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Shelf Life Determination of Pineapple Juice Using Extended Storage Studies (ESS) Method

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ABSTRACT

Pineapple is one of perishable horticultural commodities that usually consumed in fresh form. Based on that, commercial food processing technology are required to extend shelf life of product. Shelf life product information is necessary before product launched in the market to ensure and guarantee the customers. The object of this research was to determine shelf life of pineapple juice that estimated by using ESS (Extended Storage Studies) method. Pineapple juice with preservative (0.05% sodium benzoate) and no preservative was processed, packaged and stored at chilling temperature (7°C) and room temperature (25°C). The juices were analyzed for the sensory attributes such as, taste, aroma, appearance, and viscosity. Sensory test was stopped when the panelist refused to do test for bubble, foam and mold growth on the surface, fermentation aroma appeared, and viscosity of pineapple juice increased. The shelf life were estimated to be 14 week for pineapple juice stored at 7°C with preservative (T_1B_1), 10 week for pineapple juice stored at 7°C without preservative (T_1B_2), 2 week for pineapple juice stored at 25°C with preservative (T_2B_1) and less than 2 week for pineapple juice stored at 25°C without preservative (T_2B_2). Therefore, chilling combined with use of preservatives are able to retard spoilage and slowed down deterioration of sensory attributes in pineapple juice.

Keywords: *pineapple juice, sensory test, shelf life determination, ESS method.*

INTRODUCTION

Pineapple (Ananas comosus (L.) Merr. Family: Bromeliaceae) is one of the most important commercial fruit crops in the world. It is known as the queen of fruits due to its excellent flavor and taste (Baruwa, 2013). Pineapples are consumed or served fresh, cooked, juiced and can be preserved. Pineapple composition has been investigated mainly in the edible portion. Mature fruit contains 14% of sugar, a protein digesting enzyme, bromelin, and good amount of citric acid, malic acid, vitamin A and B (Joy, 2010).

Pineapple contains 81.2 to 86.2% moisture, and 13-19% total solids, of which sucrose, glucose and fructose are the main components. Carbohydrates represent up to 85% of total solids whereas fiber makes up for 2-3%. The pulp has very low ash content, nitrogenous compounds and lipids (0.1%). From 25-30% of nitrogenous compounds are true proteins. Out of this proportion, Ca. 80% has proteolytic activity due to a protease known as Bromelin. Fresh pineapple contains minerals as Calcium, Chlorine, Potassium, Phosphorus and Sodium (Dull, 1971; Ameh, *et al*., 2015). Several essential minerals exist in pineapples, including manganese, a trace mineral instrumental to the formation of bone, as well as the creation and activation of certain enzymes. Pineapples also include copper, another trace mineral. It assists in the absorption of iron and regulates blood pressure and heart rate (Debnath, *et al*., 2012).

In South Kalimantan, pineapples produced all year round. This fruit are highly perishable. A great proportion of pineapples are wasting due to spoilage when pineapples are kept for a long

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time without processing. Therefore, exploring an affordable and easily adoptable food processing and preservation methods to convert the abundant fruits into shelf stable products like juices which are easy, cheap and economically reliable alternative for reducing post-harvest losses are necessary (Ameh, *et al*., 2015).

Fresh fruit juices are favorable to microbial and enzymatic action. The spoilage of fruit juices is basically reasoned to the presence of osmophillic microflora, which causes fermentation and leads to produce off-flavor happened in the fruit juices (Tournas, *et al*. 2006). Thermal treatment and uses of preservatives could be effective way to inactivate the microbial and enzymatic activity and extend the shelf life (Islam, *et al.* 2014). Shelf life of a food is the period of time under defined conditions of storage, after manufacture or packaging, during which a food product will remain safe and suitable for use (Man, 2002). Shelf life of pineapple juice can be determined by monitoring the sensory changes that occurred during storage whereby measurable deterioration parameters of pineapple juice may be chosen. This study aimed at determining the shelf life of pineapple juice using ESS method, and investigates its sensory attributes during storage period.

