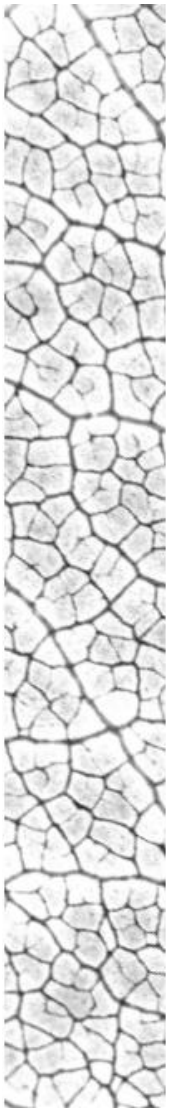

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Best formulation of cacao butter and powder for chocolate bar production

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Abstract

Background: Chocolate is one of the most popular consumer products worldwide. But its high-calorie content means that it is often avoided for health considerations. Manufacturers faced with this issue in the formulation of chocolate products therefore often focus on the improvement of cocoa quality.
Aim: This research aimed to determine the best formulation of fat and chocolate powder for chocolate bar production based on the latter's organoleptic and physicochemical properties.
Methods: Bars were produced using cocoa butter (15, 20, and 25%) and cocoa powder (20 and 25%). The analysis was undertaken regarding parameters including fat content, melting point and stability, and organoleptic properties including color, odor, flavor, and texture.
Results: The results showed that the addition of 20% cocoa butter and 20% cocoa powder produced chocolate bars with the best flavor and texture parameters. The concentration of fat and cocoa powder in the manufacture of the chocolate bars influenced organoleptic taste and texture but did not affect color and aroma.
Conclusion: Cocoa butter levels in chocolate formulations had a significant effect ($p < 0.05$) on fat content.

Keywords: best formulation, chocolate bar, cacao butter, cacao powder

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INTRODUCTION

The island of Sulawesi in western Indonesia is one of the world's most critical cocoa-producing regions. Cocoa's unique chemical and physicochemical properties mean it can be processed into various food products, including chocolate, which is produced by mixing cocoa butter with various other ingredients such as milk, cocoa powder, and sugar. The use of cocoa to manufacture chocolate offers several advantages, including providing a distinctive flavor, melting resistance at room temperature, and melting at body temperature. Cocoa also contains bioactive compounds that have several health benefits, such as catechin, phenols, and flavonoids (Scapagnini et al., 2014).

Different fat sources in chocolate vary in their physical and chemical characteristics, including their melting point, refractive index, and free fatty acid content (Vitova et al., 2009). Differences in the quality of cocoa fats thus influence the quality of the resulting chocolate bar. In addition to cocoa butter, the cocoa powder also affects chocolate bar quality regarding taste, aroma, and color (El-Kalyoubi et al., 2011). Considering the above, the content of cocoa butter and cocoa powder has a considerable influence on the characteristics of the resulting chocolate bar.

Although chocolate is one of the most popular consumer products worldwide, its high-calorie content means that it is often avoided for health considerations. Manufacturers faced with this issue in the formulation of chocolate products therefore often focus on the improvement of cocoa quality. The characteristics of cocoa raw materials are affected by several factors, including the region of cultivation, cultivation method, and post-harvest handling. According to Moriarty et al. (2014), some of the best cocoa worldwide is produced using fermented dry cocoa beans grown in the district of Mamuju in western Sulawesi. However, there remains a lack of knowledge regarding how chocolate formulation affects consumer preference.

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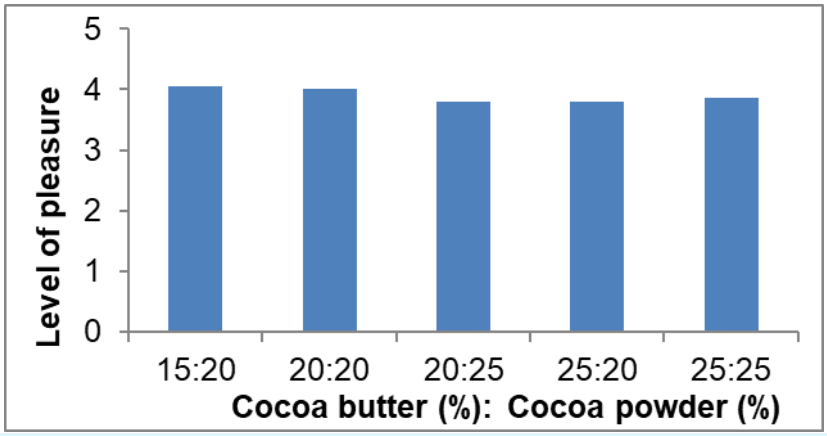

