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ANTIOXIDANT ACTIVITY, PHYSICOCHEMICAL PROPERTIES AND SENSORY ACCEPTABILITY OF DARK CHOCOLATE DRINK INCORPORATED WITH KACIP FATIMAH (*Labisia Pumila*) POWDER EXTRACT

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Abstract:

Dark chocolate drinks are cocoa-based beverages produced using a higher percentage of cocoa powder and lower milk powder content than milk chocolate drinks. Furthermore, dark chocolate drinks offer a more intense chocolate flavour, antioxidants, and a luxurious mouthfeel. Kacip Fatimah (*Labisia pumila*) powder extract is increasingly available to incorporate into cocoa-based drink powder for women's health and wellness. This study aimed to evaluate the potential of Kacip Fatimah powder extract (KFPE) as a functional ingredient in dark chocolate drink powder (DCDP) to enhance nutritional profile without compromising sensory qualities. Four DCDP formulations were prepared with varying concentrations of KFPE (0 mg, 60 mg, 120 mg, and 180 mg). Each formulation was analysed for antioxidant activity; 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity, physicochemical properties (water activity, total soluble solids, pH, viscosity, solubility and colour) and sensory acceptability. Adding KFPE significantly increased ($p<0.05$) the antioxidant activity from 70.19% to

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79.50%. Addition of KFPE increased the water activity (from 0.29 to 0.32) and total soluble solids (from 12.23% to 13.87%), but decreased the pH (from 7.47 to 7.42) and viscosity (from 36.67 to 10.67 cps) of DCDP. Solubility of hot dark chocolate drink (HDCD) with KFPE remained consistent, although dissolution time increased at higher concentrations due to larger particle sizes. Meanwhile, lightness (L*) of dark chocolate drink with KFPE increased in powder (from 36.52 to 46.45) and dissolved in hot water (from 4.81 to 15.99). In contrast, adding KFPE significantly increased the redness (a*) and yellowness (b*) of the HDCD. Sensory evaluation showed that HDCD with or without KFPE received similar scores ($p>0.05$) for all attributes (colour, bitterness, viscosity, cocoa flavour, and overall acceptability). Therefore, KFPE can be effectively incorporated into dark chocolate drinks to enhance their antioxidant activity and maintain physicochemical and sensory properties.

Keywords:

Dark Chocolate Drink, Kacip Fatimah Powder Extract, Antioxidant Activity, Physicochemical Properties and Sensory Evaluation

Introduction

Functional foods are increasingly popular due to their ability to provide essential nutrients while offering additional health benefits (Abedini et al., 2023). Milk chocolate drinks, although widely consumed, are often high in sugar and fat, making them less suitable for health-conscious consumers. While healthier alternatives exist, there remains potential to further enhance their nutritional profile without compromising taste. Cocoa-based beverages are widely consumed across all age groups, particularly among children, due to their pleasant taste and convenience. These drinks are available in various forms such as instant, ready-to-drink, hot or cold and typically made from cocoa powder, often fortified with stabilizers, vitamins, and minerals. Preparation generally involves heating cocoa powder with sugar, followed by milk powder or sweeteners used to enhance flavour and nutritional value (Barišić et al., 2022). Besides taste, dark chocolate drinks offer health advantages, such as improved calcium and vitamin D intake, immune support via increased IFN-γ levels, and the potential to combat malnutrition. Rich in antioxidants such as polyphenols especially proanthocyanidins, catechins, and anthocyanins, dark chocolate contains 12–15 mg/g of polyphenols, surpassing tea and wine in flavonoid content (Samanta et al., 2022). Various dark chocolate products consist of high antioxidant activity due to the presence of polyphenols and flavonoids (Ishak et al., 2025).

Kacip Fatimah (*Labisia pumila*) is a medicinal plant native to Southeast Asia, especially Malaysia, and is traditionally used for women's health (Radzali et al., 2022). It is commercially available in different forms such as capsules, powders, teas, and beverages. Nutritionally, Kacip Fatimah contains macronutrients (carbohydrates, proteins, fats), essential minerals (e.g., calcium, magnesium, zinc), vitamins (C and E), and antioxidant compounds such as phenolics (gallic and caffeic acids), as well as flavonoids and carotenoids (Radzali et al., 2022). Plant-derived compounds such as phytoestrogens (coumestans and isoflavones) are also found in Kacip Fatimah, which is used in postpartum care. Additionally, saponins found throughout the plant, especially in the leaves, contribute to cholesterol-lowering and immune-modulating effects (Abdullah et al., 2013). Flavonoids present in the plant are associated with antioxidant, anti-inflammatory, and anticancer properties (Zakaria et al., 2021).

