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Influence of Cooking Temperature on the Moisture Content and Organoleptic Properties of Pineapple, Banana, and Dragon Fruit Jam

Mutia Ardila[1*], Rafidah Almira Samosir[1], Alfira Julian Pratiwi[1], Ekin Dwi Arif Kurniawan[1], Najwa Putri L. Nasution[2], Gresvita Sanova Turnip[2], Sari Mawaddah[2], Faizah A. Nasution[2], Feri P. Jahata Samosir[2], Moondra Zubir[1], Abd Hakim S[3]

[1] Chemistry Department, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, 20221, Indonesia
[2] Biology Department, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, 20221, Indonesia
[3] Physics Department, Faculty of Mathematics and Natural Science, Universitas Negeri Medan, 20221, Indonesia

* Corresponding author: mutiaardilaa@unimed.ac.id

ABSTRACT

Jam is a processed fruit product with high density and acidity, making it more stable than other fruit-based products. The jam-making process includes crushing the fruit, adding sugar, acid, thickening agents, and applying heat. Cooking temperature plays a critical role in determining the moisture content, texture, aroma, and taste of jam. This study investigates the influence of cooking temperature on the moisture content and organoleptic properties of pineapple (Ananas comosus), banana (Musa paradisiaca), and dragon fruit (Hylocereus spp.) jams. The jams were prepared by heating at various temperatures (90^0C, 100^0C, 110^0C), followed by moisture content measurement and organoleptic testing. Results showed that higher temperatures significantly reduced moisture content and enhanced sensory quality. Jams cooked at 110°C had the lowest moisture levels and the best organoleptic scores. These findings highlight the importance of temperature control in producing high-quality jam.

Keywords: Cooking temperature, Organoleptic properties, Pineapple jam, Banana jam, Dragon fruit jam

1. INTRODUCTION

Indonesia has the largest number of plantations in Southeast Asia. There are various types of fruit plantations in Indonesia. Such as banana, pineapple, and soursop plantations. Fruits contain many vitamins that are very beneficial for health. Therefore, processing fruits into various foods is very common, one of which is jam.[1]

Jam is a processed food product that contains permitted food additives such as sugar.[2] Currently, the use of jam as a bread topping is increasing in line with changes in people's habits, especially in the choice of

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breakfast foods, with bread and jam replacing rice.[3, 4] It is typically consumed as a topping or filling for baked goods. The jam sold in stores is spreadable jam made from various fruits such as pineapple, papaya, tomato, and other fruits. Jam is made through the process of fruit crushing, adding sugar and acid, thickening agents, and heating. Essential additional ingredients that affect the quality of jam include thickening agents such as pectin, carrageenan, CMC, and Arabic gum.[5]

This certainly increases the economic value of using fruit as a food product. Almost all fruits, including pineapples, bananas, and dragon fruit, can be processed into jam. Pineapples are one of the fruits that have a sweet and sour taste, making them one of the most popular fruits among all age groups. In addition to being rich in vitamin C, pineapples are also rich in vitamin A, phosphorus, calcium, potassium, protein, bromelain, sodium, iron, magnesium, and fibre.[6] The flavour of pineapples presents an excellent opportunity to process them into pineapple jam as a form of product diversification to add value.[7] The reason for using pineapple (Ananas comosus) as an ingredient in jam production is that pineapple is one of the most readily available fruits and is widely cultivated by Indonesian farmers. Therefore, further utilisation is necessary to preserve the limited shelf life of pineapples, thereby reducing waste from rotting pineapples that have exceeded their shelf life. Therefore, processing pineapples into food products with a longer shelf life is essential. One approach that can be used to utilise pineapples is by processing them into processed pineapple jam.[8]

Bananas can also be processed into a sweet-tasting jam. This makes bananas a delicious fruit that is suitable for use as an ingredient in jam. This processing also increases the shelf life of bananas compared to bananas that are eaten directly, and this use adds to the value of bananas.[9, 10] In the context of innovation, banana jam is one way of utilising fruit that can extend its shelf life while increasing its economic value. The heating process significantly affects the physicochemical and organoleptic properties of the product. Inappropriate temperatures can cause changes in texture due to water evaporation, as well as affect taste and colour due to chemical reactions such as caramelisation and pigment degradation during cooking.

