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The effect of coffee skin type and cornstarch concentration on characteristics of jam

*Suriati, L., Mangku, I.G.P., Yudi Ardana, I.D.G. and Putra, I.W.W.

Food Science and Technology Study Program, Faculty of Agriculture, Warmadewa University, Denpasar, Bali, Indonesia

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Abstract

Coffee has been the most popular commodity for decades, and an increase in its production also indirectly increases the number of coffee skins. Jam is one of the products obtained from coffee skin, and its properties are determined by the type of raw materials, moisture content, sugar content, acidity, and fillers type. Therefore, this study aims to determine the effect of coffee skin type and cornstarch concentration on jam's characteristics. A two-factor randomized block design was then used with three replications to determine its moisture content, viscosity caffeine content, antioxidant activity, reduced acid level, and acidity. Furthermore, the first factor was the type of coffee skin, which includes cherry husk, cherry pulp, and parchment skin, while the second factor was cornstarch concentrations, namely 5%, 10%, and 15%. The results showed that the two factors examined had a very significant effect on the moisture content, reduced sugar level, caffeine content, antioxidant activity, and viscosity of jam. Meanwhile, the jam produced from coffee cherry pulp with 10% cornstarch concentration had the best characteristics.

1. Introduction

Coffee is a plant commodity with a high economic value, and Kintamani Arabica (*Coffea arabica* L.) is one of Bali's leading coffees that is widely known for its antioxidant activity as well as its distinctive aroma and taste (Suhandy and Yulia, 2018). Its processing produces 55-60% green beans and 40-45% coffee skin (Klingel *et al*., 2020). An increase in its plantation also indirectly increases the number of skin coffee produced, including cherry pulps, sherry husks, parchment skin, silver skin, and spent coffee grounds (Sangta *et al*., 2021). Meanwhile, coffee skin is a problem for the community because it pollutes the environment, causes unpleasant odours, and has an irritating appearance (Torres-Valenzuela *et al*., 2020). Its utilization in Indonesia is also not optimal because it is only used for the manufacture of fertilizers and animal feed.

Coffee pods contain various secondary metabolites from its polyphenol group, which act as antioxidants, such as flavon-3-ol, hydroxycinnamic acid, flavanols, anthocyanidins, catechins, epicatechins, tannins, and ferulic acid (Esquivel and Jiménez, 2012). Klingel *et al*. (2020) also reported that cherry pulps contain 4–12% protein, 1–2% lipids, 6–10% minerals, 45–89% carbohydrates, 1.3% caffeine, as well as phenolic compounds. Meanwhile, Janissen and Huynh (2018) stated that cherry husk contains 8–11% protein, 0.5–3% lipids, 3–7% minerals, and 58–85% carbohydrates. The fiber amount contains 24.5% cellulose, 29.7% hemicellulose, and 23.7% lignin. Cherry husk also contains approximately 1% caffeine and 5% tannins. Parchment is a sturdy fibrous endocarp that covers coffee seeds' hemispheres and separates them from each other. It accounts for 5.8% of berry dry weight and consists of 40-49% (α-) cellulose, 25-32% hemicellulose, 33-35% lignin, and 0.5% ash. In wet coffee processing, the parchment is often removed after drying and hulling, which allows it to be collected and used separately. However, no study explored the use of coffee parchment as a food ingredient. Iriondo-DeHond *et al*. (2019) assessed its safety in food by investigating its extreme toxicity in mice and found no signs of toxicity, strange behaviour, or death.

Appropriate technology is needed to process coffee skin into useful products, such as jam, which is the current favourite food of the community (Bray *et al*., 2020). Furthermore, jam can be made from pulp or juice, by adding sugar and water, and then concentrating it until the consistency of jelly is obtained (Ferreira *et al*., 2021). Apart from its good taste, it also has a good

*Corresponding author.
Email: *suryati_luh@yahoo.com*

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nutritional profile and can be consumed with bread. Its physicochemical properties are also majorly determined by its basic ingredients. Meanwhile, studies on the effect of jam basic ingredients, namely the types of cherry husk skin, cherry pulps, and parchment skin on its characteristics are very limited. Thickening agents, citric acid, and food additives can also be added during its production.

