2 Colour value of snack noodle with pineapple pomace powder

Sample	Colour value	L^*	a^*	b^*
Formulation 1		44.94±3.41	9.79±0.29	11.51±0.14
Formulation 2		44.69±1.76	9.45±0.47	12.79±1.67
Formulation 3		46.31±0.31	7.52±0.30	13.41±0.20
Formulation 4		49.88±1.07	9.61±0.60	16.66±0.98

*The data was presented in mean ± SD

3.2 Texture Profile Analysis (TPA)

From Table 3 the texture profile analysis (TPA) of snack noodle with pineapple pomace showed how different formulations affected hardness (the force to compress) and fracturability (the point where the snack breaks). Formulation 1 was the hardest and also relatively brittle, likely due to its dense structure and lower moisture. Formulation 4 was moderately hard but less brittle, possibly because its higher moisture made it tougher and more resistant to breaking. Formulations 2 and 3 were softer and easier to compress, with slight differences in how easily they fractured, likely due to variations in ingredients and drying. The ANOVA analysis showed

significant differences ($p < 0.05$) in texture between the samples, highlighting the impact of formulation on snack quality.

Table 3 Hardness and fracturability of noodle snack with pineapple pomace powder

Sample	Hardness (g)	Fracturability (mm)
Formulation 1	1165.807±139.024	23.189±2.592
Formulation 2	368.049±30.696	21.931±2.399
Formulation 3	548.483±29.218	23.340±3.325
Formulation 4	793.187±14.434	19.065±4.18

*The data was presented in mean ± SD

3.3 Moisture Content

The moisture content of snack noodle with pineapple pomace ranged from 3.13% ± 0.10% to 5.63% ± 0.12%, slightly higher than the typical 3%–4% found in commercially available noodle snacks. This increase is likely due to the water-retaining properties of the dietary fibers in the pomace. Formulation 4 had the highest moisture content, while Formulation 1, with less pomace, was closest to the original noodles. Despite these differences, the p-value ($p > 0.05$) showed no significant variation between the samples, likely due to uniform drying and consistent preparation. These findings suggest that adding pineapple pomace does not negatively affect the product's stability or shelf life, as the moisture levels remain within safe limits. Accurate moisture level in snack noodles is important to quality and shelf life. Too much moisture leads to browning, spoilage, and rancidity, having the negative effects on appearance. Lacking sufficient moisture, noodles tend to crack upon processing and grow brittle [9].

Table 4 Moisture content (%) of snack noodle with pineapple pomace

Sample	Moisture content (%)
Formulation 1	3.13±0.10
Formulation 2	4.17±0.11
Formulation 3	4.45±0.34
Formulation 4	5.63±0.12

3.4 Sensory Evaluation

The sensory evaluation involved 40 panellists, aged 21 to 27, assessing 4 samples. The sensory evaluation of snack noodle with pineapple pomace showed that Sample 123 scored the highest across all attributes, including appearance (7.8 ± 1.91), aroma (6.92 ± 2.03), texture (7.3 ± 1.91), and flavour (6.7 ± 2.04). Its balance of ingredients likely made it the most appealing overall, with an optimal pomace level improving its colour, aroma, and texture. In contrast, Sample 150, with the lowest scores for appearance (4.95 ± 2.41), aroma (5.75 ± 2.14), texture (6.05 ± 2.12), and flavour (5.35 ± 2.38), may have had too much pomace, affecting its sensory qualities.

Sample 545 and Sample 808 had moderate ratings, with scores indicating acceptable but less favourable sensory qualities compared to Sample 123. Sample 545 scored 5.9 ± 1.86 for appearance, 6.27 ± 1.76 for aroma, 6.6 ± 1.91 for texture, and 6.05 ± 1.98 for flavour, while Sample 808 had slightly lower scores. These differences suggest that the amount of pineapple pomace plays a significant role in the noodles' sensory appeal, particularly for appearance and aroma.

