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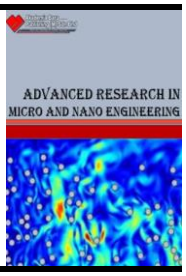

Physicochemical Properties and Sensory Evaluation of Yogurt Formulated with Pineapple and Roselle Fibres

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ABSTRACT

Functional food promotes specific health benefits and lowers the risk of acquiring health problems. Probiotics, prebiotics, and omega-3 fatty acids were added to functional food to enhance the nutritional value of the food itself. Yogurt is one of the examples of widely produced probiotic products. Concerns arise due to reduced fibre in refined food, leading to an increased risk of colon cancer and gastrointestinal diseases. Fruit-based yogurts with artificial additives were developed to cater to consumer preferences but were found to give negative health effects. To address this, yogurt with natural fibre sources like roselle and pineapple fibres was formulated, providing health-promoting components, flavor, and color without resorting to artificial additives. Current work focused on physicochemical properties and sensory evaluation of yogurt formulated with roselle and pineapple fibres. The concentration of roselle and pineapple fibres added were varied and their effect on the physicochemical properties of yogurt namely pH, viscosity, antioxidant activity, and syneresis were investigated. The evaluation was conducted at four different storage periods, which were on the 7th, 14th, 21st, and 28th days of yogurt storage. A sensory evaluation was also tested. The pH of formulated yogurt decreased as the concentration of roselle, and pineapple fibre increased. The highest viscosity was recorded for yogurt formulated with 8% pineapple fibre. Yogurt enriched with 8% roselle fibre demonstrated a superior antioxidant content. For sensory evaluation, yogurt with 4% pineapple fibre received the highest score regarding overall acceptability. The incorporation of roselle and pineapple fibre into yogurts formulation can be an alternative method in adding dietary fibres to the dairy products.

1. Introduction

The awareness of adopting healthy diets and promoting illness prevention has grown significantly in recent times, thus expanding the functional food market nowadays. Functional food is defined as food that not only provides nutritional content, but also had a favorable impact on individual's health,

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state of mind, and physical performance [1]. This kind of food is fortified with probiotics, prebiotics, or omega-3 fatty acids [2].

Lately, commercial probiotics have become available as nutrition supplements and in a variety of food products. Probiotics can be defined as live microbial food supplements that beneficially affect the host by improving its intestinal microbial balance. Most of the human consumption of probiotics is derived from dairy-based food that contains lactobacilli and bifidobacterial. In most countries, probiotic foods are almost exclusively dairy products, such as yogurt and acidified milk [3].

Yogurt is considered as a probiotic carrier food that can deliver significant amounts of probiotic bacteria into the body which can claim specific health benefits once ingested [4]. According to literature, it can be suggested that the health benefits associated with yogurt consumption have been well known for centuries. Yogurt's probiotics have been proven to boost immune systems, potentially reducing the risk of cancer, gastrointestinal diseases, and allergies. It also promoted bone health, exhibited anticarcinogenic activity, reduced the risk of type 2 diabetes, and could help alleviate symptoms of irritable bowel syndrome.

Numerous micronutrients can be found in yogurt such as zinc, magnesium, calcium, potassium, and vitamins. Compared to other dairy products, these micronutrients levels in yogurt were much higher [5]. Furthermore, the addition of artificial additives (coloring and flavoring) was developed to cater to consumer preferences. Ahmed *et al.,* [6] have reported in their study that the addition of fruits and flavors to yogurt have enhanced the yogurt's sensory attributes, marketability, and acceptance in addition to its nutritional profile. However, this refined food is lack of fibre content which may increase the risk of gastrointestinal diseases. The addition of artificial additives in yogurt also has been associated with adverse health effects. Based on literature search, many artificial additives used in dairy and other food products are carcinogens, posing health risks to consumers [7]. Therefore, there is a renewed interest in incorporating fruit fibre into yogurt in enhancing health, taste, flavor, and boosting industry profits.

Fruits are rich in antioxidants, phenolic compounds, dietary fibre, and carotenoids [8]. The fibre-rich contained in fruits will benefit the digestive system and helps in lowering cancer risk, cardiovascular disease, and gastrointestinal illness. The addition of fruit fibre into yogurt formulation will enhance the nutritional value of the yogurt itself. In previous, various type of fruit have been added into yogurt and affecting its physicochemical properties [9-12]. The success in their studies has prompted us to investigate more on the effect of adding pineapple and roselle fibres on physicochemical properties and sensory evaluation of yogurt.