Corn is one of the main sources of starch, which has numerous benefits, such as high starch levels, good consistency, high performance, ease of availability, and biodegradability (Hazrol *et al*., 2021). This is consistent with Song *et al*. (2018) that modified cornstarch effectively improved the quality of final products. Furthermore, cornstarch filler enhances products' properties and also increases their utility with low economic cost (Florencia *et al*., 2020). Mixing it with the ingredients of jam improves the smoothness and homogeneity of the product (Zhang *et al*., 2016). Modified starches and food components are held together by hydrogen bonds, and this is responsible for the heat-resistant characteristics of blueberry jam. Therefore, this study aimed to determine the effect of coffee skin types and cornstarch concentration on the physicochemical characteristics of jam.

2. Material and methods

This is an experimental study with a randomized design approach. The observation variables were tested at the Food Analysis Laboratory, Faculty of Agriculture, University of Warmadewa. The ingredients for making cherry pulps, cherry husk, and parchment skin were obtained from The Chess Village of Kintamani Bali. Meanwhile, other ingredients used for the production of jam, such as cornstarch, sucrose, vanilla essence were purchased from local businesses in Denpasar City, Bali Province, Indonesia.

The study design used a two-factor randomized block approach with three replications to determine moisture content, reduced sugar level, caffeine content, antioxidant activity, viscosity, and acidity of jam. The first factor was the type of coffee skin, which includes cherry husk, cherry pulp, and parchment skin, while the second factor was the concentration of cornstarch, 5%, 10%, and 15%. Subsequently, the data obtained were statistically tested using Analysis of Variance (ANOVA) and then continued with Duncan's Multiple Range Test to determine the difference in the remedy data.

2.1 Preparation of coffee skin

The coffee used was selected based on its maturation stage and physical integrity. It was then washed with water, and the green beans were separated from the cherry pulp using a stainless steel pulper machine (Braesi DES-10). The pulp was packaged in low-density plastic packaging (LDPE) and stored at 4°C until it was needed for jam production. Meanwhile, cherry husk was obtained by drying the coffee skin naturally with sunlight, and HKM 05 type huller was then used to dehusk the coffee. In wet coffee processing, the parchment is often removed after drying and hulling.

2.2 Production of jam based on coffee skin

Cherry pulp was stored in a refrigerator at 4°C, thawed, mixed with water in a ratio of 1:5, and then crushed with a blender until a slurry was formed. The acidity of the porridge produced was corrected with 60% citric acid to achieve the ideal pH of 3.2 for jam formation. Subsequently, the same process was carried out on cherry husk and parchment skin. Coffee skin porridge was mixed with sucrose in a ratio of 60:40, then cornstarch was added to 5%, 10%, and 15% proportions of the porridge. Cornstarch was also diluted with water and then added to the product. Vanilla essence and 2.5% ground coffee were added to the mixture to enhance its aroma. Furthermore, the ingredients were cooked in an open stainless-steel pan under continuous stirring for 20 mins, the jam was then placed in a 250 mL transparent glass jar that has been sterilized at 100°C for 15 mins. The jam was packaged, cooled by immersion in cold chlorinated water (10 ppm) to 24°C, and then stored in a dry and funky place until it was needed for physicochemical evaluation.