In addition to bananas, dragon fruit can also be used as a raw material for jam production. Dragon fruit jam is a semi-moist product made from fruit pulp mixed with sugar, with a minimum requirement of 45% fruit juice and 55% sugar in accordance with SNI 01-3746-1995 standards. The heating process is carried out until a soluble solid content of over 65% is achieved, measured using a refractometer. The gel in the jam forms from the interaction of the natural pectin in the fruit with sugar and acid at high temperatures, which becomes stable once the temperature decreases. Jam made from both fruits is generally used as an ingredient in bread or cakes.[11]

Based on previous research, the process of making dragon fruit jam begins with peeling the fruit to separate the skin from the flesh, then blending the flesh until it becomes a puree. This puree is then cooked at 70°C for 30 minutes, with the addition of other ingredients according to a predetermined formula. Heating is stopped once the mixture reaches the desired consistency.

In the gel formation process of jam, optimal conditions are required, namely a sugar concentration of 65%–70%, a pH of 3.2–3.4, and an appropriate moisture content, all of which are achieved through high-temperature heating. Important factors affecting the final quality of the jam include acidity level, fruit quality, and cooking stages. According to the National Standards Agency, good jam quality standards include a minimum soluble solids content of 65% and a maximum moisture content of 35%.[12,13] Additionally, a proportional combination of sugar, pectin, and acid is crucial for achieving a chewy texture, bright brown colour, and good spreadability. If the cooking process is not adequately controlled, the jam may become too thick or too runny.

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2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

This study used an experimental method to analyse the effect of cooking temperature on the water content and organoleptic test of pineapple, banana, and dragon fruit jam. The materials used include sugar (660 grams), water (100 ml), pineapple (1,000 grams), banana (600 grams), and dragon fruit (600 grams). The jam was made using equipment such as a digital thermometer, digital scale, pot, stove, blender, knife, spatula, and oven.

2.2. Research Procedure

1. Prepare the main ingredients: 1,000 grams of pineapple, 600 grams of banana, and 600 grams of dragon fruit.
2. Peel and cut the fruits into smaller pieces to facilitate the blending process.
3. Blend each type of fruit using a blender until it reaches a homogeneous texture.
4. Divide each type of fruit into three equal portions.
5. Cook each portion of fruit at different temperatures: 90°C, 100°C, and 110°C.
6. After cooking for 10 minutes, add sugar to the fruit mixture.
7. Continue cooking until the jam reaches the desired consistency.

2.3. Moisture Content Analysis of Jam Samples

Weigh the sample before testing, then place it in an oven at 105 °C for 4 hours. Weigh the sample again after testing.

2.4. Organoleptic Test of Samples

Organoleptic evaluation is conducted through sensory observation by tasting, smelling, chewing, and touching the sample. This test uses a 5-point scale, with the following categories: 1 = strongly dislike, 2 = dislike, 3 = somewhat like, 4 = like, and 5 = strongly like.[14]

3. RESULTS AND DISCUSSION

3.1. Moisture Content Analysis of Pineapple Jam, Banana Jam and Dragon Fruit Jam

The percentage of moisture content in jams is influenced by heating during jam processing, which causes the water contained in the material to evaporate. In the moisture content test, it was found that the higher the temperature during the jam cooking process, the lower the moisture content. Among the three types of fruit, it is clear that as the cooking temperature increases, the moisture content of the fruit tends to decrease. This occurs because heat is used to evaporate water from the ingredients. The difference in moisture content between treatments is due to the main ingredients of the jam, namely dragon fruit pulp and pineapple pulp, which have different moisture contents. The moisture content of the jam tends to decrease as the amount of pineapple pulp used increases. This is because the moisture content in pineapple flesh is lower than that in dragon fruit flesh.[15]

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Table 1. Moisture Content of pineapple jam, banana jam, and dragon fruit jam

Temperature (℃)	Moisture Content		
	Pineapple Jam	Banana Jam	Dragon Fruit Jam
90	80	60	94
100	70	55	90
110	60	50	86

