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Research Article

# Optimizing Quality of Pineapple (*Ananas comosus* L.) Jam Influenced by Different Sweeteners and Pulp Proportions

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## Abstract

This study was conducted to investigate the effect of different sweeteners and varying pulp proportions on the quality attributes of pineapple jam. It was carried out factorial arrangement in 2×4 randomized complete block design with three replications. The two types of sweeteners (sugar and jaggery) were used, and the treatments were varying pulp proportions with 1 proportion of sweetener included by (0.5:1), (1:1) and (1.5:1), respectively. The treatment without sweetener was used as a control (only pulp). There were significant differences in the quality attributes of moisture content (%), total soluble solids (°Brix), pH, ascorbic acid (mg/100g) and crude fiber (%) while there was no significant difference in yeast and mold count with the regardless of pulp proportions and sweetener till 3 months. However, there was a significant difference on the total titratable acidity of pineapple jam influenced by pulp proportions. There was no interaction effect on the crude fiber. The higher pulp proportion influenced on the yellowness of jam with the regardless of sweeteners till 3 months. The total titratable acidity and total soluble solids of pineapple jam in all treatments were gradually increased; however, there was a decreasing trend in moisture content, pH, and the ascorbic acid were gradually decreased during the storage days. The sugar-treated jam with a higher pulp proportion (1.5:1) had a lower moisture content with a higher ascorbic acid content and total titratable acidity, while the one with jaggery (1.5:1) had a higher moisture content and fiber content. In food safety aspects, all treatments have the acceptable range of yeast and mold count (1.0 × 104 cfu/g) except control (no sweetener) stored at room temperature till 3 months. Among the treatments, the highest pulp proportion with sugar-treated pineapple jam (1.5:1) was the most appropriate proportion because it retained the highest ascorbic acid, natural fruit color, and flavor with minimal browning. In addition, the use of sugar also decreased the moisture content which inhibited the microbial growth.

**Keywords:** Pineapple Jam; Sweeteners; Pulp Proportions; Quality

## Introduction

The pineapple (*Ananas comosus* L.) belongs to the family Bromeliaceae, and its origin is South America. The world pineapple production was 28.96 million metric tons (MT) [1]. In Myanmar, the total production of pineapple was 262,259 metric tons (MT) with sown areas of 26,529 ha with the average yield of 10.32 MT/ha [2]. The major pineapple producing areas are Tanintharyi, Ayeyarwaddy, Yangon, Bago Regions and Kayin State and southern and northern Shan State [2]. Both quantitative and qualitative losses are occurred in fruit and vegetable crops due to improper practices during postharvest operations. Pineapple harvesting ensures uniform ripening with a one-time harvest that encountered the low price in peak season, and the quantitative loss can be estimated around 30 - 35 percent of the total production [3]. Therefore, it is necessary to develop processing technology and value-added products from pineapple. The various products from pineapple fruits are rolls, jelly, candy, core powder, canned, dried chips, concentrated juice, sauce, wine, and jam [4].

Jam is a fruit product made by cooking the fruit pulp with the sugar, pectin, and citric acid and it is also a fruit preserve with high sugar content [5]. Jam should contain at least 65% total soluble solids and 45% fruit pulp [6]. Sucrose (sugar) is added to jams for sweet taste and acts as a natural preservative by inhibiting microbial growth by binding the water in the jam [7], thereby making it unavailable for microbial activity, thus extending the shelf life.

Jaggery is a traditional, unrefined sweetener made from toddy palm juice and it is a form of sugar, and it retains natural minerals, vitamins, and fiber giving a caramel-like flavor and a dark brown color [8]. In making jam, a thickener is also used for viscosity, such as corn starch is cheap and very abundant for the development of a jam product. The citric acid is also used as a preservative to regulate pH and to extend the shelf life in making jam [9]. In the Asian region, jam is typically used as fillings and toppings for bread and cakes [10]. The postharvest losses of pineapple are still serious, and value-added products from pineapple are still limited with the use of natural preservatives to extend the storage life. In Myanmar, there is a few academic information on making pineapple jam influenced by sweetener and pulp proportions. Thus, the objectives of this experiment were to determine the influence of sweeteners and to assess the appropriate pulp proportion on the quality attribute of pineapple jam.

