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Physicochemical Properties Analysis of Three Indexes Pineapple Core Extract Variety MD2 and Morris

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Abstract

Two popular pineapples (*Ananas comosus*) cultivars that are prized for their distinct flavours and nutritional value are MD2 and Morris. The physicochemical characteristics of pineapple cores from the MD2 and Morris cultivars at three ripeness stages (Indexes 2, 4, and 6) are investigated in this study, focusing on total soluble solids (TSS), pH, titratable acidity (TA), absorbance, moisture content, and texture profile. The results indicate that TSS (°Brix) values were slightly higher in Morris (11.508 ± 0.324) than in MD2 (11.378 ± 0.496), suggesting comparable sweetness levels. pH increased with ripening, with MD2 exhibiting a slightly higher pH (3.8278 ± 0.0630) than Morris (3.7178 ± 0.0307), indicating lower acidity in MD2. TA declined as maturity advanced, confirming acid metabolism during ripening. Juice clarity decreased with maturity, with Morris demonstrating greater clarity than MD2. Pulp content increased with ripening, with Morris containing significantly more pulp (2.1800 ± 0.2215%) than MD2 (1.843 ± 0.415%). Colour analysis revealed significant changes in lightness (L*), redness (a*), and yellowness (b*), with Morris exhibiting a more pronounced yellow hue. Moisture content declined as MD2 matured, while Morris maintained a relatively stable moisture level. Texture profile analysis showed increased firmness with ripening, with Morris (7930 ± 2398 g) being firmer than MD2 (7012 ± 1052 g). The findings provide valuable insights into the effects of variety and maturity on pineapple quality attributes, guiding optimal harvest timing and processing applications.

1. Introduction

A popular tropical fruit, pineapples (*Ananas comosus*) are prized for their flavour, rich nutritional content, and health advantages. Costa Rica produces the most pineapples [1], making pineapple the third most sought-after fruit in the world, behind bananas and citrus. With the guided from the Malaysian Pineapple Industry Board (LPNM), pineapple is grown in Malaysia using both conventional and contemporary agricultural techniques. As seen in Fig. 1, MD2 and Morris are the two main cultivars among the nine types grown in Malaysia. They are valued for their flavour and nutritional content, which includes vitamins, organic acids, and the proteolytic enzyme bromelain. Despite its advantages, the pineapple core remains underutilized, even though it contains minerals, fibers, and bioactive components that make it excellent for value-added products [2]. The core also contains important bioactive phenolic compounds that may positively impact metabolism and overall health. These compounds, as secondary metabolites of plants, exhibit anti-inflammatory, anti-cancer, and antithrombotic properties, along with other health and therapeutic benefits [3]. Throughout the post-harvest

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stage, pineapples experience several physicochemical changes that might impact fruit maturity, variety, and condition throughout fruit development, as well as juice production [4]. Fruit quality is greatly impacted by ripeness during harvest, which influences qualities including sweetness, acidity, texture, and chemical composition.

Regarding the physical-chemical properties of pineapple core extracts from two popular cultivars, MD2 and Morris. Both varieties are often cultivated; MD2 is known for its exceptional sweetness and consistency, while Morris is valued for its robust texture and acidic flavour. This study investigates the impact of different maturation stages of selected pineapple cultivars, represented by three maturity indices, on the physicochemical properties of their cores. Key parameters influencing these properties include pH, colour, total soluble solids (TSS), titratable acidity (TA), pulp content, clarity, moisture content, and texture profile. Texture analysis is conducted using a texture analyzer to provide a comprehensive assessment of core characteristics.

Understanding these variations is essential, as the core is often discarded despite its potential as a valuable source of nutrients, bioactive compounds, and functional ingredients. Currently, researchers have conducted limited studies on the physicochemical characteristics of pineapple cores, particularly about different maturity stages. This lack of data restricts efforts to optimize their use in value-added products, such as functional foods, nutraceuticals, and sustainable food processing applications. By examining the MD2 and Morris cultivars, this study provides a detailed assessment of their core composition, addressing the existing gap in knowledge about these widely cultivated pineapple varieties.

