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Characteristics of Pasteurization Milk Formulated with Ambon Banana Syrup (*Musa acuminata* colla) at Different Maturity

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Abstract. Pasteurized milk defined as fresh cow milk that processed through heating process with temperature 65°C. Generally, pasteurized aimed to prevent the damage of milk due to destructive microorganism (pathogen) activity, and able for controlling nutrition quality. Indonesia banana production in 2016 approximately 7.45×10^6 t, but only 1.5×10^6 t were consumed. Banana mostly consumed as fresh fruit, or processed as chip or nugget. This indicated that, banana is less treated for food product. Therefore, the objective of this research was to define the optimum Ambon banana maturity, and syrup concentration for producing the best pasteurized milk. This research consisted into 2 main stages consisted banana syrup production, and followed by application into pasteurized milk. Nested design was applied, with the main factor was the Ambon banana maturity (115 d, 120 d, and 125 d after flowering) and the sub-factor was banana syrup concentration (5%, 10%, 15%) with 3 replications. There was significant effect of banana maturity and syrup concentration to the fat content and aroma of pasteurized milk. While there was significant effect of banana syrup on the total dissolved solid (TDS), and total plate count (TPC) of pasteurized milk. The best treatment was 125 d Ambon banana and 15% syrup concentration, with TDS 13.11 °Brix, TPC 8.1×10^4 CFU mL^{-1}, fat 12.65 %, protein 19.08 %, aroma 3.9 (like), and taste 2.5 (simply delicious).
Keywords: banana syrup, TDS, TPC, viscosity

INTRODUCTION

Milk has potential to transmit the pathogenic microbes that may lead many diseases (Angelidis, 2015). Pasteurization considered as an effective solution to reduce or kill the pathogens and render it safe. Milk is able to be contaminated after pasteurization process, by poor sanitary practice, the usage of unsterilized utensils and improper handling procedures. The pathogenic bacteria in raw milk i.e. *Salmonella* was 13% , *Listeria monocytogenes* was 27%, *Yersinia* was 13%, and *Pseudomonas aeruginosa* was 67%. Pasteurization applied consisted of three type methods, namely low temperature long time (LTLT) pasteurization, high temperature short time (HTST) pasteurization, and ultra high temperature (UHT) (Dhotre, 2014).

In 2016, Indonesia banana production approximately 7.45×10^6 t, but only 1.5×10^6 t were consumed (Trisnaputri *et al.,* 2018). Bananas as climacteric fruit, indicated able to increase the carbohydrates level in form of starch as maturity (Anyasi *et al.*, 2013). There are numerous of banana processing techniques i.e. fried, drying, steamed, roasted, baked, pureeing, brewing, and extracted as syrup. Banana as one of the fruit that contains the highest carbohydrate, with great contains of sugar become more acceptable as an important raw material in supporting food diversity, especially as the glucose syrup (high maltose syrup) source. Based on Zhang *et al.*, (2005), the banana with a lot of bruise on the skin had 2.6% starch, 33.6% reduction sugar, and 53.2% sucrose.

Ambon banana is very popular due to it has big fruit size (16 cm to 20 cm), weight (76 g to 200 g), fine curved shape, soft and very aromatic pulp (ivory to yellow), has greenish and thick peel (3 mm), and predominant taste is sweet (Hapsari and Lestari, 2016). The total sugar, consisted of non-reducing (sucrose) and reducing sugar (fructose, glucose, lactose, maltose, mannose, etc.) (Zomo *et al.*, 2014). According to Hapsari and Lestari (2016), water content 72.94 %, ash 0.78 g, carbohydrate 24.33 g, protein 1.92 g, fat 0.03 g, total sugar 15.91 g, vitamin C 19.10 mg, potassium 275 mg and calories 105.27 cal.

MATERIAL AND METHOD

Material

Fresh cow's milk obtained from breeders in Batu City, while Ambon bananas with different levels of maturity (115 d, 120 d and 125 d) obtained from farmers in Pagak –Malang East Java Indonesia. The addition materials that used were aquades, sugar, alcohol 70 %, anthrone 1 %, HCl, NaOH, and concentrated sulfuric acid.