Fig. 1. Survey scores regarding color for each cocoa butter/powder formulation

MATERIALS AND METHODS

Research design

Data processing was carried out based on descriptive statistics and the experiments' randomized complete block design (RCB). Two factors were analyzed for a variance, namely cocoa butter concentrations, and the concentration of cocoa powder and sugars, with two replications.

Extraction of cocoa butter/fat and cocoa powder manufacture

Dried fermented beans (Tappalang, Mamuju District) for 3-5 days were sorted and the skins peeled to obtain cocoa nibs, with the nibs then ground roughly (stone mill). The resulting cocoa paste was placed in a cylindrical container with holes for filter pressing. Butter extraction was carried out using a hydraulic press at a pressure of 40 psi for 10 minutes at 50 °C. Cocoa butter flowed through the cylinder holes and into the surrounding container, with the cocoa cake retained in the cylinder as a byproduct. The obtained extract was then analyzed regarding its physical and chemical parameters (fat content, water content, free fatty acids, refractive index, and melting point). For cocoa powder, after drying, the cocoa cakes obtained as above were ground to form cocoa powder.

Chocolate bar manufacture

The first step involved weighing out all the ingredients according to the selected formula. Three different treatments or concentrations of cocoa butter were employed (A1 = 15%; A2 = 20%; A3 = 25%), and two different concentrations of cocoa powder (B1 = 20%; B2 = 25%). Cocoa butter was heated at 50 °C until melting, with cocoa powder, skimmed milk, sugar, vanilla and lecithin then added. The mixture was then subjected to a conching temperature of 70 °C for 16 hours, producing a chocolate emulsion. Tempering of the emulsion was performed at temperatures of 45 °C – 26 °C – 40 °C, followed by printing in a mold at 35 °C. Finally, the bars were cooled at 10 °C to harden the chocolate emulsion and conditioned at 20 °C for 24 hours.

Research parameters

Chocolate bars were measured by organoleptic and physicochemical properties. Organoleptic properties were tested to 20 panelists regarding their color, aroma, taste, and texture. Preference levels of both used hedonic 5 scale (really like, like, kind of like, dislike, and immensely dislike). Physicochemical properties were stability (incubated in 37 °C), fat blooming (stored at room temperature for 3 weeks and observed daily for white spot in surface) and calorie content by using bomb calorimeter.

Data analysis

Data were analyzed by analysis of variance (ANOVA) two ways factorial and significant different were further subjected to Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Organoleptic surveys

Color

The survey revealed that participants preferred the color of the chocolate bar containing 15% cocoa butter and 20% cocoa powder. Overall, the panelists liked (score >4) the color produced, which was a little darker than chocolate bars in general (**Fig. 1**). This is by Aprotosoaie et al. (2016), who reported that the standard 60% of cocoa beans used in chocolate manufacture exhibit a purple color initially, but change to brown when the fermentation process is complete due to an enzymatic reaction.

Odor

Product odor may have a significant influence on consumer preference, in particular as an indicator of quality. As with color, the panelists preferred the aroma of chocolate bars produced using 15% cocoa butter and cocoa 20% powder (**Fig. 2**). Chocolate bar odor is influenced mainly by the base material, with cocoa powder, in particular, providing a distinctive odor. In the