(a) (b)

Fig. 1 Figure shown (a) Different index of MD2; (b) Different index of Morris

2. Material and Method

2.1 Preparation of samples

Ladang Agroteknologi Nanas Alor Bukit, Johor, supplied the fresh MD2 and Morris pineapples used in this study. The Federal Agricultural Marketing Authority (FAMA) classified the pineapples according to their ripeness stages (maturity indices 2, 4, and 6). These stages corresponded to the early, mid, and fully ripe phases, which were analysed to examine the physicochemical changes that occurred during ripening. After washing, the pineapples were peeled, and standardized techniques were employed to separate the pulp and core [5]. To preserve the sample integrity, the juice from the core was removed using a muslin cloth and stored at -20°C. The physicochemical examination, conducted in triplicate for accuracy, evaluated pulp content, colour, clarity, titratable acidity, total soluble solids, and pH to ensure comparable comparisons across ripeness stages and types.

2.2 Physicochemical analyses

The physicochemical analysis of pineapple core extract MD2 and Morris variety at three different indexes was done using the following methods:

2.2.1 Total Soluble Solid (TSS)

The determination of Total Soluble Solids (TSS) in pineapple core extracts was performed using an Automatic Digital Refractometer (Atago RX-5000α), which measures the refractive index and correlates it with sugar content [6]. A drop of pineapple extract was placed on the prism and allowed to stabilize before recording the Brix value, which represents the concentration of soluble solids. To ensure reliability, each sample was analysed in triplicate.

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2.2.2 pH

The pH of the sample is precisely measured using a calibrated pH meter (SX751 portable pH) at room temperature, which provides accurate and reliable readings of the hydrogen ion concentration. Before measurement, the pH meter is calibrated using standard buffer solutions at pH 4.0, 7.0, and 10.0 to ensure the accuracy and consistency of the readings, particularly within the typical pH range of food samples [7]. To ensure reliability, each sample was analysed in triplicate.

2.2.3 Titratable Acidity (TA)

Titratable acidity was assessed as outlined by the AOAC 962.12 method. The titration procedure begins by diluting ten mL of pineapple core extract with 250 mL of deionized water in a 500 mL Erlenmeyer flask. While continuously stirring the mixture, 0.1 N sodium hydroxide solution is gradually added to the acidic sample, with 1 mL of phenolphthalein serving as the pH indicator. The endpoint of the titration is identified by the appearance of a stable pale pink colour. To ensure precision, the procedure is performed three times, and the volume of sodium hydroxide consumed is recorded. The measurement is repeated at least three times, and the percentage of citric acid is determined using the following expression:

$$\%\ Acid\ (as\ anhydrous\ citric\ acid) = Volume\ of\ N\ NaOH\ (ml) \times 0.64 / 10 \quad (1)$$

2.2.4 Clarity (Absorbance)

Absorbance was determined by UV-Vis spectrophotometer (Jenway 7205 Scanning Spectrophotometers) at 660 nm wavelength and distilled water was used as blank. The clarity was expressed in an absorbance value (abs). This procedure is repeated three times for each sample, with thorough cuvette cleaning between readings to prevent contamination.

2.2.5 Pulp Content

The pineapple juice is centrifuged using an Eppendorf Centrifuge 5810 at 3000 rpm for ten minutes to separate the solid pulp from the liquid phase. A centrifugal force of 360 × 50 g facilitates effective separation while preserving pulp integrity. Following centrifugation, the liquid supernatant is carefully decanted to prevent disturbance of the sedimented pulp. The sedimented pulp is then weighed or measured by volume and expressed as a percentage of the initial juice volume to determine the pulp content using the following equation:

$$Pulp\ content\ \% = Weight\ of\ Sedimented\ Pulp / Total\ Weight\ of\ Original\ Juices \quad (2)$$

2.2.6 Colour

The pineapple juice was measured in CIE $L*a*b*$ colour space using a colourimeter. Once the cuvette is inserted, the colourimeter generates values for lightness (L*), red-green (a*), and yellow-blue (b*) components [8].

