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58% Dark Chocolate Formulation with Added Spices (Ginger Emprit, Cinnamon and Clove)

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Abstrak

Cokelat merupakan produk pangan yang digemari. Penelitian dan pengembangan produk cokelat semakin meningkat untuk meningkatkan nilai fungsionalnya. Penelitian ini bertujuan untuk mengetahui karakteristik fisikokimia dan sensori cokelat hitam 58% dengan fortifikasi gabungan jahe emprit, kayu manis, dan cengkeh untuk menambah nilai fungsional cokelat. Rancangan penelitian yang digunakan adalah rancangan acak kelompok. Hasil penelitian menunjukkan kadar air tertinggi terdapat pada sampel C3 (1,51%), aktivitas antioksidan sampel C2 (66,52%), uji kadar fenol sampel C4 (7,00 GAE/g), uji kadar flavonoid sampel C3 (4,96 QE/g), pada uji aktivitas air sampel C0 (0,52), pada jumlah lempeng total bakteri paling banyak terdapat pada C1 yaitu 3,2 x 104. pada tekstur nilai kekerasan tertinggi terdapat pada sampel C4 (170,60). Pada uji organoleptik penilaian tertinggi pada parameter warna terdapat pada sampel C2 (3,76), pada parameter aroma pada sampel C0 (3,84), pada parameter tekstur pada sampel C4 (2,96), pada parameter rasa pada sampel C2 (3,44), dan pada parameter kesukaan terdapat pada sampel C2 dan C4 (72).

Abstract

Chocolate is a popular food product. Research and development of chocolate products are increasing to increase their functional value. This study aims to determine the physicochemical and sensory characteristics of 58% dark chocolate with the combined fortification of ginger emprit, cinnamon, and clove to add functional value to chocolate. The research design used was randomized block design. The results showed that the highest water content was in sample C3 (1.51%), antioxidant activity of sample C2 (66.52%), phenol content test of sample C4 (7.00 GAE/g), flavonoid content test of sample C3 (4.96 QE/g), in the water activity test of sample C0 (0.52), in the total plate count of bacteria the most was in C1 which was 3.2 x 104. in texture the highest hardness value was in sample C4 (170.60). In the organoleptic test, the highest assessment in the color parameter was in sample C2 (3.76), in the aroma parameter in sample C0 (3.84), in the texture parameter in sample C4 (2.96), in the taste parameter in sample C2 (3.44), in the liking parameter in samples C2 and C4 (72).

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INTRODUCTION

Dark chocolate is a type of processed chocolate made from cocoa beans with a minimum percentage of 60%. The process of making chocolate is almost the same as the process of making chocolate in general. The raw material used is dry cocoa beans which have been fermented and roasted (Jaćimović et al. 2022). To add functional value to chocolate products, a lot of chocolate research has been developed with the addition of various spices.

Spices are parts of plants that are beneficial for health (Mahatma et al. 2024). Spices have a distinctive and strong aroma, such as ginger, cinnamon, and cloves. Herbal ingredients such as ginger and cinnamon have high bioactive content such as polyphenols, antioxidants, and flavonoids. Cinnamon bark extract with a high trans-cinnamaldehyde content (68.65%) is a source of antioxidant compounds that are able to capture free radicals (Rahayu et al., 2022). Ginger contains several phytochemicals, with 6-shogaol and 6-gingerol being the most active and widely studied for their neuroprotective effects against neurodegenerative diseases. A total of 66 components were identified in emprit and red ginger essential oils, with eucalyptol (17.92%) and camphene (15.12%) as the main components, respectively (Badrunanto et al. 2023). Clove contains bioactive components such as gallic acid, flavonoids, eugenol acetate, and eugenol, contributing to its antibacterial, anti-inflammatory, and analgesic properties. Major phenolic constituents in cloves include eugenol, eugenyl acetate, and caryophyllene, which contribute to their antioxidant and antimicrobial properties (Paidi et al. 2021).

Some previous studies have not yet to fortify chocolate by combining ginger, cinnamon, and cloves. However, research on adding ginger powder and cinnamon to dark chocolate has been conducted. Several factors, such as the addition of ginger and cinnamon powder percentage, will increase the content of active substances contained therein. Therefore, the purpose of this study was to determine the physical, chemical, and sensory characteristics of 58% dark chocolate with the combined fortification of ginger emprit, cinnamon, and cloves.

METHODS

The ingredients used in the preparation of this spice mix chocolate include clove powder from Koepoe brand, cinnamon powder from Mr Boem-Boe brand, ginger powder from Djamoeku brand, and 58% dark chocolate from Chocolate Monggo, Follin-Ciocalteu reagent, 7% Na2CO3, distilled water, diphenylpicrylhydrazyl (DPPH), 96% ethanol, AICIL3. 6H2O (10%), NaNO2 (5%), NaOH (1 N).