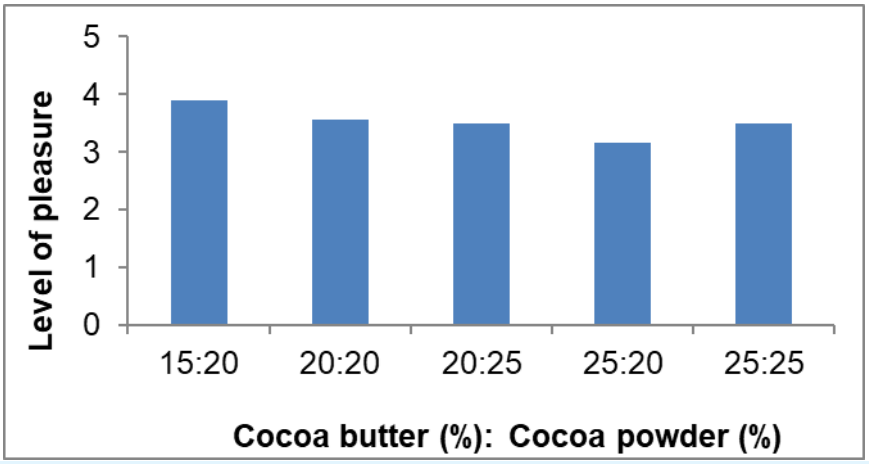

Fig. 2. Survey scores regarding chocolate bar odor for each cocoa butter/powder formulation

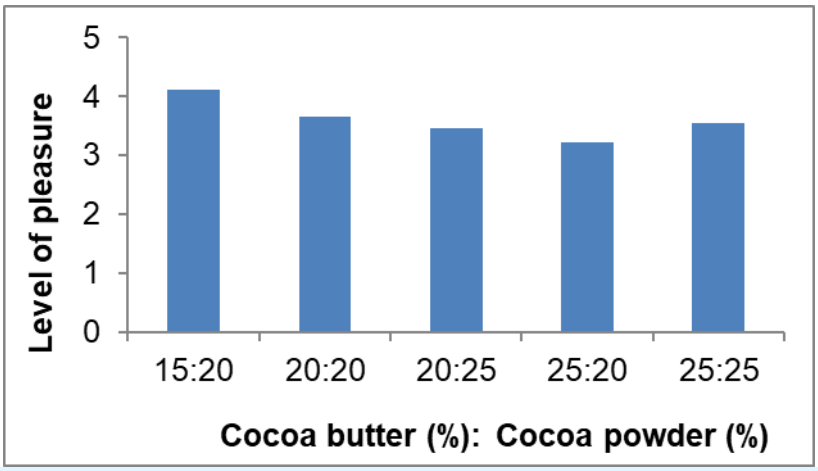

Fig. 3. Survey results regarding chocolate bar flavor, for each cocoa butter/powder formulation

present study, the cocoa beans used to manufacture the chocolate bars had been through the process of fermentation, producing an odor preferred by the panelists compared with that of unfermented beans. The results are also consistent with the work of Meng et al. (2009), who found the highest phenolic compound content in dark chocolate due to the increased amount of cocoa used, including both cocoa butter and cocoa powder. Other than phenolic compounds, theobromine is also found in dark chocolate.

Flavor

As shown in **Fig. 3**, the panelists again preferred the taste of the chocolate containing 15% cocoa butter and 20% cocoa powder.

Texture

A soft chocolate texture, which is generally preferred by consumers, is typically achieved via the addition of cocoa butter or other fats. Here the assessment panel again preferred the texture of the chocolate bars containing 15% cocoa butter and 20% cocoa powder. Although panelists generally liked the texture of all the produced chocolate bars, the use of additional cocoa butter and cocoa powder affected chocolate texture and therefore consumer preference. In particular, the chocolate manufactured with 20% butter and 20% powder differed from that containing 25% of each ingredient, i.e., the same ratio (**Fig. 4**). This result is consistent with the statement of Torbica et al. (2006), who reported that the final texture of chocolate, related to its melting resistance and crystal formation, is influenced by the use of fat powders.

Physicochemical Test

Stability

The melting points of the chocolate bars produced using each of the selected formulations are shown below in **Fig. 5**. The tested chocolate bars exhibited melting points ranging from 28 °C to 32 °C, only a little lower than that of pure cocoa butter (34-37 °C). Here the chocolate containing the least cocoa butter (15%) presented the lowest melting point.