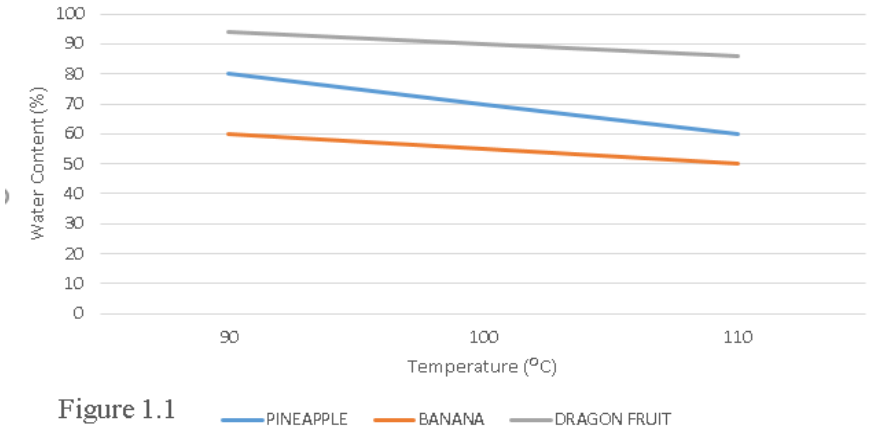

Figure 1.1

Figure 1.1 The Relationship Between Cooking Temperature and Water Content in Jam Making

In Figure 1.1, it can be seen that pineapples experience the most significant decrease in water content. At 90°C, the water content of pineapples was recorded at around 80%, and decreased to around 60% at 110°C. Meanwhile, bananas showed the lowest decrease in water content compared to pineapples and dragon fruit, from around 60% at 90°C to around 50% at 100°C. Dragon fruit had the highest water content at the initial temperature, approximately 94% at 90°C, which then decreased to approximately 86% at 110°C. Although the decrease in water content in dragon fruit was significant, the rate of decline was not as drastic as that of pineapple within the same temperature range.

3.2 Organoleptic testing of pineapple jam, banana jam, and dragon fruit jam.

3.2.1 The texture of pineapple jam, banana jam, and dragon fruit jam

The most noticeable physical change in fruit is shrinkage. One factor that causes shrinkage is excessively high temperatures during processing, which negatively impacts the product's sensory appeal. Therefore, it is essential to pay attention to the temperature when processing fruit.[16]

Table 2. The texture of pineapple jam, banana jam, and dragon fruit jam

Temperature (℃)	Texture		
	Pineapple Jam	Banana Jam	Dragon Fruit Jam
90	2	4	2
100	4	4	4
110	5	5	3

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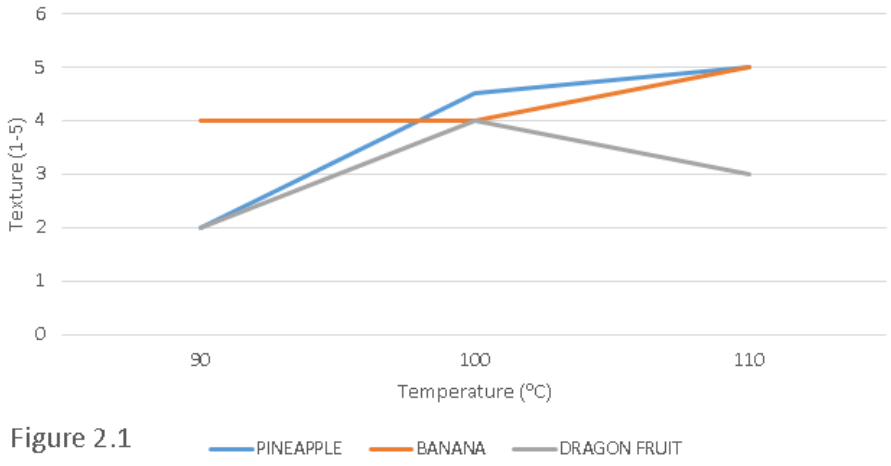

Figure 2.1

Figure 2.1 The Relationship between Temperature and Cooking Texture in Jam Making

Based on the organoleptic test results shown in Figure 2.2 on the texture of the jam, the heating temperature was found to have a significant effect on the panellists' level of preference. Pineapple jam showed an improvement in texture quality as the temperature increased. At 90°C, this jam only scored 2, indicating that its texture was less preferred. However, the score increased to 4 at 100°C and reached a maximum value of 5 at 110°C, indicating that pineapple jam texture is most preferred when cooked at high temperatures. Banana jam consistently showed good texture across the entire temperature range, starting from a score of 4 at 90°C to 5 at 110°C. This indicates that bananas can form a preferred texture even at lower heating temperatures, but remain optimal at high temperatures. Conversely, dragon fruit jam showed a different trend. The texture scores at 90°C and 110°C are relatively low, at 2 and 3, respectively, while at 100°C they increase to 4. This indicates that the medium temperature (100°C) is the best condition for producing the dragon fruit jam texture preferred by the panellists. This difference is likely due to the characteristics of each fruit, particularly their water content and fibre structure, which influence the final viscosity of the jam product.