## Materials and Methods

### Experimental site and duration

The experiment was conducted at the laboratory of Food Science and Technology Department, Yezin Agricultural University, Nay Pyi Taw from June 2024 to October 2025. The experiment was carried out 2×4 factorial arrangement in a randomized complete block design with three replications. The first factor was two types of sweeteners (sugar and jaggery), while the second factor was pulp proportions. The treatments were varying pulp proportions with 1 proportion of sweetener included by (0.5:1), (1:1), and (1.5:1), respectively. The treatment without sweetener was used as a control (only pulp).

### Procurements of pineapple jam

The uniform mature pineapples (150 days after flowering) were collected from a private orchard in Hsihseng Township, southern Shan State and it took 24 hours to reach the experimental site. The fruits were washed with tap water to remove dust, and dirt; the crowns of the fruits were removed. They were peeled, the core was discarded, and the pulp were cut into small pieces. Then they were ground by a blender, and these pulps were mixed with sweeteners of sugar or jaggery according to the treatments.

The mixture of pulp and sweetener were heated at 90°C for 30 minutes and then the thickening agent of 5% corn starch and 1% citric acid were added for every treatment [11,12]. The heating process was done continuously until the water activity ($a_w$) reached 0.70 ± 0.05, and then it was cooled down for a while before bottling. A total of 96 plastic containers were subdivided into sugar and jaggery for each sweetener type and it included 12 samples in each treatment. The 150 g of pineapple jam was filled into sterile plastic containers (200 ml size), and then they were kept at room temperature (27-32°C) and 50-60% relative humidity.

### Data collection

The data on total soluble solid (°Brix), pH, total titratable acidity (TTA%), color, ascorbic acid (mg/100g), moisture, and crude fiber were collected at 0 day and monthly intervals till 3 months. The yeast and mold count (cfu/ml) were recorded at 0 day and 3 months after storage. The total soluble solid of pineapple jam was measured using a pocket digital refractometer (RUDOLPH J47 automatic, Tokyo, Japan). The pH of pineapple jam was measured using a laboratory pH meter (PHOENIX Instrument, EC-45). The total titratable acidity (TTA%) of pineapple jam was determined by the acid-base titration method [13]. The color of pineapple jam was measured by using a handheld digital Minolta (NR-20XE) to determine the yellowness (b*). The ascorbic acid (mg/100 g) content of pineapple jam was determined by the titration method [14] and the moisture content was measured by the hot air oven drying method [13]. Crude fiber of pineapple jam was measured by using a VELP SCIENTIFICA ANKOM 200 fiber analyzer [15] and the yeast and mold count (cfu/g) of the pineapple jam was analyzed by the serial dilution method [16].

### Data analysis

The collected data were statistically subjected to analysis of variance (ANOVA) using Statistix 8.0 version software, and treatment means were compared using the least significant difference (LSD) test at the 5% level of significance ($P \leq 0.05$).

## Results and Discussion

### Moisture

The effect of different sweeteners and pulp proportions on the moisture content of pineapple jam is shown in Table 1. The shelf life of any food commodity is dependent on its moisture content [17]. A highly significant effect by different sweeteners and different pulp proportions on the moisture content of pineapple jam was observed in this study. The moisture content of jaggery-sweetened jam was significantly higher than that of sugar-sweetened jam. Among the treatments, the highest moisture content (22.24%) was found in the pulp proportion of 1.5:1, followed by the pulp proportions of 1:1 (17.22%) and 0.5:1 (13.36%) at 3 months after storage. The higher moisture content was observed in higher pulp proportion.

