

Physicochemical, Sensory and Microbiological Analysis of Banana Jam Value Added with Collagen

Rodiah Mohd Hassan, Nurul Aishikin, and H. Nurul Ain

Abstract

This study was carried out to investigate the feasibility of producing banana jam is value added with collagen. Evaluation on the physical and chemical properties and consumer acceptability of the product were also performed. Three formulations of banana jam (835, 759 and 291) were formulated along with other ingredients by varying the ratios of banana and water content. Approximately 1.0% of collagen was employed for each formula. Two types of sensory evaluation tests were conducted which were hedonic scoring test and ranking test. The sensory data revealed a preference for formulation 835 where this sample was rated as the tastiest sample in the ranking test. As a result, the sample was further characterized with microbiological analysis (total plate count and yeast and mold count) for 60 days storage at 4 °C and 30 °C. The result shows that storage revealed sample 835 could be kept beyond 60 days under refrigeration (5 °C). Physicochemical analysis of the jam showed that sample 835 had 68.89% total soluble solid, 31.63% moisture content, 5% fat content 1.09% total acidity and 3.73 pH. This study indicated that the use of banana and collagen may be attractive to consumers as positive alternative to conventional fruit in jam production but further studies should be performed such as determination of antioxidant, rheological properties and to determine the other nutritive contents such as vitamins, amino acids, etc.

Keywords: Jam, collagen, banana – *Musaceae Cavendish*

INTRODUCTION

Banana belongs to the *Musa* genus of the *Musaceae* family (Porcher, 2002) which is in the fourth rank as an important fruit crop that provides nutrients to millions of people especially in South East Asia (FAOSTAT, 2005). In culinary terms, banana cultivars can be divided into two main groups which are sweet or dessert banana and cooking bananas. Banana is high with nutrient value, such as vitamin B6, vitamin C, vitamin A, niacin, thiamin, folacin, riboflavin, magnesium, copper, iron, phosphorus, and zinc (Ghosh et al., 2011). Banana it is classified as non seasonal fruits, therefore the price of the fruit is inexpensive (Nelson et al., 2006). Hence the availability of the fruit is persistence throughout the year.

These days, collagen has a wide range of applications in cosmetic, biomedical, pharmaceutical, leather and film industries. Collagen is the main component of connective tissues and is the most abundant protein in mammals. In humans, collagen comprises one-third of the total protein, accounts for three-quarters of the dry weight of skin and is the most prevalent component of the extracellular matrix (ECM) (Matthew & Raines, 2009).

Collagen-containing foods are expected to protect skin from aging. Tanaka et al. (2009) has studied the effect of daily ingestion of collagen peptide on the skin damage induced by repeated UV-B irradiation and the research discovered that by ingestion of collagen peptide (0.2g/kg/d) suppressed UV-B-induced decreases in skin hydration, hyperplasia of the epidermis and decrease in soluble type I collagen. These results proved that collagen peptide is beneficial as a dietary supplement to suppress UV-B-induced skin damage and photo aging. To enhance the commercial use of banana, this research attempts to produce banana jam which is supplemented with collagen to provide health benefits to people.

MATERIALS AND METHODS

Materials

Banana (*Musaceae cavendish*) was obtained from fruit stalls at Bestari Jaya, Kuala Selangor, Malaysia. Halal collagen from bovine was purchased from Amin Co. Ltd (China). Other ingredients used in the jam making are tabulated in Table 1.

Table 1: Formulation of Banana Jam Value Added with Collagen

Ingredients	Formulation 1 (835)	Formulation 2 (759)	Formulation 3 (291)	Control (356)
Banana fruit (g)	40.0	60.0	80.0	35.0
Collagen (g)	1.0	1.0	1.0	-
Sugar (g)	35.0	35.0	35.0	35
Salt (g)	0.3	0.3	0.3	0.3
Cinnamon (g)	1.0	1.0	1.0	-
Blackcurrant (g)	3.0	3.0	3.0	-
Egg yellow coloring (mL)	0.1	0.1	0.1	-
Sodium benzoate (g)	1.0	1.0	1.0	1.0
Citric acid (g)	0.3	0.3	0.3	0.3
Xanthan gum (g)	1.0	1.0	1.0	-
Pectin (g)	3.0	3.0	3.0	7.0
Banana flavor (mL)	10.0	10.0	10.0	-
Water (mL)	104.4	84.4	64.4	121.4

Note: Preparation for 200 g of formulation.

