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# Sensory and Physico-chemical Evaluation of Soft-centered chocolate with banana filling and collagen

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**Abstract** This study was carried out to investigate the possibility of producing soft-centered chocolate with banana filling that have value added of collagen. Evaluation on the physical and chemical properties and consumer acceptability of the product were also performed. Three formulations (942, 623 and 490) of chocolate's filling were formulated along with other ingredients by varying the ratios of banana, sugar and water content. Approximately 0.5% of collagen was employed for each formula. Two types of sensory evaluation test were carried out which were Hedonic Scoring Test and Ranking Test. From the results, the overall acceptability was rated highest for sample 490. Physical analyses of the chocolate showed that sample 490 had 9.0% of total soluble solid and 5.57% of moisture content. Meanwhile for the chemical analysis, result indicated that fat content was 29.6%, ash content was 1.07% and pH was 6.9. This study showed that soft-centered chocolate with banana filling and collagen has a potential to be commercialized but further studies should be performed.

**Keywords** Chocolate; collagen; banana– *Musa acuminata*

## 1. Introduction

Nowadays, people have realized the benefit of the chocolate rather than believe the myths that chocolate can cause obesity and diabetes (Beckett, 2008). It is believed that by eating chocolate enable to promote feelings of well being and sensory pleasure. 'Cravings' for chocolate are commonly reported, particularly in women during the premenstrual phase and often occur at times of emotional stress, such as boredom, depression or anxiety (Macht and Mueller, 2007). In developed economies, a key trend at the moment is confectionery products that deliver functional benefits for health and well being, such as sugarless sweets and functional chocolate (Glaberson, 2010). So far, a range of functional products for the chocolate market has been developed. These include Acticoa, a cocoa powder that contains a high level of antioxidant polyphenols, probiotic chocolate for gut health, and a tooth-friendly chocolate made with isomaltulose, a natural constituent of honey and sugar cane (Eyre, 2008).

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 (Mueller *et al.*, 2007). 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 and Raines, 2009). Therefore, daily ingestion of collagen peptide can help control of ultraviolet-B that can cause skin damage and in an aged skin phenotype (photo-aging), including wrinkle formation. Hence, a total amount of 0.2 g of collagen peptide per kilogram of body mass per day is required (Tanaka, 2009).

In this study, banana was selected as the filling of the chocolate due to banana enriched with high nutrient value, like vitamin B6, vitamin C, vitamin A, niacin, thiamin, folacin, riboflavin, magnesium, copper, iron, phosphorus, and zinc (Ghosh, 2011). In fact, banana is in fourth rank as an important fruit crop that provides diet to millions of people

especially in South East Asia (FAOSTAT, 2005). Banana is one of plants that can grow all the time because it is classified as non-seasonal fruits, so that the price is affordable (Nelson *et al*., 2006).

Soft-centered chocolate with fruit as the filling is not only acceptable due to the nutrients in chocolate but also because of its unique texture and flavor in the chocolate. Therefore to enhance the commercial use of banana, this research attempts to produce soft-centered chocolate with banana filling which is supplemented with collagen to provide more health benefits to people.

## 2. MATERIALS AND METHODS

### 2.1 Materials

Banana (*Musa acuminata*) was obtained from wet market Kuala Selangor and was used as the main ingredient of the chocolate's filling. Meanwhile, halal collagen from bovine was purchased from Amin Co. Ltd (China).

### 2.2 Formulation of Soft-centered Chocolate

Three formulations (942, 623 and 490) of soft-centered chocolate with banana filling which heighten with collagen were prepared along with other ingredients (castor sugar, water, banana essence, sodium benzoate, gelatin (from bovine) and coloring agent). For preparation of filling, the amounts of all the ingredients were kept constant except for banana, sugar and water content. The following formulations were used for the production of coating chocolates: Milk compound chocolate (70%) and couverture chocolate (30%). The ratios of coating chocolate were also kept constant for each formulation. Handmade soft-centered chocolate that available in the market was used as reference and labeled as 137.

### 2.3 Sensory Analysis

Forty volunteered untrained panelists (20 males and 20 females) were took part in sensory analysis tests. The soft-centered chocolates were served in plastic cup labeled with three-digit on plates prior to testing in the sensory evaluation venue. Sensory analysis was done using a hedonic test according to method of Nielsen (1998). The panellists were asked to score the sample for liking of filling's color, hardness of chocolate, bitterness of chocolate, aroma of chocolate and overall acceptability. 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 requested 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.

A part of that, 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 panelists 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.