Equipment

The equipment used were pasteurization tools, refigerators, plastics bottle, beaker glass, measuring cylinder, filter, scales, chiffon fabric, thermometer, GR-200 analytical balance, analytical balance Ohaus Pronner PA413, WTC Binder 7200 tutlingen / german typ: E53, color reader CR-10 konica minolta, hand refractometer atago N-1α 28-62% (cat.No.2211), and airflow laminates.

Ambon banana syrup production

The process started with Ambon banana sortation based on maturity, then it was peeled and reduced size. About 500 g of banana was boiled with 500 mL of water, and added with 500 g of sugar. The boiling duration about 30 min, and stiring. Banana juice was strained using a filter, then enter into a glass bottle.

Application of Ambon banana syrup to the pasteurized milk.

Pure cow's milk was preheated at 65 °C for 30 min, then the temperature decreased up to 40 °C. Ambon banana syrup was added based on the treatment (5%, 10%, and 15%) to each sterile bottle.

Research Parameter

The ambon banana syrup product will be tested for total dissolved solids, color intensity, and viscosity. While the pasteurized milk will be tested for fat content, protein content, total dissolved solids, total plate count, and organoleptic tests (aroma and taste) (Yuwono and Susanto, 1998).

Research Method and Data Analysis

Nested research design was applied for this research. The main factor was Ambon banana maturity consisted of 3 levels (115 d, 120 d, and 125 d after flowering). The sub factor was banana syrup concentration composed 3 levels (5 %, 10 %, and 15 % v/v). Each treatment was replied 3 times, resulted 9 samples, and followed LSD 5 % test.

RESULT AND DISCUSSION

Banana Syrup Characteristic Based on Maturity

Based on analysis of variance (ANOVA), there was not significant effect of banana maturity on the total dissolved solid (TDS), viscosity, lightness (L), redness (a^+), and yellowness (b^+) of banana syrup (Table 1). The highest TDS showed by the maturity level of banana 120 d. The additional ingredients used to make Ambon banana syrup were water, and sugar. According to Yuwono and Susanto (1998), total dissolved solids also affected by the breakdown of carbohydrates, proteins into simple and water-soluble molecules i.e. amino acids and peptons, and the breakdown of fats into free fatty acids and glycerol. The sugar addition in each treatment was same so it produced the total dissolved solids was not different. Sugar is made from 99% sucrose which has properties as a preservative has a high solubility and has the ability to bind water (Buckle, 2009).

The level of fruit maturity did not affect the viscosity of banana syrup, and the highest viscosity was obtained to 120 d, with 4.53 d Pas. Syrup is a thick liquid and has high dissolved sugar, but has almost no tendency to precipitate crystals. The increased viscosity of syrup is due to the increasing number of hydrogen bonds between the hydroxyl group (OH) in the dissolved sugar molecule and the water molecules. Therefore, it is not only able to give a sweet taste but granulated sugar also affects the texture of food (Buckle, 2009).

Table 1. The banana syrup characteristic based on maturity

Treatment	TDS (° Brix)	Viscosity (d.Pas)	L	a^+	b^+
M1 (115 d)	50.13	4.37	35.8	2.23	2.37
M2 (120 d)	51.40	4.53	35.9	1.53	2.40
M3 (125 d)	51.13	4.50	36.6	2.17	2.30

The lightness (L) value represents with a range of 0 to 100, the 0 value indicates black or very dark, and it becomes more bright color up to 100. The results showed that the banana syrup have a bright color. In accordance to Vargas and Lopez (2003) the color of a material is influenced by the light absorbed and reflected, and components of its constituent ingredients. The color intensity values of a^+ indicate green and red, but a^- is blue. Food color is caused by natural or additional pigments, the natural pigments included that formed in heating, storage, or food processing (De Man, 1997). The processing into syrup is able to damage the pigment in Ambon banana syrup. The greater of b^+ value, indicated the increasingly yellowness, while smaller or even reaches the negative (b-) showed the green (Vargas and Lopez, 2003). Nested design was applied with the main factor was Ambon banana maturity, and sub-factor was Ambon banana syrup concentration. The data was calculated used Analysis of Variance (ANOVA).

