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Sensory evaluation of chocolate bar production materials of dry cocoa seeds in various fermentation treatments

Nurhayati Nurhayati[1*], Mulono Apriyanto[2]

[1]*Department of Agricultural Product Technology, Faculty of Agriculture, Universitas Muhammadiyah Mataram, Mataram, Indonesia*
[2]*Department of Food Technology, Faculty of Agriculture, Islamic University of Indragiri, Indragiri Hilir city, Riau, Indonesia*

**Corresponding author: mulonoapriyanto71@gmail.com*

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Abstract: The processing of chocolate bars is influenced by cocoa beans used. Chocolate bar is one of the downstream products with a simple processing process. The taste and aroma in candy comes from chocolate bars. Fermentation is an important activity in the formation of cocoa flavour. This study aims to determine the panellists' acceptance of chocolate bars produced from various fermentation treatments of sun-dried cocoa beans. The materials used in this study were cocoa beans of varieties of Lindak. The fermentation variation consisted of two treatments, namely, the addition of the inoculum gradually (A1) and the addition of the inoculum simultaneously at the beginning of fermentation (A2). The inocula added were *Sacharomyces cerevisiae* (FNCC 3056), *Lactococcus lactis* (FNC 0086) and *Acetobacter aceti* (FNCC 0016). The control treatment was dry cocoa beans without fermentation (A0). The fermentation time was 120 h, then the fermented cocoa beans were processed into chocolate bars. The resulting chocolate bars were subjected to sensory analysis including evaluation of the taste of sepia, bitter, and sour taste and in the test the polyphenol content of chocolate bars was used. The results showed that there was a decrease in the septic, bitter and sour taste from treatment A0, A2 and A1, respectively. The highest polyphenol content was in A0, A2, and A1, respectively. Panellists stated that the preferred chocolate bar was made from cocoa beans with A1 treatment.

Keywords: dry cocoa beans; chocolate bar; fermentation

Farmers have not utilized cocoa as one of the plantation products in Indragiri Hilir, Riau Province, Indonesia country (Apriyanto et al. 2016) where the development of cocoa commodities in several regions in Indonesia and the increase in production should be followed by an increase in the quality of cocoa beans and development towards downstream processing (Li and Komarek 2017). One of the products from processed cocoa beans is chocolate bars. The processing of chocolate bars is influenced by the dry cocoa beans used (Djaafar et al. 2019). Chocolate bar is one of the downstream products with a simple processing process. Chocolate bars in candy making to give flavour and aroma (Li and Komarek 2017; Djaafar et al. 2019). Aroma and taste are formed due to chemical changes and the flavour formation process of cocoa beans (Koffi et al. 2017; Apriyanto and Umanailo 2019). There are various kinds of post-harvest handling of fresh cocoa beans at the farmer level, namely fermented cocoa beans and unfermented cocoa beans (Zhang et al. 2018).

Fermentation is an important activity in the formation of cocoa flavour. Fermentation begins with the process of changing the sugar compounds in the pulp of the cocoa beans to acetic acid, which increases the temperature and results in the death of the beans (Apriyanto 2016; Saunshi et al. 2020). During fermentation, there is a process of forming tastes, colours and aromas through the enzymic process, starting with the forma-

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tion of organic acids which induce the enzymic process as well as biochemical processes resulting in colour changes and in a decrease in polyphenol compounds (Anyimah-Ackah et al. 2019; Apriyanto and Umanailo 2019; Djaafar et al. 2019), while changes in total fermented cocoa beans are a decrease in dry weight, an increase in peptide-N content, total reducing sugars and a decrease in sucrose and total sugar. Ganeswari et al. (2015), Fidelis and Rajashekhar Rao (2017), Barišić et al. (2019), and Vitinaqailevu and Rajashekhar Rao (2019) found that the concentration of free amino acids (acidic) decreases in line with the increase in the total amino acid content, hydrophobic free amino acids. After 7 days of fermentation, the theobromine content in the seeds (cotyledons) decreased and it increased in the skin (testa), due to the migration of theobromine from cotyledons to the testa during fermentation. The theobromine migration process occurs within 24–48 hours from the beginning of fermentation (Barišić et al. 2019). Apriyanto and Umanailo (2019) found that polyphenol compounds during fermentation also decreased by 53.4%. Cocoa beans are rich in polyphenol content which contributes to the nutty taste of cocoa candies (Wei et al. 2017).