The 58% dark chocolate was melted at 40 °C. The chocolate paste was divided into five bowls, each containing 40 g of chocolate paste. Ginger powder, cinnamon, and cloves were added to each bowl according to the specified percentage. The chocolate paste was stirred until homogeneous. The chocolate paste is placed in a mold and refrigerated. The hardened chocolate bar is removed from the mold and packed using aluminum foil.

Tabel 1. Formulation of ginger : cinnamon : cloves in dark chocolat product

Sampel	***ginger powder (%)***	***cinnamon powder (%)***	***clove powder (%)***	***Dark Chocolate 58% (%)***
C0	*0*	*0*	*0*	*100*
C1	*3*	*3*	*1*	*94*
C2	*5*	*3*	*1*	*91*
C3	*3*	*5*	*1*	*91*
C4	*4*	*5*	*1*	*90*

RESULT AND DISCUSSION

The moisture content in chocolate varies significantly depending on the formulation and production methods employed. The moisture content of spices chocolate can be seen in the following Table 2.

Table 2. *Moisture content*

Sample	***Water Content (%)***
C0	0.57^{a}
C1	1.46^{bc}
C2	1.26^{b}

C3	1.51^{c}
C4	1.32^{bc}

Notes: Based on 5% Duncan test, numbers followed by different letters indicate significant differences.

Table 2 shows that chocolate with cinnamon and ginger powder added has a moisture content between 0.58% and 1.32. According to SNI, (2009) states that the maximum water content in chocolate products is 2%. This shows that all treatments of spice chocolate have met the SNI quality standards, because the water content contained is less than 2%. The water content in these products shows significantly different results. This is because the raw materials used in the spice have different water contents (Tsagareishvili et al. 2019). Raw materials have different water contents, for ginger 4-7% (Akter et al. 2020), cinnamon 9.85% (Monta 2016), clove 5% (Kang, Park, and Yoo 2019). The water content of dark chocolate (cocoa mass 40-80%) are 1.2-1.4% (Velciov et al. 2021).

Phytochemicals Content

Phytochemicals are naturally occurring chemicals in plants, also known as phytonutrients. They possess bioactive compounds that provide various health benefits, including lowering the risk of diseases, boosting the immune system, and exhibiting anti-inflammatory and antioxidant properties. The result of phytochemicas test in dark chocolate with addition of spices can be seen in Table 3.

Table 3. *Phytochemicals contents*

Sample	Antioxidant (%)	Total Phenol (GAE/g)	Flavonoid (QE/g)
C0	$52,07^{ab}$	$4,23^{a}$	$33,09^{a}$
C1	$50,75^{a}$	$6,50^{b}$	$41,19^{b}$
C2	$66,52^{d}$	$6,58^{bc}$	$43,53^{c}$
C3	$57,85^{c}$	$6,20^{b}$	$44,96^{c}$
C4	$56,25^{bc}$	$7,00^{c}$	$44,58^{c}$

Notes: Based on 5% Duncan test, numbers followed by different letters indicate significant differences.

Antioxidant is any substance that delays, prevents, or removes oxidative damage to a target molecule (Chib et al. 2020). The different antioxidant level on dark chocolate not only come from the cacao mass but also from the addition of spices (Hossain et al. 2023). The ingredient that has the most influence on increasing antioxidants in dark chocolate is ginger powder. Ginger powder has the highest antioxidant activity compared to the others (Mustafa and Chin 2023).

Phenolic content in chocolate primarily originates from cocoa beans. During chocolate production, particularly roasting, polyphenols are released from oligomers, contributing to the overall phenolic content, although processing steps generally reduce the total polyphenol levels compared to raw cocoa (La Mantia et al. 2023). The phenolic content of commercil dark chocolate around 578.64 mg CAE/100 gram (Cheng, Jalil, and Ismail 2009). The addition of spices in dark chocolate product can increase the level phenolic content. more higher the amount of spices the highest value of phenolic in the final product (Lu et al. 2011).

Flavonoids are a broad class of secondary metabolites in plants, known for their multifaceted functionalities, including roles in plant homeostasis, stress response, allelopathy, and as signaling compounds that influence interactions with microorganisms and contribute to human health as nutraceuticals (Ghitti et al. 2022). Apart from the raw materials used, the amount of dark chocolate is contribute to flavonoid in the final product. The total flavonoid content in dark chocolate samples ranged from 10.04 to 37.85 mg/g CE. Higher cocoa percentages correlated with increased flavonoid levels, enhancing antioxidant activity, particularly in samples enriched with dried fruit pieces (Jaćimović et al. 2022).

Water Activity and Texture

Water activity significantly influences the texture of food products. The results of testing water activity and texture on chocolate products can be seen in the following Table 4.

Table 4. Water activity and texture of dark chocolate

Sample	Aw	Texture (N)
C0	0,49[a]	141,17[a]
C1	0,52[c]	237,86[a]
C2	0,49[a]	145,23[a]
C3	0,51[c]	166,34[a]
C4	0,50[b]	231,31[a]

Notes: Based on 5% Duncan test, numbers followed by different letters indicate significant differences.