Formulation of Banana jam

Three formulations (835, 759 and 291) of banana jam which was added with collagen were prepared. All the formulas were prepared according to the method of Hamdzah *et al.* (2007) with a modification by adding some more ingredients. Original banana jam formulated by MARDI (Malaysia) was used as control and labeled as 356.

Sensory Analysis

Seventy volunteered untrained panelists took part in sensory analysis tests. Jams were served to the panellists to evaluate the sensory attributes (sweetness, texture, color, aroma and overall acceptance) of jams by using a hedonic scale test based on method of Misnow *et al.* (2004) The jams were served in plastic plate labeled with three-digit prior to testing in the sensory evaluation venue. The words anchoring the scale were as followed; 1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like or dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely. Panelists were asked to rate these variables in the specific order for each sample. All samples were tested and the panelists were provided with plain water and instructed to take two rinses prior to and between testing in order to cleanse their palate between samples.

The ranking test was also conducted in this sensory evaluation test in order to make simultaneous comparison of the samples on the basis of single characteristics. The respondents were instructed to rank the samples according to intensity of the characteristics identified. The panelists were asked to rank the tastiest jam formulation in the first rank and the less tasty ones in their respective places; second, third and fourth accordingly.

Microbiological Analysis

Microbial analyses of banana jams from the best formulated jam (based on Ranking Test) were determined during eight weeks storage at 4 °C and 30 °C. A total number of 32 bottles were used in this study. Samples were collected weekly for both temperature and at each sampling time, samples were randomly removed from storage for microbiological analysis. The mesophilic aerobic plate count was done using the pour plate method as described by Voon *et al.*, 2006). Serial dilutions of original samples were prepared in sterile peptone water (0.1%) to reduce the microbial population sufficiently to obtain separate colonies when plating. One millilitre of several diluted samples were mixed with 15 mL liquid plate count agar that had been cooled to about 45 °C, and poured immediately into sterile 90 mm Petri dishes. After the agar had hardened, incubation was performed at 35 °C for 48–72 h. While total fungi (moulds and yeasts) were carried out in triplicate according to method Voon *et al.* (2006) using the pour plate method on plates of Potato Dextrose Agar (PDA) medium, and then were enumerated after incubation for 5 days at 25 °C. Each value represents the mean of three samples and results were expressed as colony-forming units (CFU) per milligram.

Physicochemical Analyses

All the samples (excluding the control sample) were analyzed for pH, total soluble solid and moisture content according to methods of AOAC (2006). The pH was measured with a pH meter and total soluble solid was determined using a hand refractometer and expresses as percentage. Meanwhile moisture content was measured using oven drying method at 105 °C for 24 h. Crude fat was measured by Soxhlet apparatus through solvent extraction followed by evaporation and measuring weight difference according to the method of Nielson (1998). Method for determination of total acidity was adapted from Nielson (1998) and AOAC (2006) with a minor modification. Total acidity was quantified by titration to 10 g of sample with 0.1 mol equivalent/L NaOH and expressed as concentration of citric acid in g/100 mL. Measurements of physicochemical analysis were performed induplicate.

Statistical Analysis

Statistical evaluations of the physical, chemical and sensory analysis were made by using analysis of variance (ANOVA) SPSS version 16.0 to determine the significant difference between the samples. The significance was established using Tukey post-hoc test. The probability level of $p < 0.05$ was considered significant. All data are expressed as means \pm standard deviations (SD) of the values obtained by three independent measurements.