2. Experimental Works

2.1 Materials

Dutch Lady fresh milk, CSR brown sugar, SangChuan Lactobacillus Yogurt Starter (10 Probiotics), roselle, and pineapple were obtained from local market and directly used without further purification. Methanol (CH_3OH) and 2,2 Diphenyl-1-picrylhydrazyl (free radical) were purchased from Evergreen Engineering Resources.

2.2 Preparation of Fruit Fibre

The pineapple flesh was dried in a conventional oven at 65 ºC for 48 h. Dried pineapple flesh then was ground using a grinder processor (ZM 200, Retsch, Germany) at 6000 rpm. After that, the obtained fibre was strained through a fine mesh strainer to remove larger pieces. The fibre was later

stored in an airtight container and refrigerated at 4 ºC until further use. The steps were repeated for roselle calyces. The roselle calyces were cleaned, boiled, cut into pieces, and dried.

2.3 Yogurt Preparation and Formulation

An 800 mL of full cream milk was infused with 2 g of starter culture made up of *L. bulgaricus* and *S. thermophilus*. The mixture then was incubated at 43 ºC for 8 h before being divided into seven portions and cooled at 4-6 ºC. Six of them were fortified with Moselle and pineapple fibre at different concentrations; 2, 4 and 8% (w/w), while another one portion was left as control. Brown sugar was added to lessen the sourness and enhance the overall flavor. The formulation of roselle and pineapple- flavored yogurt samples are listed in Table 1. All the yogurt samples were duplicated.

Table 1
Yogurt formulation

Ingredient	A	B	C	D
Roselle/pineapple fibre powder (g)	-	2	4	8
Brown sugar (g)	10	10	10	10
Yogurt (g)	100	100	100	100

2.4 pH Measurement

The pH of yogurt sample was taken at 30 ºC using a pH meter (pH700, Eutech Instrument, USA). A buffer solution at pH 7 and pH 4 were used to calibrate the pH meter.

2.5 Viscosity Measurement

Yogurt viscosity was measured using a viscometer (DV2T, Brookfield Engineering Laboratories, Inc., Middleboro, MA, USA). The analysis was conducted at 4 ºC using spindle No.63 with rotational speed of 50 rpm. Viscosity results were recorded in centipoises (cP) after 50 s of shearing.

2.6 Syneresis Measurement

40 mL of each yogurt samples were tilted at 45º immediately after refrigeration, and surface whey was collected using a graduated needle syringe (in 10 s). The amount of syneresis in mL was calculated using Eq. (1). The syneresis was measured during the 7th, 14th, 21st and 28th days.

$$Syneresis(\%) = \frac{Whey\ volume}{Yogurt\ volume} \times 100 \quad (1)$$

2.7 Antioxidant Activities

Antioxidant activities of yogurt samples were assessed using DPPH method with slight modifications. 0.5 mL of yogurt was mixed with methanol in 10 mL of volumetric flask. Then, 4 mL of the solution was transferred into a dark vial. A standard solution of DPPH at 50 ppm concentration was prepared separately. After that, 2 mL of DPPH standard solution was added into the 4 mL of yogurt sample in dark vial, sealed tightly, and incubated at room temperature for 30 minutes. Later, the absorbance of antioxidant in the yogurt samples were measured using spectrophotometer (U3900, Hitachi, Japan) at 517 nm and the antioxidant activities were calculated using Eq. (2).

$$Scavenging\ activity(\%) = \frac{Abs\ control - Abs\ sample}{Abs\ control} \times 100 \quad (2)$$

2.8 Sensory Evaluation

A set of questionnaires assessing quality, acceptability, and purchase intent was prepared. 10 respondents were selected to answer the questionnaire with each of them were given 50 mL of every yogurt sample to be evaluated.

