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Acceptability of Indian Almond *Terminalia catappa* as Bitter Chocolate

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Abstract

Indian almond in the Philippines is one of the edible fruits in the country that has been ignored due to its unappreciated health benefits. In this study, the researchers aimed to utilize Indian almonds as Bitter Chocolate. This research used the Quasi-experimental design, which is the most widely used research approach, encompassing pre-experiments making use of the control of comparison group. This is to determine the sensory acceptability of each treatment. The study was conducted in one of the universities in Cebu City, Cebu, Philippines with 30 respondents using random sampling technique, utilizing structured survey questionnaires. The data gathered was used to determine the acceptability of Indian almond as bitter chocolate in terms of sensory attributes and its level of acceptability. These serve the purpose of knowing the level of acceptability of Indian almond in terms of Appearance, Aroma, Taste, and Texture. Result showed that there is a significant difference between the native chocolate and Indian almond as bitter chocolate. In terms of appearance, the treatment 3 is more acceptable to be the closest appearance to the chocolate, treatment 2 and 3 also seen a significant difference in terms of taste/flavor, and lastly, all treatments have seen no significant difference in terms of aroma, our findings shows that Indian almond can be an alternative to native chocolate. The results of the microbial analysis are within acceptable limits. There is no significant difference in the level of acceptability of the chocolate. This result means that the respondents similarly liked the bitter chocolate.

Keywords: acceptability, ignored, unappreciated health benefits, human consumption, and chocolate.

INTRODUCTION

Indian almond is an unappreciated seed bear in the Talisay tree that mainly grows in tropical areas. According to Sarkar (2020), The almond (Terminalia catappa L.) is an underappreciated crop a group of nuts having hard shelled seeds surrounding a single edible kernel. This type of almond is covered by a hard and fibrous shell called a husk which is not edible. This Indian almond is high in polyunsaturated and monounsaturated fatty acids which is particularly a good source for fighting multiple diseases such as high blood pressure, cardiovascular disease and atherosclerosis. Moreover, it is also a good source of vitamins like vitamin A, vitamin D, vitamin e, and vitamin K1 in making oil made of Indian almond. According to Ero et al. (2023), Indian almond potentially contains antidiabetic and hepatoprotective, however, there is a paucity of evidence on the ability of this plant to carry out its antidiabetic property.

Indian almond as a bitter chocolate may somehow replace the native Philippine chocolate which is called *Tableya.* In the study of Seem et al. (2019), chocolate contains antioxidants and anti-inflammatory flavonoids which may improve bone health. In another study of Beekettand Stephen (2019), chocolate consumption rises and has been recognized as a medication. This product is good for all ages to help people have a better and healthier life. The utilization of Indian almond in our study has significantly no difference

in the control of the Philippine native chocolate - *Tableya*, in terms of the level of acceptability. Hence, this product may consume the same source in cocoa beans.

MATERIALS AND METHODS

Research Methodology of Indian Almond as bitter Chocolate

In this study, the researchers used quantitative research design where this design involved collection of data to quantify and subject the information gathered in this research. To find out the acceptability of Indian almond as bitter chocolate a Quasi Experimental research design was used, this design is the most widely used research approach, encompassing pre-experiments making use of the control of or comparison group. It is used to determine the sensory acceptability and hedonic acceptability of each treatment. This study was conducted in one of the state universities in Cebu City and known as the center of excellence and multidisciplinary research university of education. The respondents of this study are 30 people, 25 of which are university students and 5 are experts in the food industry. This research utilized random sampling technique, it is one of the simplest probability sampling methods in which the population has an exactly equal probability of getting a sampling procedure. We used structured survey questionnaires to gather information and in analysis of the product in assessing the acceptability of Indian almond. We made 4 treatments including the control. In different treatments, the measurement of Indian almond and native Philippine chocolate varied in percentage to test where among the treatments showed little to none difference in acceptability. The researchers utilize one-way ANOVA. The treatment undergoes different laboratory tests. First was the Microbial analysis where in this process they determine if the product is suitable and safe for human consumption. Second is the sensory evaluation where it tested the sensory acceptability of the Indian almond as bitter chocolate in terms of the different treatments. Lastly, Hedonic Acceptability where it assesses the overall likeness of the product using the 9-point hedonic scale.

