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Short Communication

Effect of Temperature Variations on Drying Characteristics of Pineapple Pomace

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Abstract: Dried pineapple pomace has a huge potential for food product development as an additive in many kinds of food formulations. In this study, the influences of drying temperatures on the drying time of pineapple pomace were investigated. The experiment was conducted using the oven drying method to monitor the moisture changes in pineapple pomace every 15 to 30 minutes at different temperatures (50°C, 70°C, and 80°C). It was observed that the drying time of the pineapple pomace was decreased by 33.3% when the temperature increased from 50°C to 80°C. The drying curve showed that the moisture content in pineapple pomace decreased continuously over the drying period (180–270 mins).

Keywords: drying technology; temperature; pomace; food additive; pineapple

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1. Introduction

Pineapple pomace is produced as a residue from pressing the fruits to extract the pineapple juice. The pomace contains high-fibre and bioactive compounds that have a lot of health benefits (Ignatia *et al.*, 2022; Kumar, 2021; Moreira *et al.*, 2022). Therefore, it has huge potential as a value-added ingredient and additive in food products. Recently, the potential of pineapple pomace as a value-added ingredient in food products has been developed such as for cookies (Jose *et al.*, 2022; Nguyen *et al.*, 2024), yoghurt (Meena *et al.*, 2022), jams (Kapoor *et al.*, 2023), and bread (Darshini *et al.*, 2021). Besides, the trends in the utilisation of fruit pomace are not limited to food products but also has been extended to animal feed (Foti *et al.*, 2022; Lu *et al.*, 2022; Sokač Cvetnić *et al.*, 2023). Based on the mentioned studies, the use of pineapple pomace can either be dried and processed into powder or be used as it is in food product development.

Research has indicated that pineapple pomace is a major source of nutrients such as vitamin C, calcium, dietary fibre, and soluble carbohydrates, making it a promising ingredient for many applications (Mnisi *et al.*, 2022). Additionally, pineapple pomace includes a varied array of bioactive components including polyphenols and carotenoids, which display powerful antioxidant, antibacterial, and anticancer effects, thus strengthening its appeal as a functional ingredient (Mnisi *et al.*, 2022). The high level of total phenolic compounds and flavonoids in pomace makes it a good choice for addition to food products as a natural additive and antioxidant agent (Vinha *et al.*, 2023). These bioactive chemicals not only contribute to the nutritional content of the pomace but also offer possible health advantages to consumers.

The application of fruit pomace in the development of composite biscuits, functional cookies, and pasta has demonstrated its versatility as a food ingredient with the ability to enhance the sensory attributes and health-promoting properties of the final products (Naseeha, 2023; Theagarajan *et al.*, 2019; Tolve *et al.*, 2020). Additionally, using fruit pomace in chicken nutrition and livestock feed not only gives economic benefits by decreasing disposal costs but also adds to sustainable waste management techniques (Oduntan *et al.*, 2022). Overall, the broad nutritional benefits and functional features of pineapple pomace underline its significance as a desirable food additive with the potential for extensive application across various industries.

Drying is one of the techniques used in the food industry to preserve food quality by reducing the water activity and moisture content of the product (Cao *et al.*, 2021; Jayaraman & Gupta, 2020). The study on drying kinetics includes the influence of moisture loss and other associated variables, thereby enabling informed decisions regarding the selection of dryers and operational parameters for food processing (Oyinloye & Yoon, 2020). Therefore, it is important to study the effect of drying temperature to optimise the drying process for dried pineapple pomace.

In recent years, studies on the drying kinetics of fruits pomace have been published such as for apples (Tulej & Głowacki, 2022), grapes (Conte *et al.*, 2024; Guaita *et al.*, 2021), and blueberries (Calabuig-Jiménez *et al.*, 2022). Despite the increasing popularity of pineapple pomace, extensive research on the effect of temperature variations on the drying characteristics (i.e. drying time) of the product has not yet been highlighted. Therefore, the study aimed to assess the effect of different drying temperatures on the drying time to produce dried pineapple pomace. This study determined the moisture content of the pineapple pomace at 15 to 30-minute intervals during the drying process to examine the moisture loss over time using the drying curve of the pineapple pomace. The findings from the study offer some important insights into the considerations for evaluating the drying conditions to optimise the drying time and energy consumption to preserve pineapple pomace using the drying technique.