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The incorporation of Kacip Fatimah powder extract into dark chocolate beverages presents a promising approach to developing a functional drink. However, challenges such as interactions between bioactive compounds and other ingredients, as well as stability during processing and storage, must be addressed. This study investigates the effects of Kacip Fatimah powder extracts at different concentrations on antioxidant activity, physicochemical properties, and sensory acceptability in dark chocolate drinks, aiming to formulate a product aligned with modern dietary trends.

Materials and Methods

Materials

The cocoa powder (Favorich, Guan Chong Berhad), monk fruit sweetener (Lakanto, Saraya Goodmaid Sdn. Bhd.), skimmed milk powder (NZMP, Fonterra), and Kacip Fatimah powder extract (A&T Ingredients Sdn. Bhd.) were used. Materials for chemical analysis (analytical grade from Sigma Aldrich, Germany) such as methanol, Folin-Ciocalteu reagent, sodium carbonate solution, sodium chloride and DPPH solution were used in this research.

Methods

Preparation of Dark Chocolate Drink with Kacip Fatimah Powder Extract

Four dark chocolate drink powder (DCDP) formulations were developed by incorporating different amounts of Kacip Fatimah powder extract (KFPE) at different concentrations (0 mg, 60 mg, 120 mg, and 180 mg) to examine their effects on antioxidant activity, physicochemical characteristics, and sensory attributes. Table 1 presents four DCDP formulations enriched with KFPE. Once all ingredients weighed, the formulation were mixed thoroughly using a double cone mixer (DNK Pharmatech and India) set at 15 rpm for 45 minutes to ensure uniform mixing and consistent quality.

Table 1: Formulations of Dark Chocolate Drink with Kacip Fatimah Powder Extract

Ingredients	Formulation 1	Formulation 2	Formulation 3	Formulation 4
Cocoa powder	30 g	24.94 g	24.88 g	24.82 g
Monk fruit sweetener	55 g	60 g	60 g	60 g
Kacip Fatimah powder extract	0 g	0.06 g	0.12 g	0.18 g
Skimmed milk powder	15 g	15 g	15 g	15 g

Determination of Antioxidant Activity: DPPH Radical Scavenging Assay

The antioxidant activity of the DCDP with KFPE at different concentrations was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging method, as described by Karim et al. (2019). To prepare the DPPH solution, 0.004 g of DPPH was dissolved in methanol and made up to 100 mL. For the standard, 0.01 g of ascorbic acid was dissolved in distilled water and diluted in a 10 mL volumetric flask to obtain a 1000 ppm stock solution.

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Then, a series of standard solutions were prepared at concentrations of 0, 200, 400, 600, 800, and 1000 ppm. Both the standard and the DCDP samples were diluted using methanol. Then, 1.2 mL of each ascorbic acid dilution (ranging from 20 to 100 ppm) was mixed with 9.0 mL of the methanolic DPPH solution and vortexed thoroughly. The mixtures were kept in the dark for 30 minutes. Absorbance was measured at 517 nm using a Genesys 30 Visible Spectrophotometer (Thermo Fisher Scientific, USA), and each sample was tested in triplicate. The same procedure was applied to assess the antioxidant activity of the DCDP with KFPE at different concentrations. Absorbance values of both the blank (methanolic DPPH solution) and the samples were recorded and calculated for antioxidant activity using the formula below:

$$\%\ Inhibition = \frac{Absorbance\ of\ DPPH\ blank}{Absorbance\ of\ sample\ with\ DPPH} x\ 100$$