RESULTS AND DISCUSSION

Microbial Analysis of the Chocolate

Microbiological analysis of food uses biological, biochemical, molecular, or chemical techniques to detect, identify, or count microorganisms in a material. Testing the process of determining the levels of microbial contamination in production and finished goods. It is crucial in making Indian almond as chocolate to avoid spoiling and ensure food safety. This involves identifying bacteria that may represent a danger to human health in food. The analysis results of the chocolates from the DOST Regional Standards and Testing Laboratory are presented in Table 1.

Table 1. Results of microbial analysis of the Indian almond

Parameter	Results	Interpretation
Aerobic plate count	1.6×10^3 cfu/g	Acceptable
E. coli count	<1.0 x 10 cfu/g	Acceptable
Salmonella detection	Negative	Acceptable
Mold and yeast count	5.7 x 10 cfu/g	Acceptable

Based on Bacteriological Analytical Manual, 8th Edition, 2001.

Legend: Aerobic plate count (Normal plate count (25-250)), E. coli count (average aw 0.40) Salmonella detection (**0.50 (3.98–7.46 min**)), Mold and yeast count (10-150 colonies)

According to Table 1, the microbial analysis results showed that the four chocolates have acceptable parameters, including normal ranges for aerobic plate count, *E. coli* count, Salmonella detection, and mold and yeast counts. Microbial growth can also impact physicochemical properties such as color, pH, viscosity, and development of off-flavors (Caspers et al., 2011). The off-flavors develop primarily due to lipid hydrolysis while changes in pH can be attributed to the presence of lactose-fermenting bacteria (Ziyaina et al., 2018). These changes become prominent with time and make the product unfit for consumption. However, these incidences occur only when the bacterial load reaches 106–107 CFU/ml for enzyme production (Silcock et al., 2014). According to Dijk et al., (2015) when applying the cocoa industrial powder guidelines [56], which include specifications for total aerobic mesophiles (<5000 CFU/g), molds (<50 CFU/g), yeasts (<10 CFU/g), Enterobacteriaceae (absent in 1 g) and Salmonella (absent in 25 g), it was concluded that all investigated cocoa powders are largely acceptable.

In addition, Salmonella spp. cannot grow chocolate due to the low Aw. Moreover, Salmonella and E. coli are rarely found in cocoa. In chocolate, low levels of aerobic bacteria are generally acceptable, as long as they fall within regulatory limits because chocolate has low moisture content and a relatively low pH, which are not conducive to bacterial growth. Because of the low water activity (aw) and the high fat content of chocolate Salmonella spp. shows an increased heat resistance, even during the thermal process of chocolate making (Krapf et al., 2014).

Sensory Acceptable of the Chocolates

Sensory evaluation analyzes and quantifies human reactions to food and drinks Chocolate's most crucial sensory characteristics play a significant effect on taste. In this study, four attributes were observed—appearance, aroma, taste/flavor, and texture. These attributes are presented in the subsections below.

Appearance of the Chocolates

Appearance describes chocolate's appearance, such as shape and color. Food product is the most important indicator used to quickly determine the product's quality. If it does not meet our expectations, we might perceive its flavor and taste differently. The appearance of the chocolates is gleaned in Table 2 below.

Table 2. Appearance of the chocolates

Chocolates	Mean	SD	Interpretation
Control	3.10	1.09	Medium
T1	3.47	1.28	Dark
T2	2.97	1.30	Medium
T3	4.07	1.36	Dark

Legend: 1.00-1.80 (Very light), 1.81-2.60 (Light), 2.61-3.40 (Medium), 3.41-4.20 (Dark), 4.21-5.00 (Very Dark)

As gleaned in Table 2, the control (100% tableya) chocolate has a medium appearance, similar to T2 (75% Indian almond) chocolate's appearance. T1 (25% Indian almond) and T3 (100% Indian almond) chocolates have a dark appearance. This was the expected result for Indian almond as chocolate appearance is naturally brown in color. According to Della Lucia et al., (2016), also revealed strong brown color and brightness besides strong chocolate aroma and flavor linked to lower acceptance of chocolate milk beverages. Cocoa has a medium brown appearance because of its natural color. Cocoa beans, from which cocoa powder is made, have a brown color. During processing, when cocoa beans are roasted and ground into cocoa powder, this brown color is retained, giving cocoa its characteristic medium-brown appearance. So, the brown color of cocoa is a result of its natural composition and the way it's processed. Properties of roasted beans, such as formation of a characteristic brown color, texture of roasted beans, concentration of volatile flavor compounds, total acidity and fat content, depend on roasting conditions mainly temperature and processing time (Ramli et al., 2006; Krysiak et al., 2013; Owusu et al., 2013). On the contrary, Thompson et al., (2004), reported a wide variation among chocolate milk samples suggesting that high chocolate flavor, high sweetness, or dark color may not necessarily drive consumers' liking; however, the

cocoa aroma was reported to be a major driver.