RESULTS AND DISCUSSIONS

Sensory Analysis

Based on Table 2, there are significant difference ($p < 0.05$) among panelist's response to the three formulations of banana jam (835, 759 and 291) with control sample in term of sweetness, color, aroma and overall acceptability. In addition, the sample without collagen (356) was not preferred by the panelists as the results showed the lowest score in term of overall acceptability. Based on the response, the panelist rated higher score for formulation with less of banana content (835 and 759) in term of overall acceptability. The relatively high score may be due to the fact that they disliked the texture of the other two samples (291 and 356) which have firmer texture. In fact, in the case of texture; sample 291 and 356 indicated significant difference ($p < 0.05$) between sample 835 and 759.

Table 2: Hedonic test of banana jam and control sample

Samples	Attributes				
	Sweetness	Textures	Color	Aroma	Overall acceptability
835 (F1)	6.71 ^c ±1.10	6.64 ^b ±1.27	6.94 ^c ±1.31	7.00 ^c ±1.43	6.90 ^c ±1.03
759 (F2)	6.63 ^c ±1.52	6.90 ^b ±1.56	6.95 ^c ±1.66	6.77 ^c ±1.91	7.11 ^c ±1.56
291 (F3)	5.31 ^b ±1.83	4.70 ^a ±1.82	5.60 ^b ±2.00	5.97 ^b ±1.56	5.68 ^b ±1.60
356 (control)	4.15 ^a ±1.99	4.24 ^a ±2.28	4.18 ^a ±2.12	3.78 ^a ±2.01	4.28 ^a ±1.92

^{a-c}Means in columns without common superscripts are significantly difference ($p < 0.05$).

From Table 3, the results showed that there was no significantly difference ($p > 0.05$) between three formulations of banana jam (835, 759 and 291) and the results also exhibited that all the samples were close to the first place of ranking test for the tastiest jam. The lower the mean value, the closer it is to the first rank. In this test, sample 835 showed the lowest score which was 1.74; therefore, this sample was placed at the first ranking and was selected as the best formulation.

Table 3: Ranking test of banana jam and control sample

Samples	Mean ± std dev.
835 (F1)	1.74 ^a ±0.86
759 (F2)	2.08 ^a ±0.94
291 (F3)	2.67 ^a ±1.00
356 (control)	3.48 ^b ±0.79

^{a-b}Means in columns without common superscripts are significantly different ($p < 0.05$).

Microbial analysis

The growth of mesophilic bacteria and total mold and yeast in banana jam value added with collagen was measured at two different condition temperatures; at room temperature (30 °C) and refrigerated condition (5 °C). Table 5 shows the changes of mesophilic microorganisms and total mold and yeast of sample 835 during storage at two different conditions from 0 day until days 60. The initial count for total plate count for both condition showed that no growth of bacteria at 0 day. However, the increasing of microbial growth was higher for sample which stored at room temperature (30 °C) than those stored at 5 °C. As mentioned by Foo (1987), room temperature (30 °C) is an optimal temperature for the growth of mesophilic microorganisms. The number of mesophilic bacteria growth began to increase after fourth week's storage at room temperature and from the observation the growth of mesophilic bacteria increased with storage time. However, according to Ray (1996) food still can be considered as safe for consumption if the total plate counts as below the range 10^7 and 10^9 CFU/mL.

Based on Table 4, yeast and mold did not exhibit any growth started from day 0 until week 4 when stored at both temperatures. However, less microbial growth was detected in sample stored at room temperature started at week 5 till week 7 which less than 10^1 cfu/g was observed. Meanwhile, during refrigerated storage (5 °C), total mold and yeast was not observed as storage progressed beyond 60 days.