Determination of Moisture Content

Moisture content of DCDP with KFPE at different concentrations was conducted following the method by Ishak et al. (2025) with few modifications. An aluminium dish was pre-heated in an oven at 105°C for 1 hour, then cooled in a desiccator for 30 minutes. After cooling, approximately 5 g of the sample was weighed into the dish. The sample was then dried in an oven at 105°C for 4 hours until it reached a consistent weight. After drying, the sample was cooled again in a desiccator for 30 minutes and reweighed. To ensure accuracy, the sample was reheated for an additional 30 minutes, cooled in the desiccator for 15 minutes, and weighed again. This process was repeated until the sample achieved a constant weight. The moisture content was calculated using the formula below:

$$Moisture\ by\ weight\ \% = \frac{(m1 - m2)x100}{(m1 - m0)}$$

m_0 = mass of aluminium dish without sample

m_1= mass of aluminium dish with sample before drying

m_2 = mass of aluminium dish with sample after drying

Determination of Colour

The colour of DCDP with KFPE at different concentrations was carried out based on the method by Arifin et al. (2022), with slight modifications. Two types of samples were analysed: hot dark chocolate drink (HDCD) with KFPE and the DCDP with KFPE. For the HDCD, the DCDP with KFPE was dissolved in a suitable solvent to ensure a uniform mixture, then poured into a petri dish, while the DCDP with KFPE was placed in a transparent ziplock bag. Colour measurements were taken using a spectrophotometer (CM-5, Konica Minolta, Japan) following the CIE colour system, which includes L* (perceptual lightness), a* (red-green axis), and b* (yellow-blue axis) values. Each sample was measured in triplicate to ensure accuracy.

Determination of pH Value

The pH of the DCDP with KFPE at different concentrations was measured according to the method by Sioriki et al. (2021), with minor modifications. A portable pH meter (PHB-4, Henan, China) was first calibrated using a standard buffer solution with a pH of 7. For the

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analysis, 10 grams of the powdered sample were mixed with 50 mL of distilled water and filtered through filter paper. The filtrate was then transferred into a clean container. Once the pH meter was ready, the electrode was inserted into the sample, and the pH reading was recorded after the meter stabilized.

Determination of Viscosity

The viscosity of the HDCD with KFPE at different concentrations was measured using a Brookfield Viscometer (LVT model, Brookfield, Massachusetts, USA), following the method described by Jensen et al. (2010). The viscometer was fitted with a No. 2 spindle, and its position was properly adjusted prior to measurement. The sample was heated on a hot plate until it reached 75°C. The spindle was immersed in the sample, and the reading was recorded after two complete rotations at a constant speed of 30 rpm, as displayed on the viscometer.

Determination of Total Soluble Solids

The total soluble solids of the HDCD with KFPE at different concentrations were determined according to the method of Rongtong et al. (2018) with slight modifications. An Atago PAL-3 Digital Refractometer (Atago Co., Tokyo, Japan) was used to measure the dark chocolate drink at 25°C, and the results were expressed as °Brix.

Determination of Solubility and Dissolution Time

The solubility of the DCDP with KFPE at different concentrations was measured using a modified method based on Indiarto et al. (2022). 1 g of the powdered sample was mixed with 30 mL of distilled water in a beaker and stirred at 500 rpm for one minute. The stirring speed was then increased to 1000 rpm and continued for two minutes. The mixture was transferred into a 50 mL centrifuge tube and centrifuged at 3000 × g for five minutes. A 5 mL portion of the supernatant was collected, placed in a pre-weighed Petri dish, and dried at 105°C for four hours. Solubility (S) was calculated using the formula:

$$S(\%) = \frac{Solid\ grams\ in\ supernatant}{sample\ weight\ in\ grams} x\ 100\%$$

To determine dissolution time, a 5 g sample was dissolved in 100 mL of water at 80°C, and the time required for complete dissolution was recorded with a stopwatch.

Determination of Water Activity

Water activity of the DCDP with KFPE at different concentrations was measured using a water activity meter (Aqualab, 4TE, USA). Three replications of the measurements were performed on the samples.

Determination of Hygroscopicity

The hygroscopicity of the DCDP with KFPE at different concentrations was determined using the method described by Indiarto et al. (2022), with slight modifications. The samples were pre-dried in an oven at 70°C until a constant weight was achieved. Approximately 2 g of each powder sample was placed in an aluminium dish along with 30 g of saturated sodium chloride solution, which provided a relative humidity of 75.29% at 25°C. The samples were reweighed after a week, and the hygroscopicity was calculated as a percentage.

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Determination of Sedimentation

The sedimentation index of HDCD with KFPE at different concentrations was determined according to the method of Jensen et al. (2010) with slight modifications. 1 g of powdered sample was mixed with 30 mL of distilled water in a 50 mL centrifuge tube and thoroughly homogenized using a vortex mixer. The mixture was then centrifuged at 3000 rpm for 20 minutes. After decanting the supernatant, the tubes were inverted and allowed to drain for 30 minutes. The percentage of weight was used to represent sediment.