2.2.7 Moisture Content

Moisture content was measured using the AND MX-50 moisture analyzer, which determines the moisture level through a combination of heat application and weight measurement. The process involves heating the sample material to remove moisture. Most moisture analyzers employ a halogen heating lamp for this purpose. 5g of pineapple core were crushed using mortar and pestle then weighed and placed on the aluminium pan in the rapid moisture analyzer at a temperature of 180°C. The heating lamp was activated, and the sample was heated until a constant weight was achieved, indicating complete evaporation of moisture [9]. The moisture content was measured in percentage in triplicate.

2.2.8 Texture Profile Analysis

The TA.XT Plus Texture Analyzer was employed to assess the hardness. Compression strength was determined under specific parameters: compression test mode, pre-test speed of 1.50 mm/s, test speed of 2.00 mm/s, post-test speed of 10.00 mm/s, target mode set at distance with a distance of 17.000 mm, trigger force of 10.0 g, and data acquisition rate of 400 PPS. This analysis utilized a 3-Point Bending Rig (HDP/BSK) equipped with a blade set with a knife and a HeavyDuty Platform (HDP/90). The texture assessment of the pineapple core was performed in triplicate using the Texture Analyzer.

2.3 Data analysis

Data were analysed by Minitab Statistical Software 22. Analysis of variance (ANOVA) was performed. The data that has been obtained by One-way ANOVA for the collecting the means and standard deviation. The Tukey test was also performed. The Two-way ANOVA was also performed to obtain the interaction between both factors which were the variety of pineapples and the maturity index of pineapples.

3. Result and Discussion

Table 1 TSS, pH, Titratable acidity, and Absorbance of pineapple core extract juice

Sample	°Brix	pH	% of acid	Absorbance
Variety (C)				
MD2	11.378 ± 0.496[a]	3.8278 ± 0.0630[a]	0.8178 ± 0.0595[a]	0.4711 ± 0.0898[b]
Morris	8.508 ± 0.324[b]	3.7178 ± 0.0307[b]	0.8511 ± 0.1237[a]	0.5500 ± 0.0548[a]
Maturity index (S)				
2	9.418 ± 1.466[a]	3.7167 ± 0.0372[a]	0.9350 ± 0.0532[a]	0.5817 ± 0.0279[a]
4	10.082 ± 1.546[a]	3.7783 ± 0.00677[ab]	0.8433 ± 0.0301[b]	0.5300 ± 0.0352[a]
6	10.328 ± 1.703[a]	3.8233 ± 0.0769[b]	0.7250 ± 0.0288[c]	0.4200 ± 0.0701[b]
Interactions (SxC)	ns	ns	ns	ns

The data is presented from the mean of triplicate determination ± SD. Means separation within columns and factors followed by the same letter are not significantly different by the Tukey test at $p \leq 0.05$.
ns and *, ** = non-significant or significant at $p \leq 0.05$ or $p \leq 0.01$, respectively.

3.1 Total Soluble Solid (TSS)

Previous investigations have shown increased TSS concentration as the ripening phases go from dark green to yellow [10]. Based on Table 1, the °Brix values indicate the total soluble solids (primarily sugars) in pineapple juice. The MD2 variety recorded a lower °Brix (11.378 ± 0.496[a]) compared to the Morris variety (11.508 ± 0.324[b]), suggesting that Morris pineapples have a slightly higher sugar content. However, the differences are minimal, indicating both varieties exhibit comparable sweetness levels. Regarding maturity index, the °Brix values increased as the fruit matured [11], with maturity index 6 showing the highest value (10.328 ± 1.703[a]). This trend aligns with the natural accumulation of sugars as the fruit ripens. The non-significant interaction (ns) suggests that the effect of variety and maturity index on °Brix is independent.

3.2 pH

Based on Table 1, the pH values reflect the acidity of the juice, where a lower pH corresponds to higher acidity. The MD2 variety exhibited a slightly higher pH (3.8278 ± 0.0630) than the Morris variety (3.7178 ± 0.0307), indicating that MD2 juice is slightly less acidic. As the fruit matured, the pH increased, from 3.7167 (maturity index 2) to 3.8233 (maturity index 6), suggesting a reduction in acidity over time, which is a typical ripening effect. The interaction between variety and maturity index was not significant (ns), implying that the acidity changes independently of the variety and maturity stage. While titratable acidity (TA) shows the quantity of acid present as a proportion of the most prevalent acid, the pH of a fruit reveals the degree of the acidity [12].