Pasteurized Milk Characteristic

Based on Table 2, it was known that physicochemical quality parameters of pasteurized milk was differences compared to the literature.

Tabel 2. The comparison of pasteurized milk (raw material) and National Indonesian Standard (SNI) **SNI 01-3141-1998.**

Parameter	SNI	Pasteurized Milk
Fat (% b/b)	1.5	11.01
Protein (% b/b)	2.8	1.75
T.P.C (CFU mL^{-1})	3×10^4	5.87×10^4
TDS	7.5	13.14

The fat content in pasteurized milk was higher 11.01% compared to SNI 1.5%. Protein content according to SNI has a value of 2.8%, but pasteurized milk had slightly below about 1.75%. Likewise according to Fischer *et al.* (2011) the

most important composition in milk is protein, and fat. The average milk protein content ranges from 3% to 5% while the fat content of milk ranges from 3 % to 8 %. The composition of milk is influenced by several factors including cow breed, lactation period, milking interval, feeding, temperature, and age.

Sugitha *et al.,* (1999) stated that the physical properties of milk i.e. color, aroma, taste, specific gravity, boiling point, freezing point and thickness affected the quality. The high quality of fresh milk color is grayish white to slightly yellowish golden. Milky white color is resulted of the dispersion of light reflection by fat globules and colloidal particle from casein and calcium phosphate. In addition, the yellowness of milk indicated of cows suffering from mastitis due to the presence of leukocyte cells. While, the aroma affected with the lactose and chloride content, low lactose and high chloride cause salt flavor. This causes at the beginning of the lactation period, milk has a salt taste and aroma (Sugitha *et al.,* 1999).

According to Fischer, et al. (2011), raw milk bacterial contamination generally comes from 3 sources, namely in the nipple, outside the nipple, and from the surface of the equipment, handling and storage of milk. The pasteurized milk obtained had microbial amount of 165 000 CFU mL^{-1} that was not in accordance to SNI 01-3141-1998 (30 000 CFU mL^{-1}). According to the survey Hidayat *et al.,* (2006) showed that 60% of fresh milk farmer levels containing microbes under 3 x 10^6 CFU mL^{-1}. The number of microbes increased a lot due to handling during transportation and storage.

Pasteurized Milk with Ambon Banana Syrup

Total Dissolved Solid (TDS)

Based on the analysis of variance, there was not significant effect of fruit maturity, but significant effect of Ambon banana syrup concentration to the total dissolved solids of pasteurized milk (Table 3).

Table 3. The TDS pasteurized milk based on banana syrup concentration

Treatment	TDS (° Brix)
5 %	11.12 a
10 %	11. 51a
15 %	12.41b

Total solids are constituent components of the solution in the form of dissolved and non-dissolved solids. According to Monica and Prasetyo (2004) the particles that contributed to the TDS in milk composed of protein, fat, and sugar. Pasteurized milk added with Ambon banana syrup concentration of 15% has a

higher total dissolved solid value compared to another treatment. According to Yuwono and Susanto (1998) Total dissolved solids component consisted not only organic acids and protein but also sucrose. Based on Monica and Prasetyo (2004) studies, the particles contributed in soy milk TDS was proteins because it was the most dominant content in soy.

Protein Content

Analysis of variance showed that the addition of Ambon banana maturity and syrup concentration did not gave a significant effect ($\alpha = 0.05$) on the protein content of pasteurized milk. The highest protein value is in the treatment of Ambon banana syrup maturity 115 d and 125 d with 1.82 %. This is due to 100 g bananas contains 110 calories, 30 g of carbohydrates and 1 g of protein, in addition bananas provide various vitamins and minerals (Radiati, 2003).