Determination of Sensory Acceptability

Sensory acceptability of HDCD with KFPE at different concentrations was conducted. Each sample was made by mixing 20 g of powdered chocolate with 150 mL of hot water. The prepared drinks were served in 15 mL portions using transparent plastic cups labelled with random three-digit codes, as outlined by Pourhaji et al. (2022). A total of 30 female panellists aged between 21 and 33 years participated in the sensory evaluation. Panellists were instructed to rinse their mouths with water between testing each sample. The panellists were needed to evaluate and rate the samples on a 9-point hedonic scale based on the attributes (colour, sweetness, cocoa flavour, bitterness, viscosity, and overall acceptability). The indicator for the 9-point hedonic scale used: 1- Dislike extremely, 2- Dislike very much, 3- Dislike moderately, 4- Dislike slightly, 5- Neither like nor dislike, 6- Like slightly, 7- Like moderately, 8- Like very much, 9- Like extremely, for the sensory evaluation of HDCD with KFPE at different concentrations. All scores were recorded, and the total and mean scores for each attribute were calculated.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics software. A one-way analysis of variance (ANOVA) was conducted, followed by Tukey's post-hoc test to determine significant differences among the sample groups at a significance level of $p < 0.05$. Results are reported as the mean ± standard deviation.

Results

DPPH Scavenging Assay

Table 2 presents the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity of dark chocolate drink powder with Kacip Fatimah powder extract at different concentrations. The results indicated that samples containing Kacip Fatimah extract (60–180 mg) exhibited significantly higher ($p<0.05$) antioxidant activity, ranging from 75.85% to 79.50%, compared to the control sample at 70.19%.

Table 2: Antioxidant Activity of Dark Chocolate Drink Powder with Kacip Fatimah Powder Extract at Different Concentrations

Sample Formulation	DPPH Inhibition (%)
F1 (Control)	70.19 ± 2.15^{c}
F2 (60 mg)	75.85 ± 0.41^{b}
F3 (120 mg)	75.57 ± 0.64^{b}

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F4 (180 mg)	79.50 ± 0.70[a]

[a,b,c] Values with different letters in the same column are significantly different ($p < 0.05$)
Mean±SD each value in the table is the mean of triplicate

Moisture Content

According to Table 3, the moisture content of dark chocolate drink powder with Kacip Faimah powder extract at different concentrations ranges from 2.49% to 5.92%. Statistical analysis revealed no significant differences ($p>0.05$) among all the dark chocolate drink powder with Kacip Fatimah extracts at different concentrations.

Table 3: Moisture, Water Activity and Hydroscopicity of Dark Chocolate Drink Powder Incorporated with Kacip Fatimah Powder Extract

Parameter	Sample formulation			
	F1 (Control)	F2 (60mg)	F3 (120mg)	F4 (180mg)
Moisture content (%)	5.92 ± 0.38[a]	2.49 ± 1.70[a]	3.77 ± 2.79[a]	3.08 ± 1.03[a]
Water activity (a_w)	0.32 ± 0.00[a]	0.31 ± 0.00[b]	0.29 ± 0.00[d]	0.30 ± 0.00[c]
Hygroscopicity	4.16 ± 0.46[a]	3.17 ± 0.25[b]	3.18 ± 0.27[b]	3.32 ± 0.02[b]

[a,b,c] Values with different letters in the same row are significantly different ($p < 0.05$)
Mean±SD each value in the table is the mean of triplicate

Water Activity

As presented in Table 3, the water activity (a_w) of dark chocolate drink powder with Kacip Fatimah powder extract at different concentrations varied significantly ($p<0.05$), ranging from 0.29 to 0.32. The control sample (F1) recorded the highest a_w value at 0.32 compared to other formulations containing Kacip Fatimah extracts at different concentrations (a_w 0.29-0.31).

Hygroscopicity

The addition of Kacip Fatimah powder extract did not influence the hygroscopicity of the dark chocolate drink powder as shown in Table 3. The hygroscopicity values of dark chocolate drink powder with Kacip Fatimah extracts at different concentrations ranged from 3.17% to 4.16%. Although no significant differences ($p>0.05$) were observed among the dark chocolate drink powder containing Kacip Fatimah extracts, a significant difference ($p < 0.05$) was found when compared to the control sample, which obtained the highest hygroscopicity (4.16%). Meanwhile, the lowest hygroscopicity (3.32-3.17%) was observed in dark chocolate drink powder samples with Kacip Fatimah extracts compared to the control.