| Treatment | Moisture Content (%) | | | |
|---|---|---|---|---|
| | 0 Day | Month | | |
| | | 1 | 2 | 3 |
| Sweeteners | | | | |
| Sugar | 18.66 b | 17.55 b | 17.31 b | 17.02 b |
| Jaggery | 19.11 a | 18.22 a | 18.19 a | 18.15 a |
| $LSD_{0.05}$ | 0.01 | 9.90 | 0.03 | 0.06 |
| Pulp proportions | | | | |
| Control (no sweeteners) | 20.69 b | - | - | - |
| 0.5:1 | 14.29 d | 13.91 c | 13.67 c | 13.36 c |
| 1:1 | 17.41 c | 16.95 b | 16.87 b | 17.22 b |
| 1.5:1 | 23.15 a | 22.81 a | 22.66 a | 22.24 a |
| $LSD_{0.05}$ | 0.01 | 0.01 | 0.03 | 0.08 |
| Pr > F | | | | |
| Sweeteners | ** | ** | ** | ** |
| Pulp proportions | ** | ** | ** | ** |
| Sweeteners × Pulp proportions | ** | ** | ** | ** |
| CV% | 0.06 | 0.05 | 0.14 | 0.33 |

**Table 1:** Effect of different sweeteners and pulp proportions on moisture content (%) of pineapple jam during 3 months.

In a column, means followed by the same letters are not significantly different at P ≤0.05 by LSD test.
** = significant at 1% level, 0 day = 10 hrs after treatment

The moisture content of all treatments was observed within the range of 13.36% to 23.15% during storage; it was lower than the findings of [11], who reported that the moisture content of pineapple jam was within the range of 29.23% to 32.98%. There was a decreasing trend in moisture content along the storage period. A similar trend in moisture content was also noted by [18], who reported that the moisture content of pineapple jam gradually decreased during 3 months. There was an interaction effect on moisture content between different sweeteners and pulp proportions.

### Total Soluble Solid

The effect of different sweeteners and pulp proportions on the total soluble solid (°Brix) of pineapple jam is shown in Table 2. Different sweeteners and pulp proportions were significantly affected on the total soluble solids of pineapple jam during the storage days. The total soluble solid of sugar-treated jam was 79.82°Brix and it was significantly higher than jaggery-treated jam of 74.17°Brix. Among the pulp proportions, the highest total soluble solid (80.90°Brix) of pineapple jam was observed in the lower pulp proportion (0.5:1) while the lowest total soluble solid (71.95°Brix) was observed in the higher pulp proportion (1.5:1) at 3 months after storage.

| Treatment | Total Soluble Solid (°Brix) | | | |
|---|---|---|---|---|
| | 0 Day | Month | | |
| | | 1 | 2 | 3 |
| Sweeteners | | | | |
| Sugar | 67.17 a | 79.42 a | 79.56 a | 79.82 a |
| Jaggery | 62.85 b | 73.83 b | 73.99 b | 74.17 b |
| $LSD_{0.05}$ | 0.23 | 0.12 | 0.04 | 0.43 |
| Pulp proportions | | | | |
| Control (no sweeteners) | 31.07 d | - | - | - |
| 0.5:1 | 80.18 a | 80.48 a | 80.62 a | 80.90 a |
| 1:1 | 77.35 b | 77.75 b | 77.90 b | 78.13 b |
| 1.5:1 | 71.43 c | 71.65 c | 71.80 c | 71.95 c |
| $LSD_{0.05}$ | 0.33 | 0.15 | 0.05 | 0.52 |
| Pr > F | | | | |
| Sweeteners | ** | ** | ** | ** |
| Pulp proportions | ** | ** | ** | ** |
| Sweeteners × Pulp proportions | ** | ** | ** | ** |
| CV% | 0.41 | 0.15 | 0.05 | 0.53 |

**Table 2:** Effect of different sweeteners and pulp proportions on total soluble solid (°Brix) of pineapple jam during 3 months.

In a column, means followed by the same letters are not significantly different at P ≤0.05 by LSD test.