T1 and T2 has a combination of cocoa and indian almond when Indian almonds and cocoa are combined, their dark colors blend, producing a range of medium to dark colors. Depending on the amounts of Indian almonds and cocoa in the method, as well as the other components, the end color may be medium or deeper brown. According to Reyes et al., (2020), color depends on the ingredients and their qualities, formulation and ingredient ratios, and processing technologies. increase and then decrease with increasing roasting temperature and time. Due to the fact that roasting may cause the dark color of seeds (Mijena et al., 2017). Similar results were observed by (Zhao et al., 2012).

T3 (100% Indian almond) During maturation, it changes color from green to dark purplish-red; it has an oleaginous kernel coated with a thin film (Thomson & Evans, 2006). The fruits were selected according to the maturity stage in which they are ready for consumption dark purplish-red (Santos et al., 2016). Indian almonds are dark in color because of their natural composition and how the fruit grows. As Indian almonds ripen, their exterior shells often become dark brown or black. This dark color is caused by the presence of pigments like melanin, which the fruit produces as it grows. Additionally, Indian almonds contain oils and other substances that may contribute to their dark hue. So the dark color of Indian almonds is a natural feature of the fruit as it matures.

Aroma of the Chocolates

Aroma refers to the smell of chocolate, which varies based on the type of cocoa used. The aroma of a product may cause senses of freshness which influence the choices of the consumer. The aroma of the chocolates is gleaned in Table 3 below.

Table 3. Aroma of the chocolates

Chocolates	Mean	SD	Interpretation
Control	3.90	1.03	Strong cocoa and mild nutty
T1	3.60	0.89	Strong cocoa and mild nutty
T2	3.40	1.19	Mild cocoa and strong nutty
T3	3.17	1.56	Mild cocoa and strong nutty

Legend: 1.00-1.80 (No cocoa and nutty), 1.81-2.60 (Mild cocoa and mild nutty), 2.61-3.40 (Mild cocoa and strong nutty), 3.41-4.20 (Strong cocoa and mild nutty), 4.21-5.00 (Strong cocoa and strong nutty)

As gleaned in Table 3, the control (100% tableya) chocolate has strong cocoa and mild nutty aroma, similar to T1 (25% Indian almond) chocolate's aroma. The steamed nuts, however, yielded 66 peaks from which 63 volatile compounds were identified. The small number of aldehydes, ketones, pyrazine, and alcohols identified are the ones most likely to contribute to the aroma of the nuts (Lasekan et al., 2012). Cocoa has a moderate cocoa and nutty flavor due to its natural flavor ingredients and processing methods. Roasting cocoa beans produces moderate chocolate-like and nutty tastes. These tastes are derived from natural compounds in the beans and chemical processes that occur during roasting. So, when you taste cocoa, you get a blend of mild cocoa and nutty flavors that make it pleasant. Roasting is known to increase the levels of compounds such as pyrazines, furans, and pyrrols in food products. The above compound represents three groups of chemicals with nutty and roasted aromas (Franklin et al., 2020). Besides brown color, texture and aroma are also some of the major characteristics that contribute to the quality of roasted products. The development of brown color and aroma are phenomena that results from the Maillard reaction (Ng et al., 2014).

T2 (75% Indian almond) and T3 (100% Indian almond) chocolates has mild cocoa and strong nutty Indian almonds naturally have a distinct aroma that is often described as nutty. It means they smell a little bit like cocoa but mostly like nuts. This aroma comes from the oils and compounds naturally present in the almonds. The nutty scent comes from the natural oils and compounds in the almonds, while the cocoa-like smell might be subtle and reminiscent of chocolate. The seeds when roasted developed a nutty-cacao flavor (Jr et al., 2014). The nutty aroma in Indian almonds is primarily contributed by a combination of volatile organic compounds. These compounds, along with others present in Indian almonds, work together to create

the characteristic nutty aroma that is associated with these nuts. Studies were also conducted on amino acid profile and free fatty acid composition of the seed oil. Indian almond has that glutamic acid was the major essential amino acid while methionine and lysine were the limiting amino acids. The major saturated fatty acid was palmitic acid, while the main unsaturated fatty acid was oleic acid followed by linoleic acid (Ng et al., 2015).