Total Soluble Solids

The incorporation of Kacip Fatimah powder extract significantly affected ($p<0.05$) the hot dark chocolate drink in Table 4, which led to an increase in TSS values, which ranged from 12.23 to 13.87°Brix. The control sample (F1), which contained no Kacip Fatimah extract,

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recorded the lowest TSS at 12.23°Brix, while the sample with the highest concentration of Kacip Fatimah extract (F4) exhibited the highest value at 13.87°Brix.

Table 4: Parameters of Dark Chocolate Drinks Incorporated with Kacip Fatimah Extract After Brewing

Parameter	Sample formulation			
	F1 (Control)	F2 (60mg)	F3 (120mg)	F4 (180mg)
Total soluble solids °Brix (%)	12.23 ± 0.15^{c}	13.33 ± 0.15^{b}	13.23 ± 0.06^{b}	13.87 ± 0.06^{a}
pH value	7.47 ± 0.007^{b}	7.46 ± 0.007^{b}	7.42 ± 0.007^{a}	7.47 ± 0.000^{b}
Solubility (%)	10.67 ± 1.15^{a}	14.33 ± 3.21^{a}	11.67 ± 1.15^{a}	12.00 ± 3.00^{a}
Dissolution time (s)	82.62 ± 6.18^{a}	57.15 ± 2.12^{b}	69.21 ± 8.68^{b}	57.42 ± 4.43^{b}
Sedimentation (%)	4.05 ± 0.74^{a}	3.73 ± 0.67^{ab}	2.38 ± 0.71^{b}	4.09 ± 0.30^{a}
Viscosity (cps)	36.67 ± 2.89^{a}	31.67 ± 2.89^{ab}	26.67 ± 2.89^{b}	10.67 ± 3.06^{c}

^{a,b,c} Values with different letters in the same row are significantly different ($p < 0.05$)
Mean±SD each value in the table is the mean of triplicate

pH Value

As shown in Table 4, adding Kacip Fatimah powder extract significantly affected the pH of the hot dark chocolate drink ($p<0.05$). The pH values ranged from 7.42 to 7.47, remaining close to neutral. The control sample (F1) showed the highest pH (7.47), while other samples with Kacip Fatimah extracts (F2, F3, and F4) had slightly lower values.

Solubility

As shown in Table 4, the solubility of hot dark chocolate drink with Kacip Fatimah powder extract ranged from 10.67% to 14.33%, with no significant differences observed between formulations ($p>0.05$). This suggests consistent solubility across all samples, likely due to the uniform particle size of cocoa powder. The addition of Kacip Fatimah extracts at different concentrations did not significantly impact solubility.

Dissolution Time

In this study, the addition of Kacip Fatimah powder extract significantly influenced dissolution time ($p<0.05$), with values ranging from 57.15 to 76.13 seconds compared to the control sample, as shown in Table 4. Sample F2 (0.6 g Kacip Fatimah powder extract) dissolved the fastest at 57.15 seconds, while sample F3 showed the longest time.

Sedimentation

According to Table 4, the sedimentation index of the hot dark chocolate drink with Kacip Fatimah powder extract ranged from 2.38% to 4.09%. The addition of Kacip Fatimah extract did not significantly influence sedimentation ($p>0.05$).

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Viscosity

Based on Table 4, the addition of Kacip Fatimah powder extract significantly reduced the viscosity of the hot dark chocolate drink ($p<0.05$), with values ranging from 10.67 to 36.67 cps. The control sample exhibited the highest viscosity (36.67 cps), while sample F4, containing the highest concentration of the Kacip Fatimah powder extract (1.8 mg), had the lowest viscosity (10.67 cps).

Colour

Table 5 presents the colour properties (L*, a*, b*) for both powdered and dissolved hot dark chocolate drink samples with Kacip Fatimah powder extract. The addition of Kacip Fatimah powder extract significantly increased the L* values ($p<0.05$), meaning the dark chocolate drink powder became lighter in colour. In powdered form, the control sample (F1) had the lowest L* value (34.84). In contrast, F4 (180 mg of Kacip Fatimah powder extract) had the highest lightness (46.45), showing that Kacip Fatimah lightens the cocoa mixture due to its natural colour characteristics. A similar trend was observed in dissolved drink samples, with F1 showing the lowest lightness (4.81) and F4 the highest lightness (14.72), further confirming the lightening effect as the concentration of KFPE increased. In contrast, there were no significant changes in a* and b* values for powdered samples (dark chocolate drink powder with Kacip Fatimah powder extract). However, a significant difference ($p<0.05$) was observed in the a* and b* values for hot dark chocolate drink samples.