3. Results and Discussions

3.1 pH Value

Figure 1 illustrates the effect of adding fruit fibre on pH value. A higher pH value is recorded for plain yogurt samples at four selected storage periods and becomes more acidic after adding pineapple and roselle fibres into the formulation. The addition of fruit fibre contributes to an additional source of carbohydrates that enhances the activity of lactic acid bacteria, thus leading to pH drop [12]. Pineapple and roselle also were known for their abundances of organic acid compounds, which might be the addition factor in lowering pH value. Based on the Figure 1, addition of roselle fibre into yogurt sample gave a lower pH value compared to pineapple fibre added sample. This might happen since roselle has a tart, tangy and slightly acidic taste compared to pineapple. The pH value decreases as the concentration of both fruit fibre increases. These findings are consistent with previous studies on fibre concentration and yogurt pH [12]. According to Cho *et al.,* [13], the normal pH value for yogurt is between 3.27 and 4.59 for the texture and flavor of good quality yogurt. In the current study, the 28 days of yogurt storage have resulted the pH values within the range, indicating that the yogurt possessed the same quality as commercialized one.

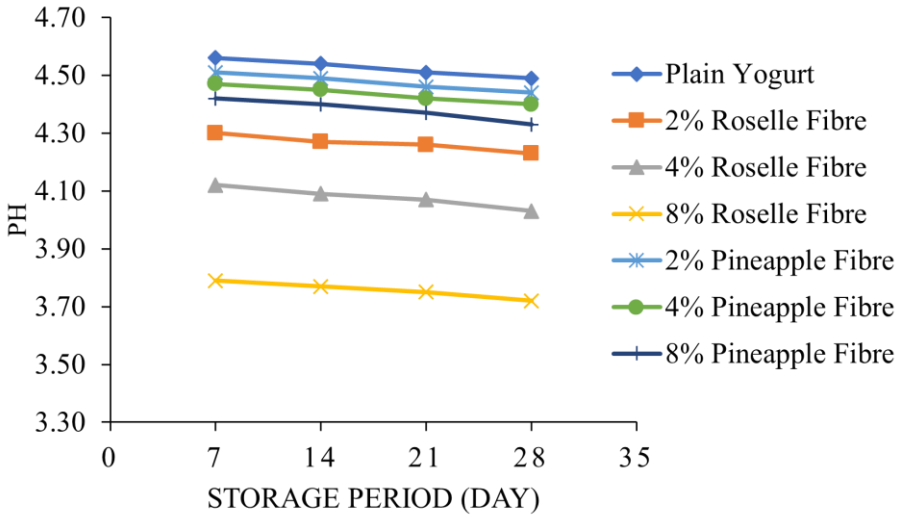

Fig. 1. Effect of different fruit fibre concentration on pH value at selected storage period

3.2 Viscosity

Yogurt drink was an example of non-Newtonian fluids characteristic of pseudoplastic materials. The shear-thinning fluid's viscosity was time-dependent. Figure 2 shows the yogurt viscosity at various concentrations of fruit fibre. In general, the viscosity decreased as longer storage period for

all tested samples. However, viscosity of yogurt increases in correlation with fibre concentration. The addition of pineapple and roselle fibres had a significant impact on the perceived viscosity of yogurt samples. Interaction between fibre and water molecules likely caused structural changes in yogurt, reinforcing the gel structure, and enhancing rheological properties. The increased viscosity can also be attributed to the rise in total solid content [12]. Viscosity of pineapple fibre added yogurt is found to be higher than roselle fibre added sample even though the fibre content of roselle is higher. This happened because the pineapple fibre is water soluble and forms a gel-like substance that traps water molecule, thus more viscous formulation is produced. Meanwhile, roselle fibre absorbs water which makes it swell and becomes bulky, thus producing a less viscous formulation [14].