## 2.4 Physical and Chemical Analysis

### a) Determination of Total Soluble Solid (TSS)

The determination of total soluble solid (TSS) was done by directly measured using hand-held Refractometer MASTER-M (Atago, Japan) and the range of refractometer was from 0.0 until 33.0%. Due to sample was too concentrated, 10 g of homogenized chocolate sample was diluted with 10 mL of distilled water before sample was measured.

### b) Determination of Moisture Content

The determination of moisture content of the chocolate was performed using an oven method (AOAC, 1995). About 5 gram of the sample was weighed into a moisture dish which was previously dried at 105 °C for more than five hours in an oven and weighed until a constant weight was achieved. Then the uncovered dish was dried alongside for five hours. The chocolate was measured for moisture content with triplicate measurements. Then, the sample was cooled in desiccators and weighed until a constant weight was obtained. The percentages of moisture content were calculated by the following expression.

$$\text{Moisture content (\%)} = \frac{a - b}{b} \times 100$$

a = weight of sample before heating (g)
b = weight of sample after heating (g).

### c) Determination of pH

The determination of pH was done according to method of AOAC (1995). The pH was determined using the pH meter (Atago, Japan). Approximately, 15 gram of chocolate was mixed with 15 mL of distilled water until dissolved. Then, the electrode was immersed into the mixture for pH determination.

### d) Determination of Ash Content

The determination of ash content was performed according to AOAC method (AOAC, 1995). Approximately, 5 g of homogenized sample was weighed and put into pre-dried crucible. Later the sample was dried in a muffle furnace and heated at 550 °C for 24 hours. Then, the samples were allowed to cool down. Ash samples were weighed after all the sample became whitish or grayish appearance. The ash content was calculated by using the formula as followed.

$$\text{Ash content (\%)} = \frac{\text{(weight of crucibles and ash)g} - \text{(weight of crucible)g}}{\text{Weight of sample (g)}} \times 100\%$$

### e) Determination of Fat

Method for determination of fat content was determined using Soxhlet method (Nielsen, 1998; James, 1995). A pre-dried thimble was removed from the desiccators and weighed after the temperature attained at room temperature. Approximately, 2 gram of sample was placed in a thimble and reweighed. The thimble and its content were then placed in a Soxhlet extractor. Approximately, 80 mL of petroleum ether was also added into the flask and

extracted for three hours or longer. The extracted thimble was placed into a beaker under the Soxhlet extraction unit before it gets dried. Then, the thimble was removed from the Soxhlet extractor and was dried in an oven at 105 °C for one hour. The thimble was cooled in desiccators and weighed after the temperature attained at room temperature. After that, the fat content was calculated using the formula as follows.

Calculation :

$$\text{Percentage fat in sample} = \frac{\text{Weight of fat in sample}}{\text{Weight of sample taken}} \times 100\%$$

Weight of fat in sample = (Weight of flask + fat) – Weight of flask

### 2.5 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 three formulas and the reference sample. 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±standard deviations (SD) of the values obtained by three independent measurements.

## 3. Results and discussion

### 3.1 Sensory Analysis

A sensory evaluation test using Hedonic scale was conducted to compare the sensory of three formulations of soft-centered chocolate (942, 623 and 490) and reference sample (137). The averages for hardness, color, aroma, sweetness, bitterness and overall acceptability of soft-centered chocolate as well as their statistical significance and standard deviation are summarized in Table 1. From the result, there were no significant difference ($p>0.05$) among the three formulations of soft-centered chocolate (942, 623 and 490) and reference sample (137) except for the sweetness and overall acceptability. Sweetness indicated significant difference due to the dissimilar of content banana, sugar and water for each formulation. The results of this study are in line with those reported by Golob *et al.* (2004), who studied sensory acceptability of chocolate with inulin where the results showed that sweetness was also the attributes which devoted the most attention among panellists. From the result of hedonic test, the sensory data revealed a preference for formula 490 which has low sugar content but high proportion of banana. In this study, the sweetness was also contributed from the banana.

**Table 1**: Hedonic test of soft-centered chocolate and reference sample.

| | Attributes | | | | | |
|---|---|---|---|---|---|---|
| Samples | Hardness | Color (filling) | Aroma | Sweetness | Bitterness | Overall acceptability |

| | | | | | | |
|---|---|---|---|---|---|---|
| 942 (F1) | 7.40[a]±1.22 | 7.32[a]±1.39 | 6.95[a]±1.34 | 7.15[ab]±1.37 | 6.98[a]±1.44 | 6.75[b]±1.01 |
| 623 (F2) | 7.55[a]±1.36 | 7.03[a]±1.35 | 6.77[a]±1.49 | 7.25[b]±1.24 | 6.93[a]±1.82 | 6.85[b]±0.88 |
| 490 (F3) | 7.65[a]±1.55 | 7.60[a]±1.45 | 7.25[a]±1.46 | 7.47[b]±1.50 | 7.05[a]±1.68 | 7.70[bc]±1.07 |
| 137 (Ref.) | 7.20[a]±1.29 | 6.78[a]±1.76 | 6.63[a]±1.79 | 6.30[a]±2.02 | 6.68[a]±1.62 | 5.83[a]±1.03 |

[a-c]Means in columns without common superscripts are significantly difference ($p < 0.05$).