Table 5: Colour Of Dark Chocolate Drink with Kacip Fatimah Powder Extract in Powdered and Dissolved Forms

Sample formulation	Powder sample			Dissolved sample		
	L*	a*	b*	L*	a*	b*
F1 (Control)	36.52 ± 0.17c	2.02 ± 0.21a	2.61 ± 0.16b	4.81 ± 0.74b	-0.53 ± 0.20b	1.73 ± 0.12b
F2 (60mg)	44.55 ± 0.17ab	3.43 ± 0.17a	3.34 ± 0.47ab	1.48 ± 0.11c	-0.93 ± 0.07b	2.05 ± 0.02a
F3 (120mg)	44.17 ± 1.31b	3.32 ± 1.23a	4.32 ± 0.84a	15.03 ± 0.59a	0.79 ± 0.10a	2.03 ± 0.13a
F4 (180mg)	46.45 ± 1.28a	3.10 ± 0.48a	3.88 ± 0.83a	15.99 ± 0.98a	0.86 ± 0.19a	1.89 ± 0.11ab

[a,b,c] Values with different letters in the same column are significantly different ($p < 0.05$)
Mean±SD each value in the table is the mean of triplicate

Sensory Evaluation

Table 6 presents the mean scores for sensory attributes (colour, sweetness, cocoa flavour, bitterness, viscosity, and overall acceptability) of hot dark chocolate drink with Kacip Fatimah powder extract at different concentrations.

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Table 6: Sensory Characteristics of Hot Dark Chocolate Drink with Kacip Fatimah Powder Extract

Sample formulation	Sensory Characteristics					
	Colour	Sweetness	Cocoa flavor	Bitterness	Viscosity	Overall acceptability
F1(Control)	6.82± 1.61a	4.75± 1.80b	5.82± 1.79a	5.57± 1.73a	6.43± 1.73a	5.71± 1.58b
F2 (0.6 mg)	7.21± 1.23a	6.18± 1.28a	5.79± 1.23a	6.43± 1.55a	6.43± 1.45a	6.71± 1.38a
F3 (1.2 mg)	7.46± 1.35a	6.11± 2.01a	6.46± 1.35a	6.39± 1.73a	6.71± 1.54a	6.75± 1.73a
F4 (1.8 mg)	7.07± 1.56a	6.11± 1.81a	5.86± 1.38a	6.43± 1.50a	6.46± 1.64a	6.61± 1.47a

Values are presented as mean ± standard deviation; values annotated with different letters in the same column show a significant difference at $p < 0.05$.

ANOVA results revealed significant differences ($p<0.05$) in sweetness and overall acceptability between hot dark chocolate drink with and without Kacip Fatimah extract. However, no significant differences ($p>0.05$) were found in the scores for colour, cocoa flavour, bitterness, or viscosity, indicating that these sensory attributes remained largely unaffected by the addition of the Kacip Fatimah powder extract in hot dark chocolate drink. The significant variation in sweetness scores suggests that KFPE influenced the sweet taste profile of the hot dark chocolate drink. The mean score for the colour of hot dark chocolate drink with Kacip Fatimah powder extract at different concentrations ranged from 6.82 to 7.46, indicating that all samples were generally liked in terms of appearance. No significant differences in cocoa flavour were observed among the samples. Bitterness scores, ranging from 5.57 to 6.43, also remained consistent for all formulations, suggesting that Kacip Fatimah did not introduce additional bitterness. Panellists slightly liked the viscosity of all dark chocolate drink formulations, and the presence of Kacip Fatimah did not significantly impact the drink's mouthfeel. This implies that the Kacip Fatimah was well-integrated and did not alter the beverage's texture. In terms of overall acceptability, all hot dark chocolate drink with Kacip Fatimah powder extract received similar scores, while the control sample (without extract) scored the lowest (5.71).