Fat Content

There was significant effect of Ambon banana maturity separately on the fat content. In the 125 d treatment showed the highest fat content 12.65 %, followed by 120 d and 115 d were 11.74 % and 11.36 % respectively. The different notation of 125 d indicated significant difference with 120 d and 115 d treatments. This is due to the fat content in banana is not too high, every serving (100 g), the fat is about 0.39 g (Radiati, 2003). Moreover, there was also very significant interaction between maturity and Ambon banana syrup concentration into fat content of pasteurized milk (Table 4.). The highest fat content was 31.90 % at 115 d maturity and 15 % syrup concentration.

Table 4. The effect of maturity and syrup concentration of Ambon banana to the fat and aroma

Maturity (d)	Syrup Concentration (%) (v/v)	Fat (%)	Aroma
115	5	9.56 a	2.6 a
	10	12.18 a	3.3 b
	15	31.90 b	3.5 b
120	5	9.22 a	2.9 a
	10	12.08 b	3.1 b
	15	31.56 c	3.3 b
125	5	9.28 a	3.0 a
	10	12.45 a	3.7 c
	15	31.70 b	4.1 d

Total Plate Count

There was a fluctuation in the number of microbial colonies (CFU mL^{-1}) pasteurized milk with Ambon banana syrup. On day 0 the number of microbes was 4 x 10^4 CFU mL^{-1}, at 3rd d, it was 5.1 x 10^4 CFU mL^{-1}, on the 6th d was 6.3 x 10^4 CFU mL^{-1}, and the 9th d was 8.1 x 10^4 CFU mL^{-1}. These results cannot meet the standard of SNI, because the raw milk quality was not good, the milk pasteurization process was not optimal, and the TPC test process was not sterile, resulting in contamination of Ambon banana pasteurized milk. TPC provides an information of milk quality and hygiene, but mostly the method used has limited ability to identify the sources of bacterial contamination (Madera *et al.*, 2004).

Milk is often used as a growth medium for pathogenic microorganisms because of its nutritional content. In addition, the number of microorganisms increase 100 times or more, if it stored at temperatures of 25ºC for a long time. Therefore, pasteurization is optimum for decreasing bacterial growth (Hosain *et al.*, 2010) and extend the shelf life. The shelf life of pasteurized milk is longer than fresh milk. This is due to the pasteurization able to inactivate phosphatase and catalase, which act as enzymes that make milk quickly damaged. The pasteurization process reduced pathogenic bacteria, yeast, fungi and most vegetative cells in bacteria (Sarinengsih, 2009).

Organoleptic Characteristic

The organoleptic test consist of taste and aroma. This test used a hedonic scale method with a range of values from 1 to 5 with criteria, 1 = very dislike, 2 = dislike, 3 = rather like, 4 = like, and 5 = very like. The result of taste ranged 2.7 to 3.9 showed that there was insignificant effect. But mostly the panelist score was on the "rather like" criteria. Moreover, the maturity and Ambon banana syrup concentration gave significantly effect ($\alpha = 0.05$) on the aroma of banana pasteurized milk (Table 4). The panelists scoring on the aroma ranged on 2.6 to 4.1. The highest value of aroma (4.1) found in milk added with Ambon banana syrup which was 125 d with 15% concentration. While the lowest aroma score was at Ambon banana maturity 115 d and concentration syrup which 5%.

CONCLUSION

There was significant effect of banana maturity and syrup concentration to the fat content and aroma of pasteurized milk. While there was significant effect of banana syrup on the total dissolved solid (TDS), and total plate count (TPC) of pasteurized milk. The best treatment was 125 d Ambon banana and 15% syrup concentration, with TDS 13.11 °Brix, TPC 8.1 × 10^4 CFU mL^{-1}, fat 12.65 %, protein 19.08 %, aroma 3.9 (like), taste 2.5 (simply delicious),

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