From the Ranking test (Table 2), the results show that there were no significantly different ($p>0.05$) between all the three formulations of soft-centered chocolate and the reference sample where the result exhibited that all the samples were quite close to the first place of ranking test for the tastiest chocolate. The lower the mean value, the closer it is to the first rank. In this test, sample 490 showed the lowest score, which was 2.17; therefore, this sample was placed at the first ranking and was selected as the best formulation (Figure 1).


Figure 1: Soft-centered chocolate from formulation 490

**Table 2**: Ranking test of soft-centered chocolate and reference sample.

| Sample | Mean ±standard deviation |
|---|---|
| 942 (F1) | 2.60[a]±1.06 |
| 623 (F2) | 2.20[a]±0.88 |
| 490 (F3) | 2.17[a]±1.19 |
| 137 (Ref.) | 3.02[a]±1.14 |

[a]Means in columns without common superscripts are significantly different ($p < 0.05$).

### 3.2 Physical and Chemical Analysis

#### Moisture Content

As tabulated in Table 3, moisture content for each formulation was low especially for the samples 137 and 942, which were 3.52% and 3.76%, respectively. However, these results were slightly higher to the result reported by Lasekan *et al*. (2007) for moisture content of sucrose sweetened chocolate bar and aspartame sweetened chocolate bar which were 0.65% and 0.38%, respectively. Generally, the lower the moisture content the higher it can discourage harmful microorganisms from surviving. In fact, according to Vuartaz *et al*. (2010), the presence of sufficient water in food is one of the main growth factors for harmful micro-organisms to survive. Moisture content is important to be measured because moisture is an indicator of shelf life for food by determined the aesthetics of food and then giving estimates to product shelf life (Beckett, 2008). Therefore, sample 942 might be stored longer than the other two formulations of soft-centered chocolate. In addition, 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).

#### Total Soluble Solid (TSS)

As shown in Table 3, total soluble solid for all chocolates show significantly different ($p< 0.05$) among others that were ranged from 9.0% till 27.6 %. This is caused by the different content of the organic materials which presence in the ingredients of each formulation (data not shown). As stated by Singh *et al*. (1996), total soluble solid is the total concentration of all soluble solid in the sample since most samples contains substances other than sugar such as salts, minerals and protein.

#### pH

Based on Table 3, pH was found not to be significantly difference ($p>0.05$) between all the chocolates. The ranges of the pH were 6.90 until 7.17, which were close to pH neutral. According to Rieneccius (1999), pH of chocolate can be as low as pH 5.5 and as high as pH 8.8. The results proved that pH for all soft-centered chocolates in this study were within range of normal chocolate in the market.

#### Ash Content

The ash content is a measure of the total amount of minerals present within a food (Nielsen (1998). Ash content for each sample was depicted significant difference ($p<0.05$) between each formulation because of the diverse content of organic substances used in the ingredients. As shown in Table 3, sample 490 indicated the highest ash content, which was 10.07 while sample 942 exhibited the lowest ash content which was 6.68%. However, these results were slightly higher to the result reported by Lasekan *et al*. (2007) for ash content of sucrose sweetened chocolate bar and 2% aspartame sweetened chocolate bar which were 5.12% and 5.61%, respectively. By knowing the ash content in food, it helps to improve the quality of the product in term of to increase their shelf life. If the ash content was higher it showed a very good food because it helps retard the growth of the microorganisms (McClements, 2001).

### Fat Content

Table 3 shows that no significant differences were determined in fat content of all chocolates. However the highest fat content was achieved by reference sample (137), which was 34.2% of fat content. From the result obtained exhibited that all formulated chocolates were low in fat content which is good in term of healthiness if compared with reference sample. The fat content from this research were comparable to the result studied by Lettieri-Barbato *et al*. (2012) which reported that high antioxidants dark chocolate and dark chocolate were 37.7% and 35.0, respectively. Product of soft-centered chocolate should have fat content for couverture chocolate and milk chocolate about 25% to 40% (Beckett, 2008).