** = significant at 1% level, 0 day = 10 hrs after treatment

The total soluble solids of only pulp (control) were 31.07 while the highest 80.90°Brix was observed in the proportion of 0.5:1 (pul : sugar) among the sweetener treated jam during storage. It was similar with the finding of Chalchisa, Zegeye, Dereje and Tolesa (2022) [11] who observed that the TSS value of pineapple jam was within the range of 63.5-71.65°Brix. The total soluble solid of pineapple jam was gradually increased during the storage period. This finding was in line with [12], who reported that the total soluble solid increased from 67.7 °Brix to 68.9 °Brix during storage. Ullah, Ullah, Khan, Ullah and Badshah (2018) [5] assumed that the increase in total soluble solids might be the formation of the monosaccharides through the hydrolysis of complex sugars. Moreover, an increase in TSS of banana-pineapple blended jam during storage stability evaluation was reported by [19]. The significant interaction effect of different sweeteners and pulp proportions on the total soluble solid of pineapple jam was observed.

### Ascorbic Acid

The effect of different sweeteners and pulp proportions on ascorbic acid content (mg/100 g) of pineapple jam is presented in Table 3. There was a significant effect of sweeteners and different pulp proportions on the ascorbic acid content of pineapple jam.

The results showed that ascorbic acid content slightly decreased during 3 months. The ascorbic acid content of sugar-treated jam (4.50 mg/100 g) was significantly higher than jaggery-treated jam (4.39 mg/100 g). Among the pulp proportions, the highest pulp proportion (1.5:1) maintained the highest ascorbic acid content (5.38 mg/100 g), followed by the pulp proportions of 1:1 (4.47 mg/100 g) and 0.5:1 (3.50 mg/100 g) at 3 months after storage. The highest ascorbic acid content (6.46 mg/100 g) of pineapple jam was found in the only pulp (control) sample with no sweeteners at 0-day. The ascorbic acid content of pineapple jam was observed in the range of 3.50 - 6.46 mg/100 g. However, [11] reported that the higher level of ascorbic acid in the pineapple jam was within the range of 7.74 - 9.9 mg/100g. The lower the pulp proportion, the lower the ascorbic acid content of pineapple jam was observed in this study. It might be due to the lesser amount of pulp proportion with addition of sweetener which caused longer heating time that resulted in lesser ascorbic acid content. The reduction of ascorbic acid during storage may be caused by the oxidation of ascorbic acid to dehydroascorbic acid in the presence of light, oxygen, and enzyme activity. There was an interaction effect on ascorbic acid (mg/100 g) affected by different sweeteners and pulp proportions.

| **Treatment** | **Ascorbic Acid (mg/100g)** | | | |
|---|---|---|---|---|
| | **0 Day** | **Month** | | |
| | | **1** | **2** | **3** |
| Sweeteners | | | | |
| Sugar | 5.24 a | 4.69 a | 4.60 a | 4.50 a |
| Jaggery | 5.15 b | 4.64 b | 4.49 b | 4.39 b |
| $LSD_{0.05}$ | 5.53 | 0.03 | 0.03 | 0.01 |
| Pulp proportions | | | | |
| Control (no sweeteners) | 6.46 a | - | - | - |
| 0.5:1 | 3.84 d | 3.73 c | 3.62 c | 3.50 c |
| 1:1 | 4.82 c | 4.69 b | 4.56 b | 4.47 b |
| 1.5:1 | 5.67 b | 5.57 a | 5.46 a | 5.38 a |
| $LSD_{0.05}$ | 7.82 | 0.03 | 0.03 | 0.02 |
| Pr > F | | | | |
| Sweeteners | ** | ** | ** | ** |
| Pulp proportions | ** | ** | ** | ** |
| Sweeteners × Pulp proportions | ** | ** | ** | ** |
| CV% | 0.12 | 0.52 | 0.56 | 0.31 |

**Table 3:** Effect of different sweeteners and pulp proportions on ascorbic acid (mg/100 g) of pineapple jam during 3 months.

In a column, means followed by the same letters are not significantly different at P ≤0.05 by LSD test.

** = significant at 1% level, 0 day = 10 hrs after treatment

## Total titratable acidity

The effect of different sweeteners and pulp proportions on the total titratable acidity (%) of pineapple jam is shown in Table 4. The sweeteners effect was not a significant difference in the total soluble solid of pineapple jam along the storage day. However, there was significantly difference on total titratable acidity of pineapple jam affected by pulp proportion during the storage. The total titratable acidity of pineapple jam gradually increased during the storage period. Kanwal, Randhawa and Iqbal (2017) [20] reported that the increase in acidity may be due to oxidation of reducing sugars and acid formation along the storage.