METHODS

Preparation of Pineapple Juice

Pineapple juice was produced in BBPP Binuang laboratory. Pineapple which were fully ripe (based on the yellowness, sweetness and softness) were selected, cleaned and peeled. Pineapple pulp was weighed and blend with water in the ratio of pulp : water was 1 : 3 (w/v). The mixture was strained and weighed again, then heated for 10 minutes at 65°C, followed by addition of 10% white sugar and 0.2% citric acid. The pineapple juice was divided into two portion and 0.05% sodium benzoate was added to one portion. The juice was packed into 100 ml bottles and sterilized in hot steam for 20 minutes.

Sample Storage

The pineapple juice stored at chilling temperature (7°C $\pm$1) define into two variables, with addition of 0.05% sodium benzoate (T_1B_1) and without preservatives (T_1B_2). Bottled samples for the same batch were stored at room temperature (25°C $\pm$1) contained 0.05% sodium benzoate (T_2B_1) and other bottles without preservative (T_2B_2)

Sensory Evaluation

Twelve panelist (5 males and 5 females) were recruited among BBPP Binuang staff to carry out the sensory evaluation. Panelist selection was based on health and able to describe sensory analysis. Panelist were trained before analysis sessions in order to build a common concept of sensory evaluation procedure. Data for sensory evaluation collected at 2 weeks intervals, 4 bottles were collected from each category (i.e T_1B_1, T_1B_2, T_2B_1, T_2B_2). The sensory attributes selected to evaluate sensory changes were taste, aroma, appearance and viscosity. The meaning of the terms were as follows: (1) taste – associated with fresh pineapple juice, deterioration was indicated by sour-bitter taste; (2) aroma – associated with fresh pineapple juice, deterioration was indicated by bad odor; (3) appearance – associated with yellow color and clarity, deterioration was indicated by the appearance of bubble, foam and mold growth; (4) viscosity –

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referred to thickness or thinness of the pineapple juice, deterioration was indicated by increasing viscosity of the samples.

Sample were presented at room temperature when sensory evaluation conducted. Each sample was served in transparent glass with random coded and presented in random order to panelist at each testing time. Panelist scaled the differences between the stored juices and fresh juice according to 5-point scale. Five-point scale was used to rate the changes of sensory evaluation. On the scale, 5 referred to “extremely good”, 4 referred to “slightly good”, 3 referred to “neutral”, 2 referred to “slightly bad”, and 1 referred to “extremely bad”. Mineral water was provide to neutralize the panelist palate before and between sample testing. Sensory test was stopped when the panelist refused to do test for bubble, foam and mold growth on the surface, fermentation aroma appeared, and viscosity of pineapple juice increased.

Data Analysis

Two-way analysis of variance (ANOVA) at p=0.05 was performed in SPSS 12.0. The factors were storage temperature and treatment (use of preservatives). The ANOVA was conducted to find out the influence of storage temperature and use of preservative on shelf life of pineapple juice determined by the sensory attributes deterioration.

RESULT AND DISCUSSION

In shelf life studies, sensory attributes evaluation of food products is one of the most important procedure due to consumer information. Food products shelf life information provide quality assurance before being consumed. The sensory attributes that confer quality of the pineapple juice such as taste, aroma, appearance and viscosity. It was observed that storage temperature and addition of preservative resulted in significant differences in all sensory attributes between fresh and stored juices to determine the shelf life of pineapple juice. Pineapple juice stored at 25°C had significantly lower shelf life than pineapple juice stored at 7°C. Higher temperatures accelerated the rate of deterioration hence rapid changes in sensory characteristics. Thus, increase in storage temperature resulted in rapid changes in all the quality attributes such as, color, viscosity, smell and taste (Mkandawire, *et al*., 2016) while low temperature can lower the rate of chemical and enzymatic reactions and slow down the growth rate of microorganism that caused microbial changes (Erkmen and Bozoglu, 2016).

In Addition, the pineapple juices without sodium benzoate had lower shelf life than pineapple juice with preservative. Use of chemical preservatives plays an important role in ensuring safety and quality of stored foods. It intentionally added to food products to inhibit spoilage caused by molds, yeast and bacteria (Dhaka, *et al.,* 2016). Chemical preservatives such as sodium benzoate were used to prevent microbial spoilage during storage due to its antimicrobial activity (Shahnawaz, *et al*., 2013), therefore the combination between low temperature storage and addition of preservative were able to enhance the shelf life of pineapple juice.