2.3 Physicochemical characteristics jam of coffee skin

The jam's physicochemical properties were determined through its moisture content, total dissolved solids, caffeine content, antioxidant activity, viscosity, and acidity. Its moisture content was tested in an oven (Memmert, Germany), while the total dissolved solids were assessed using a refractometer (950,032 B-ATC, France), and the results were expressed in °Bx. The level of acidity was determined with a digital pH meter (Hanna HI 8424, Romania), while the caffeine content was tested by diluting the caffeine extract 25 times in a 100 mL volumetric flask during the isolation process. Furthermore, its viscosity was evaluated using a UV-Vis spectrophotometer at a wavelength of 281 nm. Determination of antioxidant activity was then carried out with the DPPH method as explained by Shah and Modi (2015). The antioxidant activity percentage was calculated with the formula:

$$\text{Activity of Antioxidant (\%)} = \frac{\text{Absorbance of Control} - \text{Absorbance of Sample}}{\text{Absorbance of Control}} \times 100\%$$

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3. Results and discussion

3.1 Moisture content

Moisture content measurement provides important information about the quality of a product. This study's results showed that the treatment of coffee skin type and cornstarch concentration had a very significant effect on the moisture content of jam. The highest moisture content was obtained in jam made from 66.10% cherry pulps, while the lowest was obtained from 46.06% cherry husk, as shown in Figure 1. This is due to the high water content of cherry pulp, and this finding is in line with Klingel *et al*. (2020) that it contains approximately 71% water. Furthermore, the higher the concentration of cornstarch used, the lower the moisture content of the jam. This is because cornstarch forms a three-dimensional structure that retains water due to hydrogen bonds, and this causes a decrease in the moisture content (Zhang *et al*., 2016).

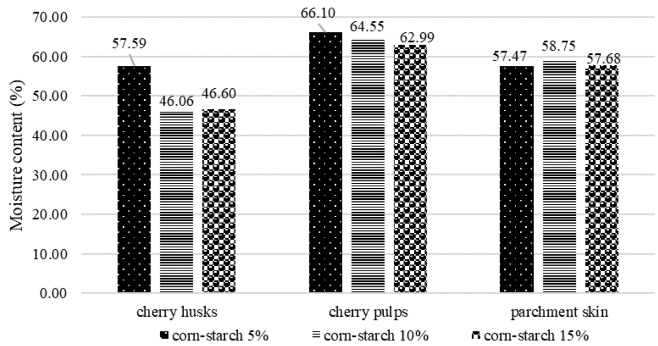

Figure 1. Moisture content (%) jam of coffee skin

3.2 Reduced sugar

Reduced sugars are a group of carbohydrates that oxidize electron-receiving compounds, for example, glucose and fructose. This study showed that the filler-type treatment and cornstarch concentration had a very significant effect on the jam's reduced sugar level. The highest amount of reduced sugar was obtained from parchment skin jams at 37.57°Bx, while the lowest was gotten from cherry pulps at 27.71°Bx, as shown in Figure 2. The increase in cornstarch concentration also led to an increase in the amount of reduced sugar. Meanwhile, cornstarch is a carbohydrate that experiences oxidation into simple sugar, and this increases its total sugar content. Di Monaco *et al*. (2018) and Suriati *et al*. (2021) also reported that reduced sugars have a sweet taste, and their interaction with water and hydrocolloids affects sol-gel transition. They also contribute to the total dissolved solids content of jam and participate in caramelization or Maillard reactions.