3.3 Titratable Acidity

Titratable acidity (% of acid) indicates the total organic acid content in the juice. Significant variations between MD2 and Morris pineapples, as well as between the three ripeness indexes (2, 4, and 6), are revealed by the ANOVA findings based on Table 1 for titratable acidity. The Morris variety had a slightly higher titratable acidity (0.8511 ± 0.1237) than MD2 (0.8178 ± 0.0595), which aligns with its lower pH value. Regarding maturity index, acidity decreased as the fruit matured, from 0.9350 ± 0.0532 at maturity index 2 to 0.7250 ± 0.288 at maturity index 6. This decline suggests that acids are being metabolized or diluted as the fruit ripens. The non-significant interaction (ns) indicates that titratable acidity changes due to variety and maturity stage independently. The natural reduction in organic acids as the fruit ripens is reflected in MD2's titratable acidity, which drops with maturity. [13] verified that TA decreased as the pineapple ripened and reached maturity.

3.4 Absorbance

In Table 1, there was significant difference in absorbance of the pineapple core extract juice for both the variety and maturity index of pineapple core. Juice clarity is an essential quality parameter, as it reflects the presence of suspended particles. The Morris variety had a higher clarity value (0.5500 ± 0.0548) than MD2 (0.4711 ± 0.0898), suggesting that Morris juice is visually clearer. In terms of maturity index, clarity decreased with ripening, with the highest clarity at maturity index 2 (0.5817 ± 0.0279) and the lowest at maturity index 6 (0.4200 ± 0.0701). Ripeness improves the clarity of both types, which might be due to enzymatic breakdown or suspended particle deposition. One of the most researched issues in food technology is the presence of pectinesterase in citrus fruit, namely in cloud loss of citrus juice [14]. This suggests that as pineapples mature, more suspended particles or colloids form, reducing clarity. The interaction effect was non-significant, indicating that clarity changes are independently influenced by variety and maturity index.

3.5 Pulp content

Table 2 Percentage of pulp content pineapple core extract juice

Sample	% pulp
Variety (C)	
MD2	1.843 ± 0.415[b]
Morris	2.1800 ± 0.2215[a]
Maturity index (S)	
2	1.785 ± 0.317[b]
4	1.943 ± 0.274[ab]
6	2.307 ± 0.330[a]
Interactions (SxC)	0.451

The data is presented from the mean of triplicate determination ± SD. Means separation within columns and factors followed by the same letter are not significantly different by the Tukey test at $p \le 0.05$.
ns and *, ** = non-significant or significant at $p \le 0.05$ or $p \le 0.01$, respectively.

Based on Table 2, the Morris variety had a significantly higher pulp content (2.1800 ± 0.2215%) than the MD2 variety (1.843 ± 0.415%), indicating varietal differences in juice composition. Pulp content increased with maturity, ranging from 1.785 ± 0.317% at index 2 to 2.307 ± 0.330% at index 6, suggesting that ripening enhances the release of insoluble solids. However, the interaction between variety and maturity index was insignificant (p = 0.451), indicating independent effects. These findings highlight the influence of variety and maturity on juice texture and may guide processing decisions for optimizing pulp content in pineapple juice production.

3.6 Colour

Table 3 Colour of pineapple core extract juice

Sample	L*	a*	b*
Variety (C)			
MD2	72.056 ± 2.170[a]	5.922 ± 1.992[a]	24.300 ± 0.265[e]
Morris	68.03 ± 3.80[b]	5.811 ± 1.293[a]	68.03 ± 3.80[b]
Maturity index (S)			
2	66.42 ± 3.28[b]	3.933 ± 0.561[c]	23.017 ± 1.422[c]
4	70.483 ± 2.183[a]	6.000 ± 0.40[b]	26.800 ± 1.218[b]
6	73.233 ± 1.219[a]	7.667 ± 0.403[a]	32.767 ± 0.876[a]
Interactions (SxC)	ns	ns	0.026

The data is presented from the mean of triplicate determination ± SD. Means separation within columns and factors followed by the same letter are not significantly different by the Tukey test at $p \le 0.05$.
ns and *, ** = non-significant or significant at $p \le 0.05$ or $p \le 0.01$, respectively.