Table 4: Changes of mesophilic microorganisms and total mold and yeast of sample 835 during storage at 30 °C and 5 °C

Week of storage	Total plate count (CFU/mL)		Total mold and yeast (CFU/mL)	
	Room temperature (30 °C)	Refrigerated condition (5 °C)	Room temperature (30 °C)	Refrigerated condition (5 °C)
1	NG	NG	NG	NG
2	NG	NG	NG	NG
3	NG	NG	NG	NG
4	$\leq 1.0 \times 10^1$	NG	NG	NG
5	$\leq 1.0 \times 10^1$	NG	$\leq 1.0 \times 10^1$	NG
6	1.3×10^3	$\leq 1.0 \times 10^1$	$\leq 1.0 \times 10^1$	NG
7	2.1×10^3	$\leq 1.0 \times 10^1$	$\leq 1.0 \times 10^1$	NG
8	3.1×10^3	1.9×10^3	8.6×10^3	NG

NG = no growth

Physicochemical Analyses

From Table 5, it can be depicted that there were no significant difference ($p > 0.05$) between all the formulated jams for pH determination, moisture content and total acidity. The pH was found not to be significantly different as the concentration of added acids was kept constant in all the formulations. The ranges of the pH were 3.66 till 3.73, which were in acidic condition. The results of this study are in line with those reported by Abdualrahman (2004), who studied pH of mango fruit jam where the results showed that the pH of the jam ranged from 3.4 to 3.6. On the other hand, the results showed that sample 835 has the lowest total acidity among the other samples which was 1.09 %. The higher total acidity values in product are suitable to retard the growth of microorganisms. Often, microorganisms cannot survive in lower pH and it is suitable for food in order to avoid microorganisms from growing.

As tabulated in Table 5, there was no significant difference ($p > 0.05$) in the moisture content for each samples (31.23 -31.63%). However, these results were slightly lower than the result reported for moisture content of mango fruit jam which ranged between 45.6% to 46.0% (Abdualrahman, 2004). According to Vuartaz, *et al.* (2010), the changes in moisture content will affect the flavour and texture of food as well as physical and chemical properties as water gives chemicals a helpful medium to catalyze chemical reaction (water activity).

Sample 835 indicated the lowest fat content (5.95%) among others. Meanwhile, the total soluble solid for all samples ranged between 51.11% till 68.89%. As stated by Silva *et al.* (2006) the total soluble solids content is expressed as a percentage of fresh matter mass which indicates the high positive correlation with sugar content, and is therefore generally accepted as an important quality trait of fruits. Hence, if the total soluble solid is higher, the degree of sweetness of the sample is also greater. The result showed that the jams from this research have high content of sugar which might influence the results for sensory analysis.

In addition, the percentage of fat content and total soluble solid from this research were considered higher than the research conducted by Alaekwe and Mojekwu (2013), who studied the fruit jam from *Napoleona imperialis*. The results exhibited that the fat and total soluble solids of the jam were 0.2% and 1.2%, respectively.

Table 5: Physicochemical analysis for banana jam

Sample	pH (%)	Total acidity (%)	Moisture content (%)	Fat content (%)	Total soluble solid (%)
835 (F1)	3.73 ^a ±0.04	1.09 ^a ±0.50	31.63 ^a ±3.42	5.95 ^a ±0.29	68.89 ^a ±16.78
759 (F2)	3.66 ^a ±0.15	1.15 ^a ±0.52	32.23 ^a ±2.26	6.17 ^b ±0.46	61.11 ^a ±18.36
291 (F3)	3.68 ^a ±0.04	1.39 ^a ±0.56	33.28 ^a ±4.21	7.22 ^c ±1.19	51.11 ^b ±18.36

^{a-c}Means in columns without common superscripts are significantly different ($p < 0.05$).

CONCLUSIONS

In this study, the potential of producing banana jam which was value added with collagen was evaluated. The sensory data revealed a preference for formulation 835 where this sample was rated as the tastiest sample in the ranking test. Therefore, this formula was further characterized with microbiological analysis where storage revealed that sample 835 could be kept beyond 60 days under refrigeration (5 °C). Results from this work revealed essential information that could promote the commercialization of banana jam but further studies should be performed particularly to characterize the product as healthy food such as determination of antioxidant, rheological properties and to determine the other nutritive contents such as vitamins, amino acids, etc.