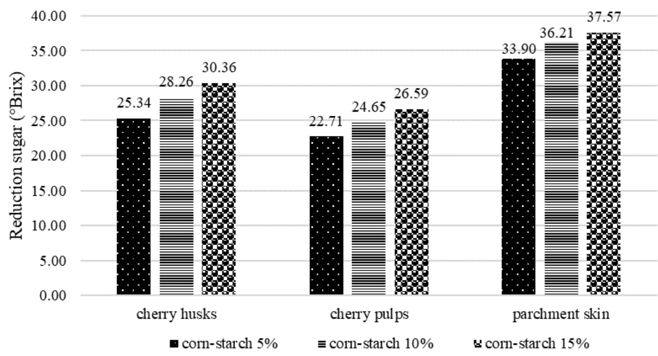

Figure 2. Reduction sugar (°Bx) jam of coffee skin

3.3 Caffeine

Caffeine, also known as trimethyl xanthine, is a stimulant that is present in some foods and beverages. The results showed that the type of coffee skin and concentration of cornstarch had a very significant effect on the jam's caffeine level. The highest jam caffeine level of 0.73 was obtained from the cherry husks treatment, while the lowest level of 0.36 was gotten from the cherry pulps treatment, as shown in Figure 3. Heeger *et al*. (2017) reported that the caffeine content of cherry pulp ranges from 3.4 to 6.8 mg/g, while Klingel et al. (2020) reported that cherry husk contains 0.283 mg/g caffeine. The addition of cornstarch reduced the caffeine content of the jam. Also, adding fillers decreased the amount of caffeine due to its high solubility in water. The caffeine content of a product depends on the type of coffee used and the extraction process (Andrade *et al*., 2012).

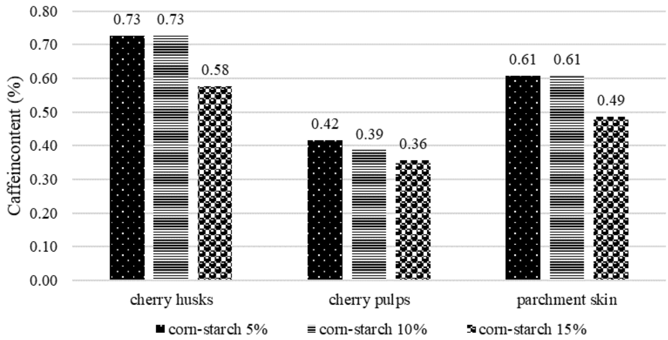

Figure 3. Caffeine content (%) jam of coffee skin

3.4 Antioxidant activity

Antioxidants are compounds in foods that neutralize free radicals, which play a role in coronary heart disease, cancer, and different diseases (Sikora and Świeca, 2018; Suriati *et al*., 2020a; Makori *et al*., 2021). Meanwhile, the antioxidant activity involves the inhibition of nutrient oxidation by restraining oxidative chain reactions (Shori *et al*., 2018; Liu *et al*., 2019; Suriati *et al*., 2020b; Wang *et al*., 2021). This study showed that the type of coffee skin treatment, the concentration of cornstarch, and their interactions had a very significant effect on the jam's antioxidant activity. Coffee skin contains several secondary metabolites, such as the polyphenol group, which consists of flavan-3-ol, hydroxycinnamic acid, flavanols, anthocyanidins, catechins, epicatechins, tannins, and ferulic acid (Esquivel and Jiménez, 2012). The highest antioxidant activity was obtained from

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88.36% cherry pulp treatment, while the lowest was gotten from 60.22% parchment skin treatment, as shown in Figure 4. Heeger *et al*. (2017) reported that the antioxidant activity of cherry pulp is 27.61 mg GAE/g. Meanwhile, the numerous secondary metabolites in coffee skin are responsible for its antioxidant properties. Sangta *et al*. (2021) reported that polyphenols from Arabica coffee pulp powder have excessive inhibitory activity against horticultural pathogens. This has led to the use of coffee skin as a food preservative.