Taste of the Chocolates

The taste of chocolate can vary from sweet to bitter and is determined by factors such as the kind of cocoa and other ingredients used. The taste of the chocolates is gleaned in Table 4 below.

Table 4. Taste of the chocolates

Chocolates	Mean	SD	Interpretation
Control	1.17	0.53	Bitter
T1	1.37	0.56	Bitter
T2	1.87	0.63	Moderately Bitter
T3	2.27	0.79	Moderately Bitter

Legend: 1.00-1.67 (Bitter), 1.68-2.33 (Moderately Bitter), 2.34-3.00 (Not Bitter)

As gleaned in Table 4, the control (100% tableya) chocolate has a bitter taste, similar to T1 (25% Indian almond) chocolate's taste. T2 (75% Indian almond) and T3 (100% Indian almond) chocolates have a moderately bitter taste. Control and T1 have a bitter taste because the bitterness of the latter type is based on the presence of cyanogenic glycosides which can be degraded by glycosidases present in the seed (Akpakpan and Akpabio, 2012). Chocolate with a higher fat content has a more intense taste than low-fat one. Cocoa's bitter taste is due to natural substances known as polyphenols, particularly flavonoids such as catechins and procyanidins. These chemicals, contained in cocoa beans, give cocoa its bitter taste. When cocoa beans are processed into cocoa powder or used to produce chocolate, these bitter chemicals are retained, adding to the overall bitterness of cocoa-based goods. According to Toker et al., (2020), changes in the perception of flavor induced by plant additives to the chocolate matrix depend on numerous factors. Cocoa astringency is driven by N-phenylpropenoyl-l-amino acids, polyphenol glycosides, and flavan-3-ols, while the latter compound class also contributes to bitterness. The key principle for cocoa bitterness was shown to be the combination of alkaloids and 2,5-diketopiperazines (Kauz et al., 2021). Cacao powder, and the participants felt the taste of natural Cacao, became more aromatic, it has a nice color, and balanced amount of sweetener to fight the bitterness of the Cacao (Corton et al., 2022).

Moreover, T2 and T3 have a moderately bitter taste because Indian almonds may have a slightly bitter taste due to various compounds present in the nut. While Indian almonds do not contain amygdalin, which is responsible for the bitter taste in some varieties of common almonds, they may still have other compounds that contribute to bitterness. These compounds could include tannins, flavonoids, or other naturally occurring substances found in the nut. The fruit of T.Catappa comprises tannin, glucose, corilagin pentosans, cyanidin-3-glucoside, brevifolin carboxylic acid, ellagic acid, gallic acid, together with β-carotene (Mininel et al., 2014). The bitterness of cocoa and Indian almond products is determined by the kind and concentration of bitter compounds present. Higher percentages of cocoa cause more bitterness due to the high concentration of bitter compounds such as flavonoids and alkaloids, whereas higher percentages of Indian almond may produce a moderately bitter taste because the specific bitter compounds and their concentrations differ from those in cocoa.

Texture of the Chocolates

Texture pertains to how chocolate feels in the mouth, and it includes qualities such as smoothness and consistency. The corresponding mouthfeel of food possesses an important impact on how consumers evaluate the product. The texture of the chocolates is gleaned in Table 5 below.

Table 5. Texture of the chocolates

Chocolates	Mean	SD	Interpretation
Control	2.10	1.06	Smooth
T1	2.73	1.01	Grainy
T2	2.60	1.00	Grainy
T3	2.40	0.97	Smooth

Legend: 1.00-1.75 (Watery), 1.76-2.50 (Smooth), 2.51-3.25 (Grainy), 3.26-4.00 (Thick)

As gleaned in Table 5, the control (100% tableya) chocolate has a smooth texture, similar to T3 (100% Indian almond). T1 (25% Indian almond) chocolate has grainy texture, similar to T2 (75% Indian almond). The cocoa powder feels smooth because it is thoroughly crushed into tiny particles. It feels soft and silky feel since it is without big and harsh pieces. This fine texture results from how cocoa beans are processed and pounded into powder. According to Qian et al., (2020) Cocoa is the primary ingredient in chocolate, and cocoa concentration attributes to the smoothness of the chocolate. T3 has a smooth texture Indian almonds typically have a smooth texture because they contain oils and fats that give them a creamy and velvety feel when touched. The main fats found in Indian almonds include Oleic Acid, Linoleic Acid, and Palmitic Acid (Sarkar et al., 2020). These fats contribute to the nutritional profile of Indian almonds and are part of what gives them their characteristic taste and texture.