Drying the cocoa beans after fermentation allows reducing the moisture content in the beans thereby extending the shelf life and suppressing the growth of fungi on the beans. During the drying process, the taste and colour of the chocolate develop, and the taste of the cocoa beans decreases (Ganeswari et al. 2015). Different methods of drying the beans and the fermentation process will affect the quality of the dry cocoa beans and chocolate bars produced. Currently, optimal conditions for drying cocoa beans in the handling process in order to obtain high quality are needed.

MATERIALS AND METHODS

Materials. The 'Forastero' variety of cocoa pods was obtained from Sanglar Village, Indonesia; the length of the pods was ± 13 cm, the diameter was ± 6 cm, the optimal ripe fruit skin was orange, the number of beans per pod was ± 30 beans. The first part of fresh cocoa beans was removed from the pod, then washed and fermented for 5 days (120 hours). The second part of the fruit without washing was then split open to remove the seeds and dried in a cabinet dryer at a temperature of 40 °C until the moisture content of the seeds was 15%. Furthermore, the dry seeds were immersed in water with chanches 10% (w/v), then spontaneously fermented for 5 days (120 hours) at room temperature (Apriyanto et al. 2016).

Fermentation of non-fermented dry cocoa beans was carried out in a fermentation box, each box contained 10 kg of non-fermented dry cocoa beans. The number of pure yeast cultures and acetic acid bacteria added (10^8 CFU g^{-1}) was based on the number of pure cultures added to ordinary cocoa fermentation (Apriyanto 2016; Júnior et al. 2020). The pure culture used consisted of *Sacharomyces cerevisiae* (FNCC 3056), *Lactobacillus lactis* (FNC 0086) and *Acetobacter aceti* (FNCC 0016) from the Microbiology Laboratory of the Centre for Food and Nutrition Studies, Gadjah Mada University, Indonesia according to the research of Apriyanto and Umanailo (2019).

Methods. Fermentation was carried out using three methods, namely: (1) non-fermented cocoa beans without addition of the pure culture (control, A0), (2) cocoa beans were added a pure culture mixture (A1), (3) cocoa beans were added the pure culture gradually when at the beginning of fermentation *Saccharomyces cerevisiae* was added, *Lactobacillus lactis* was added after 24 h, then after 48 h *Acetobacter aceti* was added (A2) (Apriyanto and Umanailo 2019). After fermentation for 5 days (120 hours) the cocoa beans were dried in the sun, the drying process was stopped when the moisture content of the cocoa beans was ± 7%, which was indicated by the cracking of the epidermis. (4) Fresh cocoa beans were fermented spontaneously without addition of the pure culture (A0).

An amount of 1 000 g of dry cocoa beans from each treatment was roasted at 150 °C for 30 min using a cylinder-type roaster equipped with a thermometer and thermocouple. The roaster works automatically at a rotating speed of 24 rpm. The cocoa beans that have been roasted are then separated from the pods manually to obtain nibs (skin-free cotyledons). The nibs of the cocoa beans are ground using a blender followed by grinding using a meat grinder until a coarse paste is formed. Then the coarse paste is mashed for 6 hours at a temperature of 50 °C. During the refining process, cocoa butter (30%), refined sugar (40%), and lecithin (0.5%) were added (Zhang et al. 2018). The temperature of the resulting paste was lowered to 27 °C while stirring, then its temperature was increased to 30 °C while stirring. Printing and cooling are done immediately after reaching the temperature of 30 °C. The resulting chocolate bars were subjected to sensory analysis including bitter and sour tasting as well as overall acceptance. Interventional studies involving animals or humans, and other studies require ethical approval must list the authority that provided approval and the corresponding ethical approval code (Ruban et al. 2016).