**Table 3**: Physical and chemical analysis for soft-centered chocolate and reference sample

| Parameters | Sample Codes | | | |
|---|---|---|---|---|
| | 942 (F1) | 623 (F2) | 490 (F3) | 137 (Ref) |
| pH | $7.17^{a}\pm0.15$ | $7.03^{a}\pm0.25$ | $6.90^{a}\pm0.10$ | $7.17^{a}\pm0.15$ |
| Ash Content | $6.68^{a}\pm0.47$ | $7.62^{ab}\pm0.39$ | $10.07^{c}\pm0.77$ | $8.21^{b}\pm0.12$ |
| Moisture Content | $3.76^{a}\pm0.47$ | $7.53^{b}\pm1.65$ | $5.57^{ab}\pm0.47$ | $3.53^{a}\pm0.17$ |
| Total Soluble Solid (Brix %) | $20.67^{c}\pm2.08$ | $14.33^{b}\pm2.08$ | $9.00^{a}\pm1.00$ | $27.67^{d}\pm2.51$ |
| Fat Content | $27.3^{a}\pm3.66$ | $28.6^{a}\pm1.52$ | $29.6^{a}\pm2.40$ | $34.2^{a}\pm1.61$ |

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

## 4. Conclusion

In this study, the potential of using banana and collagen as the filling of soft-centered chocolate in the production of different formulation of chocolate was evaluated. The sensory data revealed a preference for formulation 490 where this sample was rated highest for the overall acceptability. Therefore, this formula has a potential to be commercialized but further studies should be performed particularly to characterize the product as functional food such as determination of polyphenolic content, antioxidant and rheological properties.

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## 6. References

AOAC. (1995) *Offical Method of Analysis* (16th Edn). Association of Official Analytical Chemists. Washington, DC.

Beckett, S. T. (2008) *The Science of Chocolate*, (2nd edn.), UK: RSC Publishing.

Eyre, C. (2008) Functional chocolate creeps up on mainstream. [News headlines]. Retrieved May 15, 2012. http://www.confectionerynews.com/Markets/Functional-chocolate-creeps-up-onmainstream.

FAOSTAT. (2005) Food and Agriculture Organization of the United National Statictical Database. Retrived May 16, 2011. http://faostat.fao.org.

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.

Glaberson, H. (2010) New multi-vitamin dark chocolate range. [News headlines] Retrieved June 14, 2012. http://www.confectionerynews.com/Markets/New-multi-vitamin-dark-chocolaterange.

Golob, T., Micovic, E., Bertoncelj, J., and Jamnik, M. (2004). Sensory acceptability of chocolate with inulin *Acta agriculturae slovenica***, 83(2) :** 221-231

James, C. S. (1995) Analytical Chemistry of Food, Seals-Hayne Faculty of Agriculture, Food and Land Use. Department of Agriculture and Food Studies. University of Polymonth, United Kingdom, 1: 96-97.

Lasekan, O. O., Ogunwolu, S. O., Hamzat, R. A. and Bamgbelu, O. A. (2007) Development and evaluation of aspartame sweetened chocolate. *African Crop Science Conference Proceeding*, **8**: 1789-1790.

Lettieri-Barbato, D., Villaño, D., Beheydt, B., Fiorella Guadagni, F., Trogh, I., and Serafini, M. (2012). Effect of ingestion of dark chocolates with similar lipid composition and different cocoa content on antioxidant and lipid status in healthy humans. *Food Chemistry***.132 (3),** 1305–1310

Macht, M. and Mueller, J. (2007) Immediate effects of chocolate on experimentally induced mood states. *Journal Appetite,* **49 (3):** 667-674.

McClements, D. J. (2001) *Analysis of food products,* US: CRC Publisher.

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.

Mueller, C. A., Schluesener, H. J., Fauser, U., Conrad, S. and Schwab, J. M. (2007). Lesional expression of the endogenous angiogenesis inhibitor endostatin/collagen XVIII following traumatic brain injury (TBI). *Exp Neurol*, **208**: 228–237.

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 Edn). Gaithersbury, Maruland: ASPEN Publication.

Rieneccius, G. (1999) *Source book of flavors*, (2nd Ed.). : United State. An Aspen Publisher, Inc.

Singh, P. C., Bhamidipati, R. K., Singh, R. S., Smith, and Nelson, P. E. (1996) Evaluation of in Line Sensor for Prediction of Solid and Total Soluble and Moisture in Continuous Processing of Fruit Juice. *Food Control*, **7 (3):** 141-148.

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.

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.