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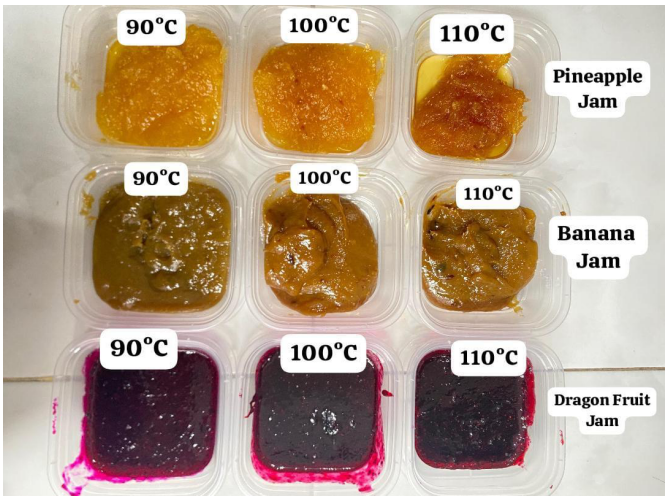

Figure 2.2 Water Content and Texture of Pineapple jam, Banana jam, and Dragon Fruit jam

3.2.2 The aroma of pineapple jam, banana jam, and dragon fruit jam

Depending on the type of ingredients used, the temperature setting during the cooking process must be carefully monitored. This is important because temperature has a significant effect on product quality, including aroma, texture, and taste, and plays a role in overcoming uneven heating of the medium.[17]

Table 3. *The aroma of pineapple jam, banana jam, and dragon fruit jam*

Temperature (℃)	The Aroma		
	Pineapple jam	banana jam	dragon fruit jam
90	4	2	2
100	4	3	2
110	5	4	5

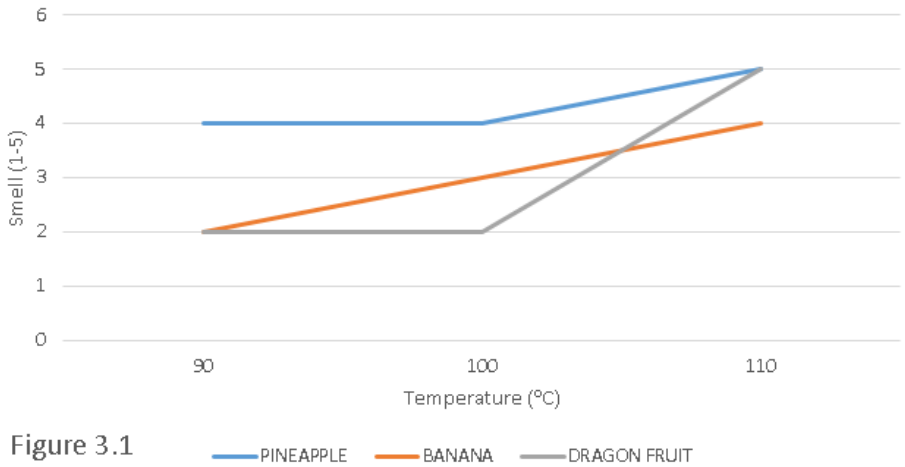

Figure 3.1 The Relationship Between Cooking Temperature and Aroma in Jam Making

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Based on the results of organoleptic testing of aroma, the three types of jam showed different responses to variations in heating temperature. Pineapple jam showed a relatively strong and consistent aroma from 90°C with a score of 4, increasing to 5 at 110°C. This indicates that the characteristic smell of pineapple becomes more pronounced and preferred at higher temperatures, possibly due to heating reactions that trigger the release of volatile compounds that contribute to the aroma. In contrast, the aroma of banana jam at 90°C was rated low by the panellists with a score of 2, but gradually increased to 3 at 100°C and 4 at 110°C.