2. Materials and Methods

2.1. Sample Preparation

Three Josephine pineapples were purchased from the local market. The fruits were washed thoroughly to remove any dirt and contaminants available on the surface of the fruits. Following the contour of the pineapple, the fruits were peeled using a knife to remove the skin. For this experiment, the eyes of the pineapple were trimmed and the core was removed to ensure that only pomace from the flesh was used to obtain the pomace. Then, the fruits were cut equally into eight wedges. A SJ-6 Slow Juicer Extractor (Russell Taylors, Klang, Malaysia) was used to separate the pineapple juice and pomace. The pomace was extracted twice to ensure minimal juice remained in the pomace. Sixty grams of pomace was spread evenly with 3 mm thickness onto individual aluminium foil trays for the drying experiment.

2.2. Drying of Pineapple Pomace

A fan-forced oven Memmert UF30 (Memmert GmbH, Schwabach, Germany) was pre-heated for 10 min at 50ºC. Once the oven reached the desired temperature, the pomace sample was placed into the oven and the weight of the samples was determined at every 15-min intervals. After there were little changes in weight loss, the weight of the samples was determined at 30-min intervals until the moisture content (wb) reached <10%. The same procedure was repeated for the remaining samples and dried at 70ºC and 80ºC temperatures. The summary of the methodology is presented in Figure 1.

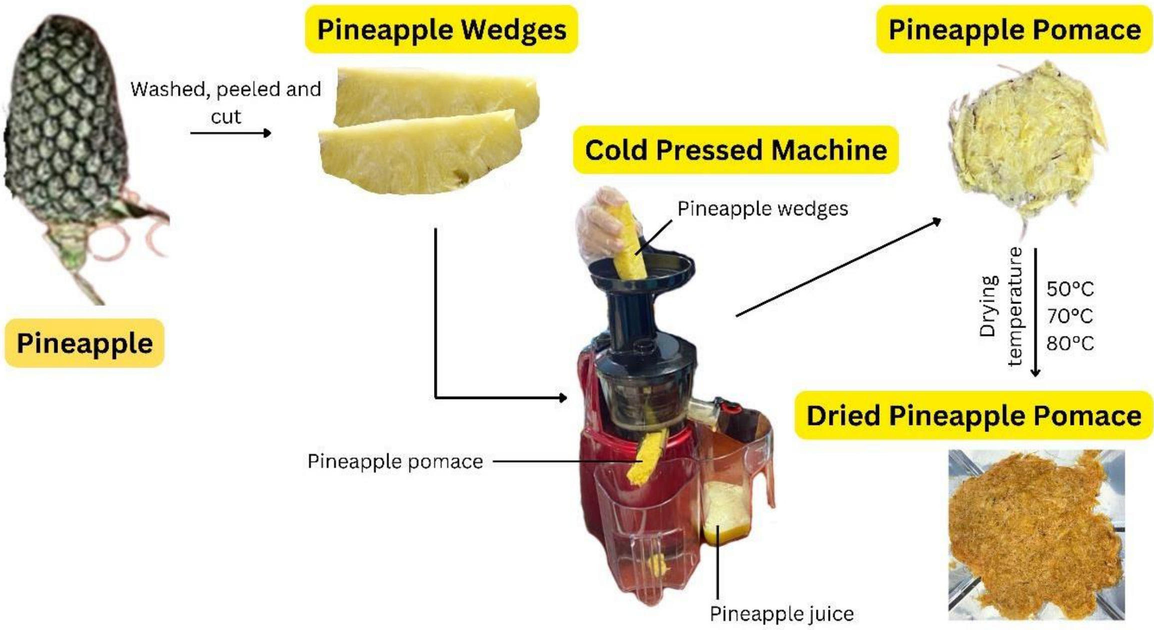

Figure 1. Steps to dry the pineapple pomace at 50°C, 70°C and 80°C of drying temperature.