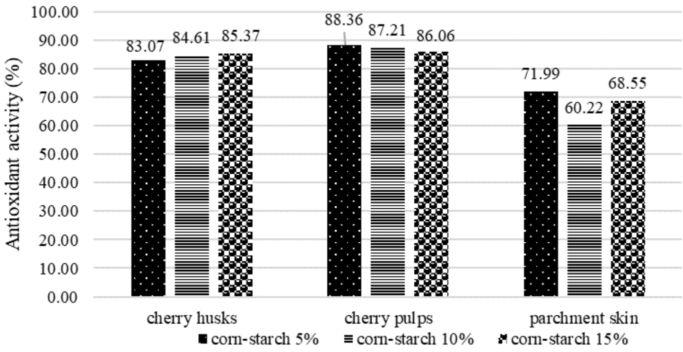

Figure 4. Antioxidant activity (%) jam of coffee skin

3.5 Viscosity

Viscosity is the resistance of a fluid to flow, and it is caused by intermolecular friction that occurs when the fluid layers touch each other. It is an important factor in the beverage industry because it affects the processing and packaging of products as well as customers' acceptance (Martínez-Ortiz *et al*., 2019; Chen *et al*., 2021). Suriati and Utama (2019), and Suriati *et al*. (2020c) stated that a product's viscosity is strongly influenced by the type of raw material used. Meanwhile, this study showed that the type of coffee skin treatment, the concentration of cornstarch as well as their interactions had a very significant effect on the thickness of the jam. The highest viscosity value of 9623.33 cP was obtained from cherry husk treatment, as shown in Figure 5. Furthermore, the viscosity increased along with an increase in the cornstarch concentration because it is a hydrocolloid that retains water. This finding is consistent with Zhang *et al*. (2016) that modified starches and food components are held together by hydrogen bonds, and this is responsible for the heat-resistant characteristics of blueberry jam.

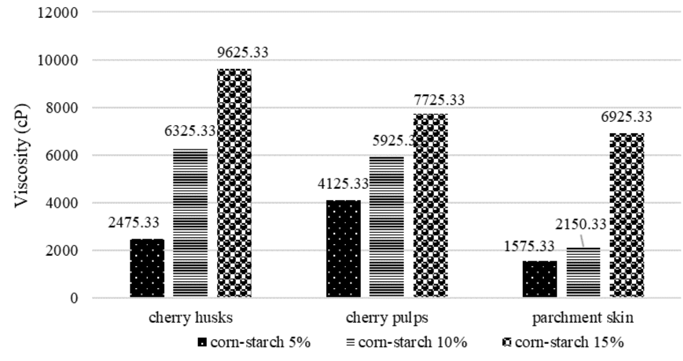

Figure 5. Viscosity (cP) jam of coffee skin

3.6 Acidity

Acidity is an important parameter that determines the success of jam production. This study showed that the type of coffee skin treatment, cornstarch concentration as well as their interactions had a significant effect on the jam's acidity. The normal acidity value ranges from 4.12 to 5.17, as shown in Figure 6. Meanwhile, the highest acidity level was obtained from the cherry pulps treatment, while the lowest was gotten from the parchment skin treatment. Fragrance-forming organic acids in parchment skin are greater compared to other types. Parchment is a robust fibrous endocarp that covers coffee seeds' hemispheres and separates them from each other (Iriondo-DeHond *et al*., 2019). It can also be used as an antifungal additive as well as a food preservative (Klingel *et al*., 2020).

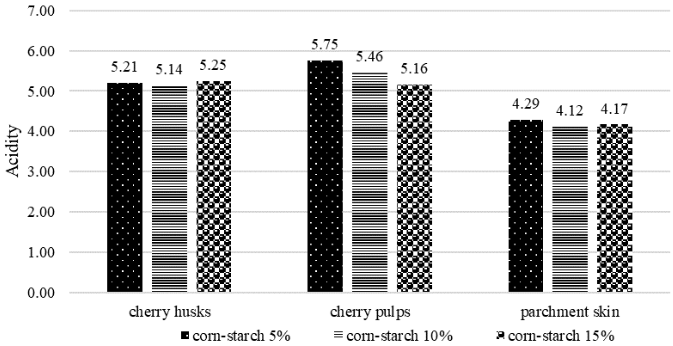

Figure 6. Acidity jam of coffee skin

4. Conclusion

The production of jam from coffee skin is a solution to several problems experienced by coffee farmers. The results showed that the type of coffee skin and cornstarch' concentration had a very significant effect on the moisture content, reducing sugar level, caffeine content, antioxidant activity, and viscosity of jam. Furthermore, the jam produced from cherry pulp with 10% cornstarch concentration had the best physicochemical characteristics.

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