Based on Table 3, the colour analysis of MD2 and Morris pineapples showed significant changes in lightness (L*), redness (a*), and yellowness (b*) across different maturity indices. As the fruit ripened from maturity index 2 to 6, L* increased, indicating a lighter core, while a* also increased, suggesting a redder hue. Similarly, b* values rose, reflecting enhanced yellowness, with Morris exhibiting a more pronounced yellow core compared to MD2. The significant interaction (p = 0.026) for b* suggests that the impact of ripeness on yellowness varies between varieties. These findings indicate that pineapple colour development is closely linked to maturity, with increased brightness, redness, and yellowness as ripening progresses, which is essential for determining optimal harvest time and quality evaluation.

Table 4 Moisture content and TPA of pineapple core

Sample	Moisture (%)	Hardness (g)
Variety (C)		
MD2	77.256 ± 0.888^{b}	7012 ± 1052^{a}
Morris	78.711 ± 0.437^{a}	7930 ± 2398^{a}
Maturity index (S)		
2	78.733 ± 0.489^{a}	6248 ± 1364^{b}
4	77.983 ± 0.866^{ab}	7450 ± 2143^{ab}
6	77.233 ± 1.065^{b}	8714 ± 1275^{a}
Interactions (SxcC)	ns	ns

The data is presented from the mean of triplicate determination ± SD. Means separation within columns and factors followed by the same letter are not significantly different by the Tukey test at $p \leq 0.05$.
ns and *, ** = non-significant or significant at $p \leq 0.05$ or $p \leq 0.01$, respectively.

3.7 Moisture content

Based on Table 4, the moisture content of MD2 and Morris pineapples varied significantly with maturity, with Morris maintaining higher moisture levels (78.711 ± 0.437%) compared to MD2 (77.256 ± 0.888%). As MD2 ripened, its moisture content gradually decreased from 78.73% at index 2 to 76.3% at index 6, indicating water loss during maturation. In contrast, Morris exhibited a more stable moisture level, with only a slight reduction from 79.2% at index 2 to 78.2% at index 6. These results suggest that maturity influences water retention, with MD2 experiencing more moisture loss as it ripens, whereas Morris retains a relatively higher and more stable moisture content throughout ripening, potentially affecting its texture and juiciness.

3.8 Texture Profile Analysis

Based on Table 4, the hardness of MD2 and Morris pineapples increased with maturity, indicating textural changes during ripening. Morris exhibited a higher hardness value (7930 ± 2398 g) compared to MD2 (7012 ± 1052 g), suggesting a firmer texture. As the fruit matured, hardness progressively increased from 6248 ± 1364 g at index 2 to 8714 ± 1275 g at index 6, demonstrating that ripening contributes to a firmer structure. This trend may be attributed to changes in cell wall composition and moisture loss over time. The findings highlight that maturity plays a crucial role in pineapple texture, with increased firmness as the fruit progresses through ripening stages, which may influence consumer preference and processing applications.

4. Conclusion

In conclusion, the study successfully meets its objectives by analysing the physicochemical properties of MD2 and Morris pineapple core extracts and evaluating the influence of maturity stages. It reveals that Morris has slightly higher sugar content, acidity, juice clarity, and moisture retention, whereas MD2 exhibits lower acidity, greater moisture loss, and increased firmness with ripening. Maturity significantly impacts both varieties, with increasing TSS and pH, decreasing titratable acidity, moisture content, and clarity, as well as enhanced colour intensity and firmness over time. These findings provide a comprehensive understanding of varietal differences and ripening effects, offering valuable insights for optimizing harvest timing, juice processing, and quality control. These results present new data on the *Ananas comosus* fruits which are useful for future research [15].