2.3. Determination of Initial Moisture Content

The initial moisture content of the pineapple pomace was determined using a moisture analyser MX-50 (A&D Co. Ltd., Tokyo, Japan). One gram of pomace sample was evenly distributed on the moisture analyser pan in the heating chamber that was equipped with an automatic weighting scale. The sample was left at 105ºC drying temperature until all the moisture had been drawn. The percentage of moisture content value was obtained once the analysis was completed. The value was used as the initial moisture content of the pineapple pomace.

2.4. Analysis of Data

The initial weight of water and the weight of the solid in the sample were determined using Equations 1 and 2, respectively. Meanwhile, the weight of water and moisture content on a wet basis at each time interval was calculated using Equations 3 and 4, respectively. The calculations using Equations 1 to 4 assumed that there was no loss of solid contained in the sample during the drying process. A drying curve plot for pineapple pomace dried at 50ºC, 70ºC and 80ºC was used to assess the trends of moisture loss over time at different drying temperatures and ensure reproducibility of the experiment.

$$\text{Initial weight of water} = \text{initial moisture content (\%)} \times \text{initial weight of sample (g)} \quad (1)$$

$$\text{Weight of solid} = \text{initial weight of sample (g)} - \text{initial weight of water (g)} \quad (2)$$

Weight of water = weight of sample (g) – weight of solid (g) (3)

Moisture content (%; wb) = [weight of water (g) / weight of the sample (g)] x 100% (4)

3. Results and Discussions

The moisture content of pineapple pomace determined using the moisture analyser was 81.3% (wb). In comparison with the pineapple flesh, the pomace contained less moisture than the flesh as reported by Manthou *et al.* (2020), which is around 90% moisture content. Figure 2 shows the drying curve of pineapple pomace dried at 50ºC, 70ºC and 80ºC from 81.3% to <10% moisture content (wb). The curves showed that the moisture loss of the pineapple pomace was continuously recorded during the drying process.