Taste

The taste of pineapple juice stored at 7°C with preservative (T_1B_1) was slightly bad at week 14, and was extremely bad at week 16. While the taste of juice stored at 7°C without preservative

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(T_1B_2) was slightly bad at week 10, and was extremely bad at week 12. On the other hand, the juices stored at 25°C with preservative (T_2B_1) was slightly bad at week 2, and extremely bad at week 4, while juices without preservative (T_2B_2) was extremely bad at week 2. The panelists indicated the alcohol taste in pineapple juice as a deterioration of taste evaluation. The alcohol taste might be appeared because of by-products (organic acids and acetaldehyde) released due to microorganisms such as yeast activity. Yeast spoilage in fruit juices is characterized by formation of CO_2 and alcohol. It could be due to non-enzymatic reactions in which sugar are used up, releasing a variety of end products leading to reduction in sweetness of juice and contribute to a fermented flavor (Jimenez and Duran, 1999; Mkandawire, *et al*. 2016; Lawlor, *et al*. 2009).

Table 1. Mean Scores For Taste Evaluation of Pineapple Juices

Storage time (week)	Variables			
	T_1B_1	T_1B_2	T_2B_1	T_2B_2
0	5.00[a]	5.00[a]	5.00[a]	5.00[a]
2	4.83[a]	4.90[a]	2.24[b]	1.07[c]
4	4.06[a]	4.33[a]	1.12[b]	-
6	3.87[a]	3.42[a]	-	-
8	3.54[a]	3.12[a]	-	-
10	3.16[a]	2.37[b]	-	-
12	2.76[a]	1.12[b]	-	-
14	2.21[a]	-	-	-
16	1.29[a]	-	-	-

Means with different letters within a row are significantly different ($p<0.05$). Intensity based on a scale 1 to 5 (1 = extremely bad, 2 = slightly bad, 3 = neutral, 4 = slightly good, 5 = extremely good).

Aroma

The aroma of pineapple juice stored at 7°C with preservative (T_1B_1) was slightly bad at week 14, and was extremely bad at week 16. While the taste of juice stored at 7°C without preservative (T_1B_2) was slightly bad at week 10, and was extremely bad at week 12. Pineapple juices stored at 25°C with preservative (T_2B_1) was slightly bad at week 2, and extremely bad at week 4, while juices without preservative (T_2B_2) was extremely bad at week 2. The deterioration in smell could be due to non-enzymatic reactions or Maillard reactions that lead to a formation of end-products variety such as organic acids, furans, furanos, pyrroles and ketones. These wide variety of end-products contribute to color change and off-flavor in juices. (Jimenez and Duran, 1999; Mkandawire, *et al*. 2016)

Table 2. Mean Scores For Aroma Evaluation of Pineapple Juices

Storage time (week)	Variables			
	T_1B_1	T_1B_2	T_2B_1	T_2B_2
0	5.00[a]	5.00[a]	5.00[a]	5.00[a]
2	4.91[a]	4.87[a]	2.36[b]	1.27[c]
4	4.26[a]	4.38[a]	1.17[b]	-
6	3.90[a]	3.34[a]	-	-
8	3.62[a]	3.21[a]	-	-
10	3.18[a]	2.30[b]	-	-
12	2.90[a]	1.28[b]	-	-
14	2.17[a]	-	-	-
16	1.26[a]	-	-	-

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Means with different letters within a row are significantly different ($p<0.05$). Intensity based on a scale 1 to 5 (1 = extremely bad, 2 = slightly bad, 3 = neutral, 4 = slightly good, 5 = extremely good).

Appearance

The appearance of pineapple juice stored at 7°C with preservative (T_1B_1) was slightly bad at week 16, and was extremely bad at week 18. While the taste of juice stored at 7°C without preservative (T_1B_2) was slightly bad at week 14, and was extremely bad at week 16. Pineapple juices stored at 25°C with preservative (T_2B_1) was slightly bad at week 2, and extremely bad at week 4, while juices without preservative (T_2B_2) was extremely bad at week 2.