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Conflict of Interest

There is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Muhammad Firdaus Azhari;* ***data collection****: Muhammad Firdaus Azhari;* ***analysis and interpretation of results:*** *Muhammad Firdaus Azhari, Hatijah Basri;* ***draft manuscript preparation:*** *Muhammad Firdaus Azhari, Hatijah Basri. All authors reviewed the results and approved the final version of the manuscript.*

References

[1] Firatoiu, A. R., Chiurciu, I. A., Marcuta, L., Chereji, A. I., Soare, E., Voicu, V., & Marcuta, A. (2021). Study on the Production and Marketing of Pineapples Worldwide. *Proceedings of the 37th International Business Information Management Association (IBIMA), Cordoba, Spain*, 1-2.

[2] Mohd Ali, M., Hashim, N., Abd Aziz, S., & Lasekan, O. (2020). Pineapple (Ananas comosus): A comprehensive review of nutritional values, volatile compounds, health benefits, and potential food products. Food Research International, 137, 109675.

[3] Kumar, N., & Goel, N. (2019). Phenolic acids: Natural versatile molecules with promising therapeutic applications. Biotechnology reports, 24, e00370.

[4] Lamptey, F. P. (2019). Assessment of the impact of some preharvest and postharvest factors on pineapple juice quality and safety (Doctoral dissertation, University of Cape Coast).

[5] Fissore, A., Marengo, M., Santoro, V., Grillo, G., Cravotto, G., Dal Piaz, F., & Adinolfi, S. (2023). Extraction and Characterization of Bromelain from Pineapple Core: A Strategy for Pineapple Waste Valorization. Processes, 11(7), 2064.

[6] Nordin, N. L., Sulaiman, R., Bakar, J., & Noranizan, M. A. (2023). Comparison of Phenolic and Volatile Compounds in MD2 Pineapple Peel and Core. Foods, 12(11), 2233.

[7] Vollmer, K., Chakraborty, S., Bhalerao, P. P., Carle, R., Frank, J., & Steingass, C. B. (2020). Effect of pulsed light treatment on natural microbiota, enzyme activity, and phytochemical composition of pineapple (Ananas comosus [L.] Merr.) juice. Food and Bioprocess Technology, 13, 1095-1109.

[8] Muhammad Shoukat Hussain. (2024, March 7). Functions of Moisture Analyzer. ResearchGate; unknown.

[9] https://www.researchgate.net/publication/378774154_Functions_of_Moisture_Analyzer

[10] Hajar, N., Zainal, S., Nadzirah, K. Z., Roha, A. S., Atikah, O., & Elida, T. T. (2012). Physicochemical properties analysis of three indexes pineapple (Ananas comosus) peel extract variety N36. Apcbee Procedia, 4, 115-121.

[11] W.A.J.P. Wijesinghe and K.H. Sarananda, Postharvest quality of 'Mauritius' pineapple and reason for reduced quality, Int. J. Trop. Agric. Res. Ext, 5(1) (2002) 53-56.

[12] Misman SAB. Soursop Pectinesterase: Extraction, Purification, Properties and Effect on Cloud Stability of Soursop Juice. University Putra Malaysia, Selangor, 1996

[13] Kumara, B. A. M. S., & Hettige, K. D. (2020). Ripening stage affects the quality of fresh and dehydrated pineapples (Ananas comosus (L.) Merr.) cv. Mauritius in Sri Lanka. *Sustainable Food Production*, *8*, 29-37.

[14] Dhar, M., Rahman, S. M. and Sayem, S. M. 2008. Maturity and post-harvest study of pineapple with quality and shelf-life under red soil. International Journal of Sustainable Crop Production 3 (2): 69-75.

[15] Muhammad Shoukat Hussain. (2024, March 7). Functions of Moisture Analyzer. ResearchGate; unknown.

[16] Joomwong A. Impact of Cropping Season in Northern Thailand on the Quality of Smooth Cayenne Pineapple. II. Influence on Physico-chemical Attributes. International Journal of Agriculture & Biology. 2006; 8: 330-336