Water activity is a measure of the energy state of water in a product, defined as the ratio of the vapor density of water in the product to the saturation vapor density of pure water at the product temperature (Campbell et al. 2022). The results of the water activity test showed significantly different results with the addition of spices in dark chocolate. Milk chocolate study show water activity around of 0.2 - 0.3 (Konar et al. 2014). In research conducted by (Norhayati, Suzielawanis, and Khan 2013) the addition of spices had no effect on water activity because spices had quite low water activity.

Texture in dark chocolate is primarily affected by storage conditions leading to fat bloom, which occurs due to temperature fluctuations or improper tempering. This results in increased hardness, chewiness, and a compromised visual quality of the chocolate (Andrae-Nightingale, Lee, and Engeseth 2009). The addition of spices not contribute to different of texture in dark chocolate (Dwijatmoko et al. 2016). The texture of 3D printed dark chocolate varies significantly with infill percentages: 25% requires 20.4 N to break, while 100% requires 54.4 N, indicating increased hardness with higher infill, affecting consumer preferences and perceptions of the product (Mantihal, Prakash, and Bhandari 2019).

Total Plate Count (TPC)

Spices are one of the raw materials that can inhibit the growth of microbes. The following are the results of TPC testing in dark chocolate spices Table 5.

Table 5. *Total Plate Count*

Sample	Number of Colonies	Notation
C0	$1,5 \times 10^3$	
C1	$4,8 \times 10^4$	*
C2	$4,8 \times 10^4$	*
C3	$8,5 \times 10^3$	
C4	1×10^3	

*Description: * : Does not fulfil the chocolate SNI requirements.*

The results of testing total microbes in dark chocolate showed different results. Spices significantly reduce total plate count (TPC) in meat and poultry products (Anggita, Budi, and Kusumaningrum 2023). The total plate count of dark chocolate without addition of spices around $2,9 \times 10^3 – 3,8\ 10^3$ (Nurhayati et al. 2022). Several components in spices can inhibit the growth of microorganisms, including cinnamic aldehyde (CIA) and cuminic aldehyde (CUA). CIA and CUA were identified as the most potent inhibitors of various microorganisms, while menthol (MT) was the least effective. Fungal strains were generally more susceptible to these bioactive components than bacterial strains (Bhatia and Sharma 2024). The study indicates that spices like clove, cumin, and cinnamon contain components that exhibit significant antimicrobial activity, effectively inhibiting the growth of various pathogenic bacteria, while fenugreek showed weak antimicrobial properties, failing to inhibit any of the tested bacteria (Anup Muni Bajracharya et al. 2023).

Organoleptics Test

Apart from physical and chemical parameters, sensory quality is also important in dark chocolate products. Below are the results of sensory testing of dark chocolate with the addition of spices, which can be seen in the Table 6.

Table 6. *Sensory Evaluation*

Treatment	Color	Aroma	Texture	Taste	Appearance
C0	3,52^{a}	3,84^{c}	2,84^{a}	3,76^{c}	3,64^{a}
C1	3,56^{a}	2,88^{a}	2,92^{a}	2,76^{a}	3,80^{a}
C2	3,76^{a}	3,52^{bc}	2,84^{a}	3,44^{bc}	3,72^{a}
C3	3,68^{a}	3,12^{ab}	2,88^{a}	3,12^{ab}	3,48^{a}
C4	3,60^{a}	3,44^{bc}	2,96^{a}	3,16^{ab}	3,72^{a}

Notes: Based on 5% Duncan test, numbers followed by different letters indicate significant differences. Score: (1)Very bad, (2)Bad, (3)Normal, (4)Good, (5)Very Good.

The addition of sipces to dark chocolate has no significant effect on the sensory quality of color, texture and appearance. However, the addition of spices greatly influences the taste and aroma parameters. Dark chocolates can range in color from light to dark brown. The study identified black chocolates and light brown chocolates, revealing that color variations are related to phenolic compounds and Maillard reaction products contributing to the chocolate's coloration (Dias et al. 2023). The texture sensory of dark chocolate varies with cocoa content; lower cocoa content chocolates are described as melting and creamy, while higher cocoa content chocolates are characterized as dry, mealy, and sticky, reflecting distinct mouthfeel attributes (Andrae-Nightingale et al. 2009). The addition of sipces in dark chocolate make significanly different for taste and aroma. Spices will give the unusual taste and aroma in dark chocolate (Olorode et al. 2024)

CONCLUSION

Based the data obtained from the research that has been carried out, the conclusion that can be taken is that there is a real influence on dark chocolate 58% 1 with the addition of ginger powder, cinnamon, and cloves on water content, antioxidants, phenols, flavonoids, aw, TPC, and Organoleptic (Aroma and Taste). However, 58% dark chocolate with the addition of ginger powder, cinnamon, and cloves had no effect on texture, color, and appearance. The addition of ginger powder, cinnamon, and cloves can add functional value to 58% dark chocolate, this is evidenced by the increase in antioxidant, flavonoid, and phenol levels.

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