Table 3. Mean Scores For Appearance Evaluation of Pineapple Juices

Storage time (week)	Variables			
	T_1B_1	T_1B_2	T_2B_1	T_2B_2
0	5.00^a	5.00^a	5.00^a	5.00^a
2	4.91^a	4.85^a	2.46^b	1.32^c
4	4.46^a	4.40^a	1.27^b	-
6	4.12^a	4.08^a	-	-
8	3.82^a	3.69^a	-	-
10	3.68^a	3.12^a	-	-
12	3.16^a	3.04^a	-	-
14	3.08^a	2.02^b	-	-
16	2.02^a	1.34^b	-	-
18	1.27^a	-		

Means with different letters within a row are significantly different ($p<0.05$). Intensity based on a scale 1 to 5 (1 = extremely bad, 2 = slightly bad, 3 = neutral, 4 = slightly good, 5 = extremely good).

The panelist indicate the appearance deterioration of pineapple juice by color changed to brownish, clarity and appearance of the bubble, foam and mold growth. The reactions of sugars, amino acids and ascorbic acids results the products of non-enzymatic browning. Yeasts also produced pectin esterase which degrade pectin causing spoilage and may also produce turbidity, flocculation, pellicles, and clumping (Falade, *et al*., 2004; Lawlor, *et al*. 2009). Yeast and molds are also present and can grow when the juice is held at a temperature permitting their growth. Yeasts are primarily responsible for the spoilage of chilled juice that is not sterile and some can withstand the effect of chemicals used to preservation (Sandeep *et al*., 2001).

Viscosity

The appearance of pineapple juice stored at 7°C with preservative (T_1B_1) was slightly bad at week 14, and was extremely bad at week 16. While the taste of juice stored at 7°C without preservative (T_1B_2) was slightly bad at week 12, and was extremely bad at week 14. Pineapple juices stored at 25°C with preservative (T_2B_1) was slightly bad at week 2, and extremely bad at week 4, while juices without preservative (T_2B_2) was extremely bad at week 2.

Table 4. Mean Scores For Viscosity Evaluation of Pineapple Juices

Storage time (week)	Variables			
	T_1B_1	T_1B_2	T_2B_1	T_2B_2
0	5.00^a	5.00^a	5.00^a	5.00^a
2	4.81^a	4.75^a	2.46^b	1.40^c
4	4.36^a	4.20^a	1.30^b	-
6	4.10^a	4.02^a	-	-
8	3.62^a	3.49^a	-	-

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Storage time (week)	Variables			
	T_1B_1	T_1B_2	T_2B_1	T_2B_2
10	3.48[a]	3.12[a]	-	-
12	3.16[a]	3.05[a]	-	-
14	2.48[a]	2.00[b]	-	-
16	2.10[a]	1.22[b]	-	-
18	1.00[a]	-		

Means with different letters within a row are significantly different ($p<0.05$). Intensity based on a scale 1 to 5 (1 = extremely bad, 2 = slightly bad, 3 = neutral, 4 = slightly good, 5 = extremely good).

Juices consist of a dispersing phase which sugars, acid, soluble pectin, and proteins are dissolve that contributes to the viscosity of the juice. Viscosity is affected during storage time and high temperature, hence the use of preservative and cooling temperature slow down the rate of viscosity deterioration (Jimenez and Duran, 1999; Mkandawire, *et al*. 2016)

CONCLUSION

The results shows that temperature and use of preservatives (0.05% sodium benzoate) have significant effects to stabilize the quality of pineapple juice during storage. Higher temperature with no preservatives added will promote microbial growth that lead to deterioration of sensory attributes. Taste and aroma deteriorate faster than appearance and viscosity. Based on deterioration on sensory attributes, especially on taste and aroma parameters, the shelf life were estimated to be 14 week for pineapple juice stored at 7°C with preservative (T_1B_1), 10 week for pineapple juice stored at 7°C without preservative (T_1B_2), 2 week for pineapple juice stored at 25°C with preservative (T_2B_1) and less than 2 week for pineapple juice stored at 25°C without preservative (T_2B_2). This study underscored the importance of using sensory analysis in ESS method, particularly taste and aroma parameters to determine the shelf life of pineapple juice.

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