Among the pulp proportions, the highest total titratable acidity (2.28%) was observed in the higher pulp proportion of (1.5:1), and the lowest total titratable acidity (1.72%) was observed in the lower pulp proportion (0.5:1) of pineapple jam at 3 months after storage. The jam incorporated with a higher pulp proportion imparted by higher total titratable acidity was observed in this study. Rana, Yeasmin, Khan and Riad (2021) [12] found that the increase in acidity may be due to the degradation of ascorbic acid and the formation of acids by the breakdown of polysaccharides like pectin; and the oxidation of reducing sugars. There was an interaction effect on the total titratable acidity of jam affected by different sweeteners and pulp proportions.

| Treatment | Total Titratable Acidity (%) | | | |
|---|---|---|---|---|
| | 0 Day | Month | | |
| | | 1 | 2 | 3 |
| Sweeteners | | | | |
| Sugar | 1.21 | 1.56 | 1.75 | 2.07 |
| Jaggery | 1.22 | 1.60 | 1.79 | 2.09 |
| $LSD_{0.05}$ | 0.09 | 0.05 | 0.13 | 0.21 |
| Pulp proportions | | | | |
| Control (no sweeteners) | 1.02 c | - | - | - |
| 0.5:1 | 1.06 c | 1.29 c | 1.50 c | 1.72 b |
| 1:1 | 1.29 b | 1.61 b | 1.82 b | 2.25 a |
| 1.5:1 | 1.48 a | 1.82 a | 1.99 a | 2.28 a |
| $LSD_{0.05}$ | 0.13 | 0.06 | 0.16 | 0.25 |
| Pr > F | | | | |
| Sweeteners | ns | ns | ns | ns |
| Pulp proportions | ** | ** | ** | ** |
| Sweeteners × Pulp proportions | * | ** | * | ns |
| CV% | 8.96 | 2.91 | 7.22 | 9.48 |

**Table 4:** Effect of different sweeteners and pulp proportions on total titratable acidity (%) of pineapple jam during 3 months.

In a column, means followed by the same letters are not significantly different at P ≤0.05 by LSD test.

* = significant at 5% level, ** = significant at 1% level, ns = non-significant, 0 day = 10 hrs after treatment

### pH

The effect of different sweeteners and pulp proportions on the pH value of pineapple jam is presented in Table 5. The pH of pineapple jam was significantly affected by different sweeteners and pulp proportion along the storage days. The pH of all treatments was within the range of 2.75 - 3.42 during storage. A similar finding was reported by [11], who reported that the pH of pineapple jam was recorded in the range of 2.92 to 3.32. It was similar with the Siddiqui, Azhar, Tarar, Masood and Mahmood (2015) [21] who stated that the pH value for jam was within 3 to 3.5. In comparison of sweeteners, the pH of sugar-treated jam (2.88) was significantly lower than jaggery- treated pineapple jam (2.77) at 3 months after storage. The highest pH (2.92) was found in the lowest pulp proportion of 0.5:1, followed by the pulp proportions of 1:1 and 1.5:1 at 3 months after storage. As the pulp proportion increased, the pH value of the jam slightly decreased which resulted increase in acidity of the jam. There was a decreasing trend in the pH of jam along the storage period. A similar trend in pH changes was also noted by [22], who reported that the pH of pineapple jam decreased during storage, which may be related to an increase in hydrogen ion concentration, which could result in an increase in acidity with time. There was an interaction effect on the pH of pineapple jam affected by different sweeteners and pulp proportions.