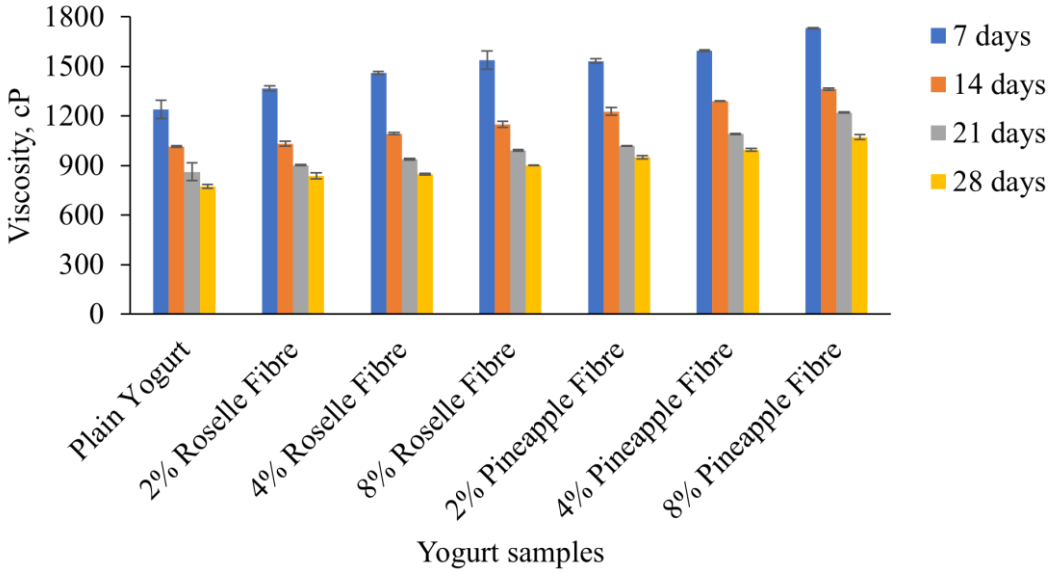

Fig. 2. Effect of fruit fibre concentration on yogurt viscosity at selected storage period

3.3 Syneresis

Spontaneous syneresis is a major visible defect that could adversely affect the acceptability of the product [15]. Syneresis was measured by an accumulation of whey on the surface of yogurt gels. The incorporation of fruit fibre into yogurt sample demonstrated a significant reduction in syneresis. Based on Figure 3, yogurt sample containing 8% of pineapple fibre exhibited the lowest syneresis rate which at 6.13 ± 0.88% while the plain yogurt produced the highest rate which at 16.38 ± 0.53%. Syneresis value decreases as fruit fibre concentration increased due to the water holding capacity of the fibres, which absorbed the whey release by the gel structure. Similar findings were reported by Cho *et al.,* [13] and Safdari *et al.,* [12].

The fibre's ability to bind water molecules and interfere with milk components, particularly proteins, contributed to the protein network stability that limiting the water movement thus reducing syneresis [16].

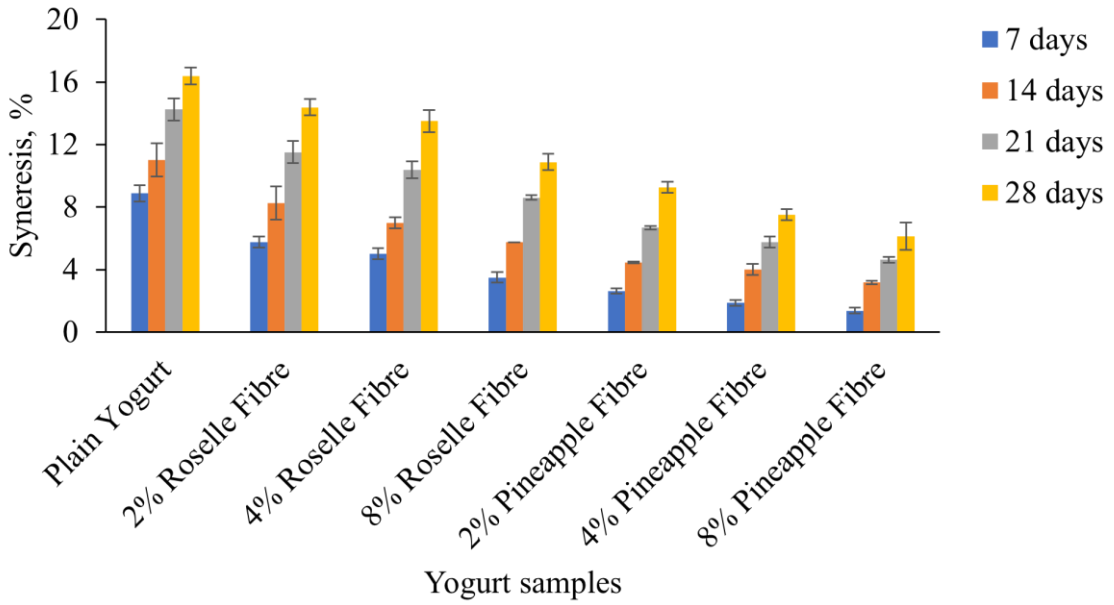

Fig. 3. Effect of fruit fibre concentration on syneresis value at selected storage period