ACKNOWLEDGMENTS

The authors would like to express greatest appreciation and gratitude to the Faculty of Sciences and Biotechnology, Universiti Selangor (UNISEL) for the financial assistance and also to Director of Bio-IT Selangor for kindly providing the collagen in this research.

References

- Abdualrahman, M. A. Y. (2013). Physico-chemical Characteristics of Different Types of Mango (*Mangifera Indica L.*) Fruits Grown in Drafur Regions and Its Use in Jam Processing. *Science International*, 144-147.
- Alaekwe, I.O., and Mojekwu, O. E. (2013). Proximate composition and utilization of *Napoleona imperialis* fruits. *Journal of Natural Sciences Research*, 6: 224-3186
- AOAC. (2006). *Official Method of Analysis* (18th Ed). Gaithersburg, MD: Association of Official Analytical Chemists
- FAOSTAT. (2005). Food and Agriculture Organization of the United National Statistical Database. Retrived May 16, 2011 from <http://faostat.fao.org>.
- Foo, M. K. 1987. *Food Technology* (6th Ed). Food Spoilage Microorganisms. Pp. 1-3, MARDI Serdang, Selangor
- Ghosh, A. K., Banerjee, S., Halder, B., and Barman, N. R. (2011). An overview on different variety of *Musa* species: Importance and its enormous pharmacological action. *IJPI Journal of Pharmacognosy and Herbal Formulations*, 1(2), 1-11.
- Hamdzah, A. R., Bahari, I., Faridah, M. S., Fatimah, M. Z., Mohd, A. W., Rashilah, M., and Zolkafli, A. 2007. Manual Teknologi Penghasilan Pelbagai Jem dan Lepa. Malaysia: Penerbit Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI), pp. 27
- Matthew, D. S., and Raines, R. T. (2009). Collagen Structure and Stability. *Annu. Rev. Biochem*, 78: 929-59.
- Misnow, S.J., Jamilah, B., Nazamid, S. (2004) Sensory properties of cocoa liquor as affected by polyphenol concentration and duration of roasting. *Food Quality and Preference* 15, 403–409.
- Nelson, S. C., Ploetz, R. C., and Kepler, A. K. (2006) *Musa Species (Banana and Plantain)*. Pacific Island Agroforestry Project Report. Africa: Pacific Island Agroforestry.
- Nielsen, S. (1998) *Food Analysis* (2nd Ed). Gaithersbury, Maruland: ASPEN Publication.
- Porcher, M. H. (2002). *Sorting Musa Names*. University of Melbourne.
- Silva, P. S. L., Antonio, R. P., and Dantas. D. A. (2006). Juice extraction for total soluble solids content determination in melon. *Revista Caatinga*, 19(3), 268-271
- Tanaka, M., Koyama, Y. I., and Nomura, Y. (2009) Effects of collagen peptide ingestion on UV-B induced skin damage. *Biosci Biotechnol. Biochem.*, 73 (4), 930-932.
- Vassey, N. P., Huang, L., and Molnor, G. V. 1981. A new patented method for mass propagation of banana shoot culture. *Aeta Hort.*, 212, 125- 130.
- Voon., Y. Y. Sheikh Abdul Hamid., N. Rusul. G., Osman, A. And Quek, S. Y. (2006) . Physicochemical, microbial and sensory changes of minimally processed durian (*Durio zibethinus* cv. D24) during storage at 4 °C and 28 °C. *Postharvest Biology and Technology* 42 168–175.
- Vuartaz, G., Meunier, V., and Andriex, J. C. (2010). TG-DTA approach for designing reference method for moisture content in food powder. *Food Chemistry*, 122, 436-442.

The authors

M. H., Rodiah

Faculty of Science and Biotechnology,
Universiti Selangor (UNISEL)
Selangor
E-mail: rodiah@unisel.edu.my

Nurul Aishikin

Faculty of Science and Biotechnology,
Universiti Selangor (UNISEL)
Selangor

H. Nurul Ain

Faculty of Science and Biotechnology,
Universiti Selangor (UNISEL)
Selangor