| Treatments | pH | | | |
|---|---|---|---|---|
| | 0 Day | Month | | |
| | | 1 | 2 | 3 |
| Sweeteners | | | | |
| Sugar | 3.41 a | 3.18 a | 3.04 a | 2.88 a |
| Jaggery | 3.27 b | 3.06 b | 2.92 b | 2.77 b |
| $LSD_{0.05}$ | 0.06 | 0.07 | 0.04 | 0.05 |
| Pulp proportions | | | | |
| Control (no sweeteners) | 3.23 c | - | - | - |
| 0.5:1 | 3.42 a | 3.20 a | 3.07 a | 2.92 a |
| 1:1 | 3.37 ab | 3.12 b | 2.98 b | 2.83 b |
| 1.5:1 | 3.33 b | 3.03 c | 2.90 c | 2.75 c |
| $LSD_{0.05}$ | 0.08 | 0.08 | 0.05 | 0.06 |
| Pr > F | | | | |
| Sweeteners | ** | ** | ** | ** |
| Pulp proportions | ** | ** | ** | ** |
| Sweeteners × Pulp proportions | * | * | ** | * |
| CV% | 1.92 | 2.03 | 1.37 | 1.70 |

**Table 5:** Effect of different sweeteners and pulp proportions on pH of pineapple jam during 3 months.

In a column, means followed by the same letters are not significantly different at P ≤0.05 by LSD test.

* = significant at 5% level, ** = significant at 1% level, ns = non-significant, 0 day = 10 hrs after treatment

### Yellowness (b*)

The yellowness values (b*) of pineapple jam affected by different sweeteners and pulp proportions are presented in Table 6. A significant effect of pulp proportions on yellowness (b*) of pineapple jam was found at 0-day and 3 months; however, there was no significant effect of pulp proportions on the (b*) value of pineapple jam at 1 month and 2 months after storage. The jam treated with sugar showed higher yellowness (b*) value than the jaggery-treated jam. The (b*) value of all treatments was recorded within the range of 7.53-27.06 and this finding is in line with [22], who reported that the (b*) value of pineapple jam treated with sugar and jaggery is in the range of 8.83 - 25.9. There was a decreasing trend in (b*) value along the storage period and the highest (b*- 14.25) was found in the highest pulp proportion (1.5:1) among the treatments. This finding is in line with [22], who reported that there was a slightly decreased (b*) value of mixed fruit jam during the storage. The color changes may be due to browning reactions such as the Maillard reaction, caramelization, and loss of ascorbic acid during storage. There was an interaction effect on the (b*) value affected by different sweeteners and pulp proportions at 0 and 3 months.

### Crude Fiber (%)

The effect of different sweeteners and pulp proportions on the crude fiber content of pineapple jam is shown in Table 7. There was a highly significant difference in crude fiber content of pineapple jam among different sweeteners and pulp proportions. The crude fiber content of jaggery-treated jam (0.50) was higher than sugar-

| Treatment | Yellowness (b*) | | | |
|---|---|---|---|---|
| | 0 Day | Month | | |
| | | 1 | 2 | 3 |
| Sweeteners | | | | |
| Sugar | 27.06 a | 25.26 a | 22.08 a | 17.56 a |
| Jaggery | 13.87 b | 8.23 b | 7.87 b | 7.53 b |
| $LSD_{0.05}$ | 1.88 | 3.46 | 3.27 | 0.93 |
| Pulp proportions | | | | |
| Control (no sweeteners) | 21.91 a | | | |
| 0.5:1 | 18.47 b | 15.62 | 14.31 | 11.92 b |
| 1:1 | 19.58 ab | 16.76 | 15.17 | 11.48 b |
| 1.5:1 | 21.92 a | 17.86 | 15.45 | 14.25 a |
| $LSD_{0.05}$ | 2.65 | 4.24 | 4.00 | 1.14 |
| Pr > F | | | | |
| Sweeteners | ** | ** | ** | ** |
| Pulp proportions | * | ns | ns | ** |
| Sweeteners × Pulp proportions | ** | ns | ns | * |
| CV% | 10.47 | 19.67 | 20.77 | 7.09 |

**Table 6:** Effect of different sugar sources and pulp proportions on yellowness (b*) of pineapple jam during 3 months.

In a column, means followed by the same letters are not significantly different at P ≤0.05 by LSD test.