3.4 Antioxidant Activity

Antioxidant activity is tested to determine the ability of antioxidant compounds in fruit-fortified yogurt to counteract free radical compounds. A DPPH method was used to evaluate the antioxidant activity of yogurt samples on day zero. The results obtained were shown in Figure 4. Fruit enriched yogurt shows higher antioxidant potential compared to plain yogurt. Increasing fruit fibre concentration has increased the antioxidant activity for both selected fruits. However, roselle-enriched yogurt exhibited better antioxidant content due to its high phenolic content, flavonoids, and antioxidant activity. The addition of fruit fibre into the yogurt formulation increased the radical scavenging ability, with the highest inhibition observed in the sample containing 8% roselle fibre. These findings suggest that fruit-fortified yogurt can effectively counteract free radicals and prevent oxidative damage [2].

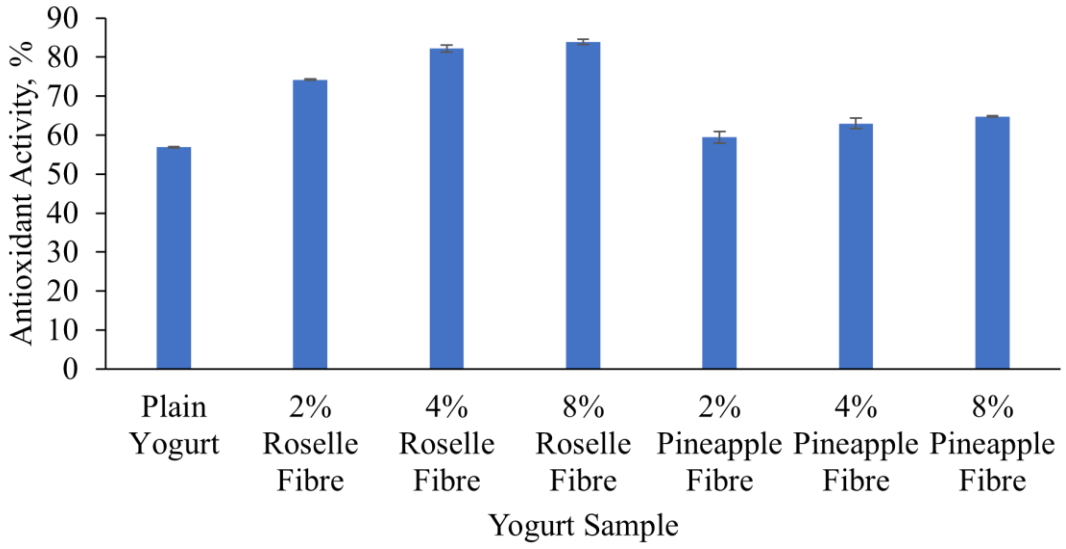

Fig. 4. Effect of fruit fibre concentration on antioxidant activities of yogurt samples

3.5 Sensory Evaluation

The evaluation of yogurt samples was evaluated based on sensory qualities, encompassing color, appearances, texture, odor, flavor, taste, and overall acceptability. Ten respondents were selected to answer the survey and the results found that roselle fibre yogurt exhibited significantly higher scores for color and appearance than the control sample due to its light pink color. Among all the tested samples, yogurt fortified with 4% pineapple fibre received the highest scores for the appearance, texture, overall acceptability, and purchase intent. Meanwhile for yogurt fortified with 8% of roselle fibre received the lowest scores for sensory characteristic such as odor, taste, overall acceptability, and purchase intent. In terms of flavor, yogurt with 4% of pineapple fibres received the highest score (4.82 ± 0.40) compared to plain yogurt which at 4.64 ± 0.50. Overall, it can be concluded that respondents accepted the yogurt fortified with 4% pineapple fibre, indicating its favorable sensory attributes.

4. Conclusion

Fruit-fortified yogurts using various concentrations of roselle fibre and pineapple fibre were successfully formulated and their effect on physicochemical properties together with sensory evaluation were determined. Enriching the yogurt with fibre improved viscosity and antioxidant properties while decreasing pH and syneresis value. Yogurt fortified with 4% of pineapple fibre exhibited superior physicochemical properties, while the 8% roselle fibre yogurt produced high antioxidant activity. Sensory testing favored the fortified yogurt with 4% of pineapple fibre due to positive scores in terms of taste, aroma, and texture. The use of fruit fibre in yogurt fortification shows a great promise in creating healthier dairy products.

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