This indicates that banana aroma requires higher temperatures to develop optimally. Dragon fruit jam showed a different trend; at 90°C and 100°C, the aroma was rated very low with a score of only 2. However, at 110°C, there was a significant increase, with a score reaching 5. This indicates that high temperatures are needed to maximise the characteristic aroma of dragon fruit. Overall, 110°C is the optimal temperature for enhancing aroma quality in all three types of jam, although sensitivity to temperature varies among fruit types.

3.2.3 Pineapple jam, banana jam, and dragon fruit jam flavours

In the context of food products such as jam, achieving a delicious taste is one of the most critical aspects in assessing quality. One factor that influences the formation of taste is the heating temperature during the manufacturing process, as temperature can affect chemical reactions that occur, such as caramelisation and the formation of volatile compounds that contribute to the final taste of the product.[18]

Table 4. Pineapple jam, banana jam, and dragon fruit jam flavours

Temperature (℃)	Flavours		
	Pineapple jam	Banana jam	Dragon fruit jam
90	3	2	3
100	5	3	2
110	5	5	2

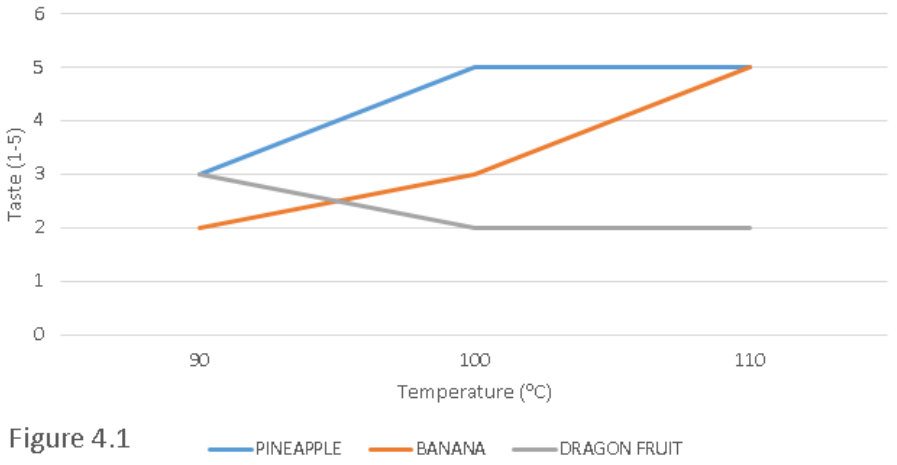

Figure 4.1

Figure 3.1 The Relationship Between Cooking Temperature and Taste in Jam Making

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Based on the results of organoleptic testing of taste, pineapple jam showed a significant increase as the heating temperature rose. At 90°C, the taste of pineapple jam was rated as moderate with a score of 3, but increased dramatically to the highest score of 5 at 100°C and remained consistent at 110°C. This indicates that heating at high temperatures can maximise the formation of the sweet and distinctive flavour of pineapple. Banana jam showed a more gradual increase; at 90°C, it scored 2, increased to 3 at 100°C, and reached the highest score of 5 at 110°C. This indicates that the optimal flavour of banana jam is only formed at higher temperatures. Conversely, dragon fruit jam showed contrasting results. The flavour score at 90°C was 3, then decreased to 2 at 100°C and remained low at 110°C. This is likely due to the neutral flavour characteristics of dragon fruit, which do not experience an increase in flavour even when the temperature is raised. Overall, heating temperature significantly affects jam flavour formation, particularly in pineapple and banana, while its effect on dragon fruit is minimal.

4. CONCLUSION

Based on the research results, heating temperature has a significant effect on moisture content and organoleptic quality (texture, aroma, and taste) in the production of pineapple jam, banana jam, and dragon fruit jam. An increase in heating temperature is inversely proportional to the moisture content in the jam, meaning that moisture content decreases as temperature increases, contributing to improved shelf life and product quality. At 110°C, all three types of jam exhibit good overall organoleptic quality. Pineapple jam and banana jam achieve the best texture, aroma, and taste at this temperature. Meanwhile, dragon fruit jam has the most optimal texture at 100°C, with better aroma and taste at 110°C. Therefore, the optimal heating temperature is crucial in producing jam with good physical and sensory quality, and 110°C is recommended as the best condition for the jam-making process of the three types of fruit.

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