Overall, the results highlight significant differences ($p < 0.05$) in sensory attributes among the samples, except for texture. Sample 123, with the least pomace, was the most liked due to its balanced sensory profile, while higher pomace levels in other samples seemed to negatively impact attributes like flavour and appearance. These findings suggest that careful adjustment of pomace levels is key to optimizing consumer acceptance.

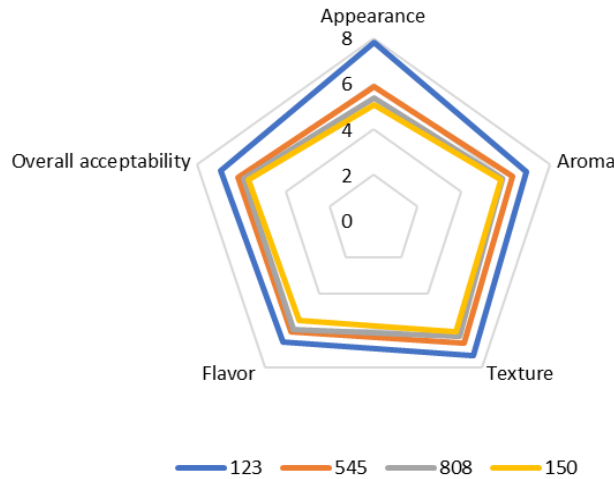


Fig. 1 Quantitative descriptive analysis for snack noodle samples

3.5 Nutritional Content Analysis

The nutritional analysis played a crucial role in determining the nutritional and sensory attributes of snack noodle with pineapple pomace, focusing on energy, total fat, total carbohydrate, protein, and sodium per 100 g unit. Selected formulations from sensory evaluation which was Formulation 1 were analysed.

Table 5 Moisture content (%) of snack noodle with pineapple pomace

Nutrient Composition	Unit	Value
Energy	kcal/100g	1889
Total Fat	g/100g	16.2
Total Carbohydrate	g/100g	68
Protein	g/100g	7.6
Sodium	mg/100g	176

Formulation 1 had an energy content of 1889 kcal per 100 g, categorizing it as a high-energy food, which is not ideal for low-calorie diets. Its fat content was relatively high at 16.2 g per 100 g, likely due to natural fats in the pineapple pomace and fats added during processing. However, research suggests that the dietary fiber in pineapple pomace can absorb fat and sodium, potentially improve satiety and reduce the need for added fats [10].

The sodium content was 176 mg/100 g, significantly lower than typical instant noodles, which often range from 950 to 3,050 mg/100 g [11]. This makes the product a healthier option for consumers seeking low-sodium foods to support heart health and reduce hypertension risks [12]. The carbohydrate content of 68 g/100 g aligns with typical snack noodles, though it may not be suitable for low-carb diets. Protein levels were measured at 7.6 g/100 g, consistent with most commercial noodle snacks, ensuring the product remains nutritionally competitive while adding the fiber benefits of pineapple pomace.

4. Conclusion

This study has successfully developed noodle snacks with varying levels of pineapple pomace, analysing their sensory attributes, texture, colour, and nutritional composition. Among the formulations, the one with the lowest pomace level (Formulation 1) stood out for its balanced texture, appealing appearance, and overall acceptability, achieving the highest sensory scores. While higher pomace levels enhanced colour vibrancy and added health benefits, Formulation 1 provided the best balance of quality, flavour, and consumer appeal. The findings highlight the potential of incorporating pineapple pomace into snack noodles to create a nutritious, sustainable, and market-ready product.

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Conflict of Interest

Declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design:** Siti Nurul Aina Abdul Razak, Faridah Kormin; **data collection:** Siti Nurul Aina Abdul Razak; **analysis and interpretation of results:** Siti Nurul Aina Abdul Razak, Faridah Kormin; **draft manuscript preparation:** Siti Nurul Aina Abdul Razak, Faridah Kormin. All authors reviewed the results and approved the final version of the manuscript.*

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