However, T1 and T2 have a grainy texture according to Talbot et al., (2012) in terms of the fats, cocoa butter is the one constant in that this is present in the fat phase, whatever the type of chocolate. The main fats found in Indian almonds include Oleic Acid, Linoleic Acid, and Palmitic Acid (Sarkar et al., 2020). When these two ingredients are mixed, the fats from both can solidify and form small granules, creating a grainy texture. A similar structure formation can be achieved at room temperature if trace amounts of a polar organic solvent like oleic acid is added. This is attributed to the partial solubility of cocoa butter in these solvents resulting in the formation of a sticky surface layer formed by these butter/solvent mixtures (Wollgarten et al., 2016). The method used to combine the ingredients can also impact the texture. For example, if the almonds are ground too finely or if the cocoa powder is not properly mixed in, it can result in a grainy consistency.

Level of Acceptability of the Chocolates

The hedonic scales for sensory evaluation of food produced varying results, each with advantages and disadvantages. Despite its flaws, sensory researchers accept the hedonic scale to infer consumer acceptance from "liking" because it allows them to indicate their level of liking for a product by circling/selecting the term from a list of nine terms that best describes their attitude toward the product in terms of liking. The level of acceptability of the chocolates is shown in Table 6.

Table 6. Level of acceptability of the chocolates

Chocolates	Mean	SD	Interpretation
Control	5.37	2.16	Neither liked nor disliked
T1	6.13	2.00	Like slightly
T2	5.47	2.03	Like slightly
T3	6.33	2.06	Like slightly

Legend: 1.00-1.88 (Dislike extremely), 1.89-2.78 (Dislike very much), 2.79-3.67 (Dislike moderately), 3.68-4.59 (Dislike slightly), 4.60-5.45 (Neither like nor dislike), 5.46-6.34 (Like slightly), 6.35-7.23 (Like moderately), 7.24-8.12 (Like very much), 8.13-9.00 (Like extremely)

As shown in Table 6, the respondents neither liked nor disliked the chocolate without Indian almond (μ=5.37, SD=2.16). Which means they feel neutral about it. They don't have strong positive or negative feelings toward cocoa. It could be because they haven't developed a preference for its taste, or they may not consume it frequently enough to have a strong opinion about it. According Wangler et al., (2023) to

perceived to be most bitter is also the sample least liked it is not known whether it is the bitterness itself driving results or the liking of the samples, including the sensory attributes such as bitterness. Means the bitterness could be the reason for the dislike, or there might be other factors influencing their preference. Consumption and preference for unhealthy food products with a high sugar and fat content (Bui et al., 2021).

On the other hand, the respondents slightly liked the chocolates with specific percentages of Indian almond and tableya, namely T1 (μ=6.13, SD=2.00), T2 (μ=5.47, SD=2.03), and T3 (μ=6.33, SD=2.06). According to Abaya (2022) The seed within the fruit is edible when fully ripe and tastes almost similar to almond with a sweet-acidic pericarp. The product gives a unique taste indicative of the Indian almond (Hashmi, 2007; Ryan, 2009). Chocolate has a similar taste to Indian almond. According to Yakubu (2021) *terminalia catappa* is known for the edible nuts commonly known as tropical almonds due to their similarity in taste with almonds of commerce. Indian almonds have a naturally nutty flavor that complements the taste of chocolate. When combined with chocolate, the nutty taste adds an extra layer of flavor complexity that some people find appealing. Taste preferences vary from person to person, and some individuals simply enjoy the combination of Indian almonds as chocolate because they like the taste and texture together.

Differences in the Sensory Acceptability and Level of Acceptability among the Chocolates

The results were subjected to comparative analysis using appropriate tests to determine whether there are significant differences among the chocolates. These results are presented in the subsections below.

Differences in the Sensory Acceptability

The sensory acceptability results were compared using the non-parametric test called the Kruskal-Wallis test due to the non-normal nature of the data. The results of the said test are shown in Table 7.