Fat blooming

All the tested chocolate bars generally exhibited fat blooms during storage, as characterized by the appearance of white dots that eventually covered the entire surface of the bar. As reported by Tisoncik (2013), the emergence of fat blooms depends on many factors,

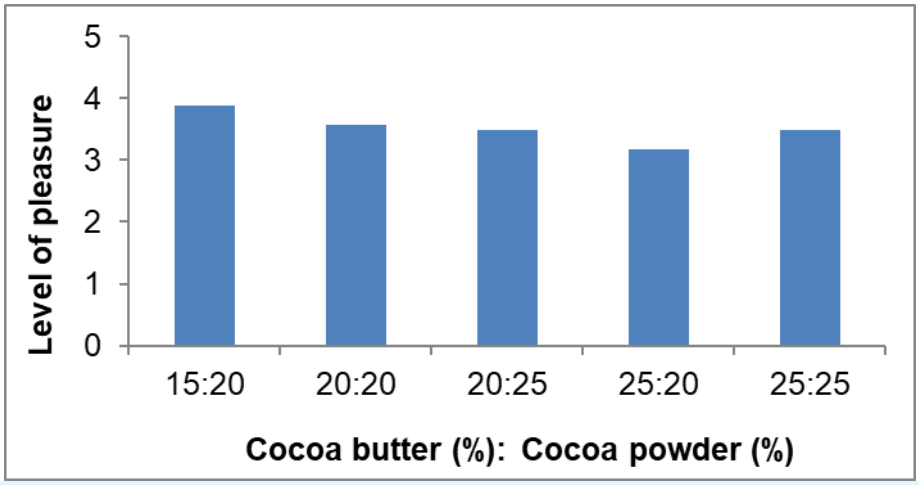

Fig. 4. Survey results regarding chocolate bar texture, for each cocoa butter/powder formulation

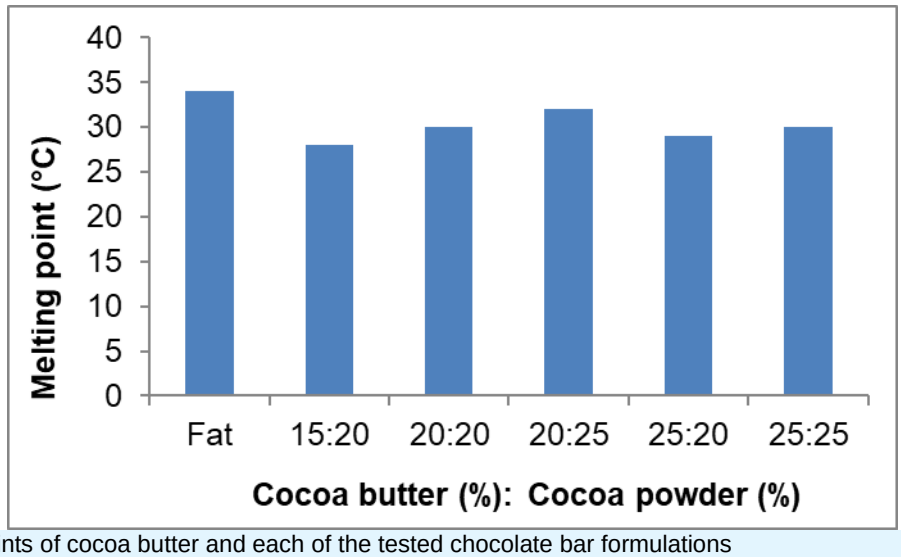

Fig. 5. Melting points of cocoa butter and each of the tested chocolate bar formulations

including chocolate formulation, the manufacturing process, bar printing, and tempering. The latter process can potentially inhibit the appearance of fat blooms, depending on the temperature used.

Calorie content

The highest calorific value was recorded in the chocolate containing 25% cocoa butter and 20% cocoa powder, while the lowest value was found in the chocolate containing 20% butter and 20% powder. As stated by the McClements (2015), the calorie content of food is influenced by that of its constituent proteins, carbohydrates, fats, and other components. In the present case, this reflects the raw materials used in the manufacture of the chocolate, as well as the manufacturing process itself.

CONCLUSION

The chocolate formulation most preferred by the panelists was that containing 15% cocoa butter and 20% cocoa powder. The concentration of fat and cocoa powder in the chocolate bars influenced their organoleptic taste and texture, no significant effect was observed on color and aroma.

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