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The resulting chocolate bar was subjected to sensory analysis including the harsh taste, bitter taste and sour taste and overall acceptance. The panellists were untrained panellists (30 persons). Descriptive rating scale: 1 – very bitter; 2 – more bitter; 3 – bitter; 4 – neutral; 5 – slightly bitter; 6 – not bitter; 7 – not very bitter. Favourite rating scale: 1 – least liked to 7 – most liked. The design used in this research was a completely randomized design (RAL).

RESULTS AND DISCUSION

Sensory evaluation is a descriptive test to see the attributes of the taste of astringency, sour taste and bitter taste of chocolate bars from the three treatments. The descriptive test results are shown in Figure 1. From Figure 1 it can be seen that A0 has bitter taste of 7 on the scale, sour taste of 2 on the scale, taste of astingency of 3 on the scale. Bitterness on a scale of 7, sour level on a scale of 4 and astringency level on a scale of 6. The A1 treatment shows bitter taste of 4 on the scale, sour taste of 3 on the scale, taste of harsh of 5 on the scale. Bitterness on a scale of 4, sour level on a scale of 4 and sepia level on a scale of 7. The A2 treatment shows bitter taste of 5 on the scale, sour taste of 4 on the scale, taste of astringency of 6 on the scale. Bitterness on a scale of 4, sour level on a scale of 6 and sepia level on a scale of 4.

Bitter taste. The descriptive test results of the bitter taste attribute show that the fermentation process of A2 treatment is the most preferred. The chocolate bars produced by fermentation of A0 and A1 treatments provide a higher bitter taste sensation than chocolate bars from the A2 treatment variations. This is in line with the research of (Ruban et al. 2016) that perfect fermentation reduces polyphenol levels. The fermentation process will reduce the polyphenol content of the cocoa beans. According to (Apriyanto and Umanailo 2019; Djaafar et al. 2019), the bitter taste of roasted cocoa beans is caused by caffeine, theobromine, some 2,5-diketopiperazine. The bitter taste attribute that appears in the descriptive test for chocolate bars is caused by the polyphenol and theobromine content, which is in line with the results of testing for polyphenol levels in fermented cocoa beans (Apriyanto and Umanailo 2019) during polyphenol oxidation through polyphenol oxidase activity. The higher the concentration of polyphenols in chocolate, the bitter and chewy taste will increase, while the other sensory attributes are not affected by the presence of polyphenol concentrations. This bitter taste attribute also appears in chocolate made from cocoa beans originating from Papua New Guinea, while the Ghana chocolate sample has a characteristic medium bitter taste (Djaafar et al. 2019). The fermentation process reduces the theobromine content by about 40% due to diffusion (Hinneh et al. 2019), while the roasting process of cocoa beans in the process of making chocolate bars reduces the levels of polyphenols which reduce the bitter taste with other alkaloids, some amino acids, peptides, and pyrazine that contribute to the bit-

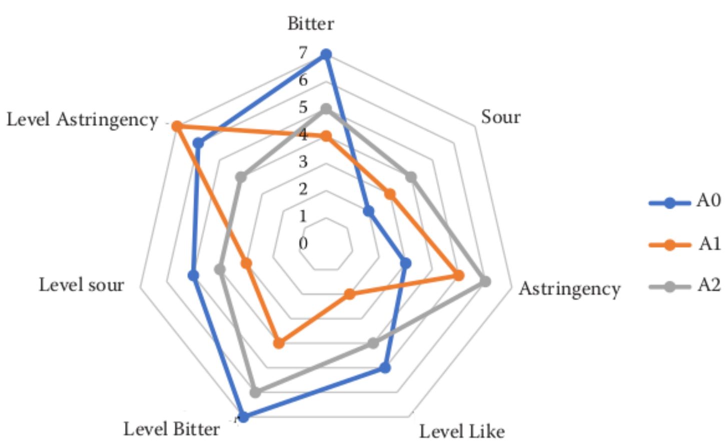

Figure 1. Descriptive test results for sour, bitter, and astringency attributes and tests for the chocolate bar preference of dry cocoa beans in various fermentation variations