Table 7. Differences in the sensory acceptability

Characteristic	χ^2-value	p-value	Significant post-hoc
Appearance	13.91*	.003	T3 > C, T2
Aroma	4.37	.224	None
Taste/Flavor	39.93*	<.001	T2 > C, T1 T3 > C, T1
Texture	6.34	.096	None

* Significant at α=.05

As shown in Table 7, a significant statistical difference (χ^2=13.91, p=.003) occurs in the appearance of the chocolates. The post-hoc test found that T3 (100% Indian almond) is more acceptable in appearance than the control and T2. Therefore, T3 has the closest appearance with chocolate. Extracts of Terminalia catappa (TC) commonly known as tropical almond or 'kottamba' and Prunus dulcis (PD) nuts (almond). These results suggested that not only PD, but also TC nuts are a great source of antioxidants, anti-diabetics, and antiobesity compounds despite not being commercially utilized. Therefore, Terminalia catappa can be used as an alternative to Prunus dulcis in food (Panditharathna et al., 2023). Indian almonds may have a similar appearance to chocolate because they both have a dark brown color. The fruits were selected according to the maturity stage in which they are ready for consumption dark purplish-red (Santos et al., 2016). Indian almonds are dark in color because of their natural composition and how the fruit grows.

Similarly, the taste/flavor of the chocolates shows a significant difference (χ^2=39.93, p=<.001). These differences are evident in the respondents' rating of T2 over the control and T1, and T3 over the control and T1. When the seeds are toasted in a suitable length of time and temperature, they become crispy and almond-like or hazel nut-like flavor Abaya (2022). At the same time, sensory characteristic of the chocolate flavors is becoming more important, affecting both the taste and marketing of food product with chocolate flavor (Hunaefi et al., 2023). Indian almond may produce a moderately bitter taste because the specific bitter compounds and their concentrations differ from those in cocoa.

However, no significant differences (p>.05) were found in the aroma and texture of the chocolates. This finding indicates that chocolates have comparable aroma and texture. Sugars of natural cocoa degrade during fermentation, leading to a greater aroma compound profile and consequently higher quality and more pleasant chocolate (Toker et al., 2020). Having the same amount of sweetener added to the Talisay nut gives the same texture to the product (Carpio et al., 2020). Additionally, both Indian almonds and chocolate can have a glossy or shiny surface, further contributing to their similar appearance. However, it's important to note that while they may look similar, Indian almonds and chocolate are made from entirely different ingredients and have distinct flavors and textures.

Difference in the Level of Acceptability

The level of acceptability was compared to the parametric analysis of variance (ANOVA) due to the normal nature of the data distribution. The results are presented in Table 8.

Table 8. Difference in the level of acceptability

Aspect	F-value	p-value	Significant post-hoc
Level of Acceptability	1.58^{ns}	.203	None

^{ns} Not significant at α=.05

According to Table 8, there is no significant difference in the level of acceptability of the chocolates. This result means that the respondents similarly liked the chocolates. The Indian almond contains sugar in the form of glucose, which according to Stuart et al., (2012), is present in the amount of 316 mg glucose per gram mesocarp of the fruit. The sugar in it contributes to the enhancement of the flavor of the product because when sugar caramelizes it forms diacetyl, esters, lactones, furan, and maltols which give good flavor to the baked product (Reyes et al., 2020). According to Abaya et al., (2022), Indian almond is acceptable as food. Its appearance, texture, aroma and taste are certainly acceptable for the consumers. Also, it is highly available at a low cost. Thus, it could be manufactured at greater scale at a reasonable cost within the reach of low-income families. According to Kongkor et al., (2023), despite the health benefits of the bioactive compounds in cocoa, the high concentrations of phenolics and methylxanthines in the raw cocoa beans negatively influence taste, confer astringency and bitterness, and affect the stability and digestibility of products with high levels of these compounds. Processing cocoa beans is necessary to develop the characteristic color, taste, and flavor, and reduce the astringency and bitterness, which are desirable in cocoa products. During cocoa bean processing, various chemical reactions occur, enhancing cocoa's flavor, color, and shelf stability. It means that the respondents liked all the chocolates equally. They didn't prefer one chocolate over another, indicating that their preferences were similar across the different types of chocolates tested.

CONCLUSION

The four treatments were subjected to microbial analysis for safety consumption purposes. The results of the microbial analysis are within acceptable safety limits. Results of the four treatments showed that a significant statistical difference occurred in the appearance of the chocolates. The post-hoc test found that T3 (100% Indian almond) is more acceptable in appearance than the control and T2. Therefore, T3 has the closest appearance to chocolate. Similarly, the taste/flavor of the chocolates shows a significant difference. These differences are evident in the respondents' rating of T2 over the control and T1, and T3 over the control and T1. However, no significant differences were found in the aroma and texture of the chocolates. This finding indicates that chocolates have comparable aroma and texture. There is no significant difference in the level of acceptability of the chocolates. This result means that the respondents similarly liked the chocolates.

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