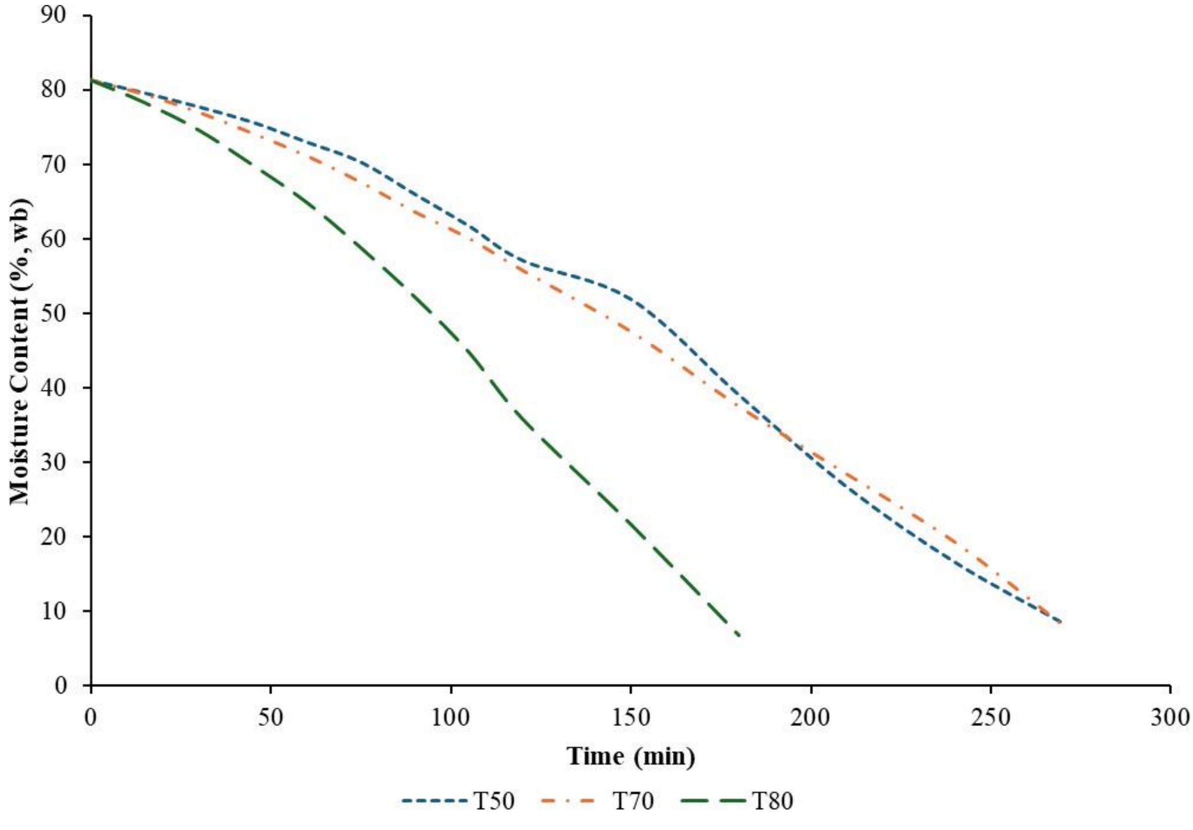

Figure 2. Drying curves of pineapple pomace dried at 50ºC (T50), 70ºC (T70) and 80ºC (T80). Abbreviations: wb = wet basis.

From the observation, the 80ºC drying temperature took the shortest drying time compared to 50ºC and 70ºC drying temperatures. The increase in temperature from 50ºC to 80ºC reduced the drying time by 33.3%. This showed that the increase in certain temperatures can accelerate the drying process and, therefore shorten the drying time. The observation was in accordance with previous works on pomace drying for other fruits (Conte *et al.*, 2024; Ross *et al.*, 2020; Tulej & Głowacki, 2022).

Previous research has shown that higher drying temperatures can lead to a decrease in drying time and phenolic content (Nguyen *et al.*, 2022). Additionally, elevated temperatures can enhance water diffusivity within fruits, reducing the processing time needed to achieve the desired moisture content (Jorge *et al.*, 2021). However, it is important to note that while higher temperatures can accelerate the drying process, there may be trade-offs in terms of the quality of the product. This observation has been studied in dried fruit production, where an increase in drying temperature can result in a decrease in the total content of phenolic compounds and antioxidant activity (Krzykowski *et al.*, 2020).

Interestingly, the time taken to reduce the moisture content to reach <10% moisture content (wb) was similar for 50ºC and 70ºC. Meanwhile, 80ºC drying temperature showed much reduction in drying time to dry the pomace. Similar observations on the effect of different drying temperatures over time were reported by Afrin *et al.* (2022) on orange pomace. The authors observed that the equal increase in temperature does not equally decrease the drying time of the dried pomace. The findings provide support for the importance of evaluating the drying characteristics of the food materials towards mass production. This consideration may help the producers to optimise the drying time and energy consumption during the process. Further work is needed to assess the effect of drying temperature on the biochemical and sensory characteristics of the pomace.

4. Conclusions

This study set out to assess the effect of different drying temperatures on the drying characteristics of pineapple pomace. The findings showed that the increase in drying temperature from 50ºC to 80ºC had decreased the drying time by 33.3%. Besides, it was observed that drying the pomace below 80ºC does not show much difference in terms of drying time. These findings suggest the influence of drying conditions (i.e. temperature) towards drying time to reduce the moisture of a food product. The insights gained from this study confirm previous findings and contribute to a deeper understanding of how drying temperature affects the drying characteristics of pineapple pomace. Moreover, this knowledge is valuable for producers to maintain the quality of dried pineapple pomace, which has significant potential as a value-added ingredient and additive in food products. By regulating drying temperatures, companies can achieve more effective drying operations, lowering drying time and energy usage. This not only assists in retaining the health benefits of the pomace but also promotes consumer preference for the product. It is recommended that further study is needed to examine the effect of drying conditions on the biochemical properties of the dried pomace. In addition, the impact of different drying methods should also be focused on in order to suggest the best drying practice for high-quality dried pineapple pomace production. These can help to optimise the drying time and energy consumption to dry the product as well as to preserve the health benefit content and increase consumer preference for the pomace.

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Conflicts of Interest: The authors declare no conflict of interest

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