* = significant at 5% level, ** = significant at 1% level, ns = non-significant, 0 day = 10 hrs after treatment

| Treatment | Crude Fiber (%) | | | |
|---|---|---|---|---|
| | 0 Day | Month | | |
| | | 1 | 2 | 3 |
| Sweeteners | | | | |
| Sugar | 1.25 b | 0.59 b | 0.49 b | 0.43 b |
| Jaggery | 1.29 a | 0.66 a | 0.57 a | 0.50 a |
| $LSD_{0.05}$ | 0.04 | 0.03 | 0.03 | 0.03 |
| Pulp proportions | | | | |
| Control (no sweeteners) | 2.89 a | - | - | - |
| 0.5:1 | 0.62 d | 0.52 c | 0.42 c | 0.33 c |
| 1:1 | 0.69 c | 0.58 b | 0.48 b | 0.43 b |
| 1.5:1 | 0.89 b | 0.79 a | 0.70 a | 0.63 a |
| $LSD_{0.05}$ | 0.05 | 0.03 | 0.03 | 0.03 |
| Pr > F | | | | |
| Sweeteners | ** | ** | ** | ** |
| Pulp proportions | ** | ** | ** | ** |
| Sweeteners × Pulp proportions | ns | ns | ns | ns |
| CV% | 3.16 | 4.68 | 4.68 | 5.62 |

**Table 7:** Effect of different sweeteners and pulp proportions on crude fiber (%) of pineapple jam during 3 months.

In a column, means followed by the same letters are not significantly different at P ≤0.05 by LSD test.

** = significant at 1% level, ns = non-significant, 0 day = 10 hrs after treatment treated jam (0.43) at 3 months after storage. Among the pulp proportions, the highest crude fiber content (0.63) was observed in the highest pulp proportion of jam (1.5:1), followed by (0.43) and (0.33) in the pulp proportions of (1:1) and (0.5:1), respectively. In this study, the crude fiber content of pineapple jam was observed within the range of 0.33 - 2.89%. According to [11], who found that the crude fiber content of pineapple jam was within the range of (0.4 - 1.02) %. The crude fiber content of pineapple jam gradually decreased along the storage period. There was no interaction effect on the fiber content of jam affected by different sweeteners and pulp proportions.

### Yeast and mold count

The yeast and mold count were analyzed to be the safety aspect of the product for human consumption. The effect of different sweeteners and pulp proportions on the yeast and mold count of pineapple jam is shown in Table 8. The yeast and mold count of pineapple jam was measured at 0-day and 3 months. In this study, there was no yeast and mold count of pineapple jam observed in all treatments at 0-day and at 3 months storage except in the control (no sweeteners; only pulp). The yeast and mold count of the control treatment was observed $1.07\times 10^4$ cfu/g at 3 months, which was over the acceptable level of $1 \times 10^4$ cfu/g [23]. Yadav, Hossain, Bharti, Das, Wasnik and Thakur (2019) [24] found that the jam of yeast and mold count was in the range of $5.67 - 6.33\times10^3$ cfu/g.

## Conclusion

The production of pineapple jam using different sweeteners (sugar and jaggery) and varying pulp proportions significantly affected the physicochemical, nutritional, and sensory characteristics. Pineapple jam treated with sugar showed significantly high total soluble solids (°Brix), pH, yellowness (b*), and ascorbic acid (mg/100g), and the jaggery-treated jam had higher water activity (aw), moisture content, and fiber content regardless of pulp proportion during the storage period of 3 months. Regardless of sweeteners, the higher pulp proportion showed the greater content in moisture content, water activity, total titratable acidity, ascorbic acid, and fiber content, while the lower pH value and total soluble (°Brix) were observed. Among the different pulp proportions, the highest proportion (1.5) is the most appropriate for both sugar and jaggery to maintain the quality attributes, mainly the crude fiber and vitamin C contents of jam. However, the pineapple jam treated by jaggery may impart distinct flavor and color profiles that might influence the lower microbial stability compared to the sugar-treated one. The interaction between sweetener and pulp proportion had a significant effect on the quality attributes of pineapple jam, such as water activity, moisture content, total soluble solids, pH, and ascorbic acid. According to the results, jaggery is recommended as a healthier alternative to sugar in pineapple jam due to the lower total soluble solid.

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