Descriptive rating scale: 1 – very bitter, 2 – more bitter, 3 – bitter, 4 – neutral, 5 – slightly bitter, 6 – not bitte, 7 – not very bitter; favourite rating scale: 1 – least liked to 7 – most liked

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ter taste. The levels of theobromine in chocolate bars also have an effect on the bitter taste of chocolate bars.

The results of the descriptive test for the flavour attribute showed that the A2 fermentation process was the smallest; it was shown by research (Júniora et al. 2020) that the high concentration of polyphenols in cocoa beans had an effect on the bitter and lasting taste of the resulting chocolate bars. According to Apriyanto (2017), the addition of the inoculum gradually produced cocoa beans with the lowest polyphenol content. Based on the sensory test, the resulting chocolate bars showed bitter taste and lower astringency. The polyphenol content of dry cocoa beans can be identified through sensory testing based on the feeling of being harsh. Non-fermented chocolate bars provide a higher sensation of heat than fermented chocolate bars.

In line with research of Rahmadewi and Darmadji (2019) the fermentation process and the drying method have a significant effect on the sensation of sleep. This shows that the processing of dry cocoa beans into chocolate bars does not reduce the tasting attribute maximally.

Sour taste. Characteristics of chocolate bar sour taste were highest in treatment A2 compared to other treatments. This shows that during fermentation, acetic acid compounds will be formed in the cocoa beans and give the chocolate a sour taste sensation. In previous research (Rahmadewi and Darmadji 2018, 2019) showed that at the end of the fermentation process the concentration of acetic acid in fermented cocoa beans with the highest inoculum addition treatment variations (A2). As a result of the pulp fermentation process, organic acids and these acids diffuse into the beans during the fermentation process. The acid in the seeds cannot completely disappear during the drying process. The chocolate bars made from cocoa beans treated with A0 and A1 did not show any detection of strong sour taste. The processing of dry cocoa beans into chocolate bars was not able to remove the acid in the beans, so the resulting chocolate bars still taste sour. The A0 treatment resulted in the chocolate bar giving a lower sour taste sensation than the other chocolate bars.

Likeness level. The results of the ranking test show that variations in the fermentation process will give different levels of preference to the resulting chocolate bars. The A2 fermentation treatment showed the highest preference compared to other treatments. This is in line with research of (Rahmadewi and Darmadji 2019) that the panellists do not like the high content of polyphenols in chocolate bars made from dry, non-fermented cocoa beans that produce a higher bitter and dry taste sensation. Favourite evaluation is done by the ranking test of chocolate bar products. The preference test for the attributes of sour, bitter, and spicy taste as well as the overall preference that was carried out showed that the fermentation process gave different levels of preference for sour, bitter, harsh, and overall tastes to the resulting chocolate bars.

The A2 treatment gave a bitter and cool taste sensation which was preferable to the chocolate bar treated with A0 and A1, while the panellists' preference for sour taste did not show any difference between fermentation treatments. Overall, chocolate bars from A1 treatment were preferred by the panellists to chocolate bars from treatments A0 and A2.

CONCLUSION

Bar chocolate made from cocoa beans treated with the addition of the inoculum gradually (A1) has less acidic, bitter, and astringent taste and is more acceptable and preferred by the panellists than chocolate bars made from cocoa beans treated with control (A0) and the addition of the inoculum simultaneously at the beginning of fermentation (A2). The process of making chocolate bars does not have a major effect on the polyphenol content of the cocoa beans, so the bitter taste and taste of chocolate bars are strongly influenced by the success of the cocoa bean fermentation process.

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