Discussions

DPPH Scavenging Assay

The enhancement in antioxidant capacity is likely due to the presence of bioactive compounds such as β-carotene and flavonoids found in Kacip Fatimah. Other than that, gallic acid, saponins, caffeic acid, and methyl gallate showed strong antioxidant activity which are also present in Kacip Fatimah (Abdullah et al., 2013). Moreover, all samples displayed antioxidant activity, which can be attributed to epicatechin and catechin compounds naturally

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present in cocoa powder (Ishak et al., 2024). The incorporation of Kacip Fatimah extract effectively enhanced the free radical scavenging potential of the dark chocolate drink powder.

Moisture Content

Similar results were reported by Indiarto et al. (2022), who observed a comparable moisture range in cocoa drink powders with different percentages of encapsulated green coffee bean extracts (2-10%) was between 3.04% and 3.84%, reinforcing the stability of low-moisture formulations. The control sample (F1) recorded the highest moisture content at 5.92%, suggesting higher water retention without the Kacip Fatimah. In contrast, formulation F2 had the lowest moisture content at 2.49%. Dried food products generally have moisture levels below 25%, and foods with less than 8% moisture content can effectively inhibit microbial growth (Chuchird et al., 2024). Overall, all dark chocolate drink powder with Kacip Fatimah extracts at different concentrations have low moisture content.

Water Activity

Water activity indicates the availability of free water in a product, which influences chemical reactions and microbial growth (Tušek & Benković, 2024). This trend reflects the findings of Schmidt and Fontana (2007), who reported a_w values for cocoa powder between 0.258 and 0.251. A reduction in moisture content is often accompanied by a decrease in a_w, due to reduced availability of free water. Furthermore, food products with a_w below 0.6 are generally considered shelf-stable, as most bacteria require a_w above 0.85 to proliferate (Tapia et al., 2020). Therefore, addition of Kacip Fatimah extracts at different concentrations in this study demonstrate strong microbial stability and potential for extended shelf life of dark chocolate drink powder due to low a_w.

Hygroscopicity

The inclusion of Kacip Fatimah powder extract slightly reduced the hygroscopic nature of the cocoa drink powder. This reduction may be attributed to hydrophobic compounds or specific phytochemicals present in the extract, which could limit the product's moisture absorption capacity (Indiarto et al., 2022). Therefore, the addition of Kacip Fatimah extract decreases the hygroscopicity of dark chocolate drink powder.

Total Soluble Solids

Total soluble solids (TSS) refer to the combined concentration of sugars, acids, and small amounts of dissolved vitamins, fructans, pigments, proteins, phenolic compounds, and minerals, which are measured by °Brix unit (Magwaza & Opara, 2015). The increase in TSS of hot dark chocolate drink is likely due to the presence of bioactive compounds in Kacip Fatimah, such as saponins, which are known to stabilize emulsions and improve solubility. These properties promote a more homogeneous dispersion of solid particles in the beverage, thereby increasing the total soluble solids content (Timilsena et al., 2023). Therefore, the addition of Kacip Fatimah extract increases the total soluble solids of the hot dark chocolate drink.

pH Value

Measuring the pH of beverages is crucial for ensuring product consistency, stability, and consumer safety. The reduction in pH of hot dark chocolate drink can be attributed to the presence of organic acids like caffeic acid in Kacip Fatimah extract, which release H^+ ions. Similar effects have been observed with ginger powder, where the presence of phenolic

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compounds and organic acids caused a lower pH in ready-to-drink cocoa beverage formulated with high and low-fat content powder (Faiqoh et al., 2021). Additionally, phenolic compounds in Kacip Fatimah may convert into monomeric phenolic acids, promoting ionization under acidic conditions and contributing further to the pH reduction (Sawale et al., 2017). Therefore, incorporating Kacip Fatimah extract increases the acidity of hot dark chocolate drink.

Solubility

Solubility refers to the capacity of a substance to dissolve in a specific volume of solvent at a given temperature (Setiadi et al., 2021). The results obtained align with findings by Dogan et al. (2013), who reported minimal variation in the solubility of prebiotic instant hot chocolate beverage model systems, attributing it to the consistent sugar content. Therefore, Kacip Fatimah extract does not affect the hot dark chocolate drink.

Dissolution Time

Dissolution time, defined as the time required for a solute to fully dissolve in a solvent is critical for beverage quality as faster dissolution enhances drinkability. Longer dissolution times at higher Kacip Fatimah powder extract concentrations may be due to larger particle sizes or more insoluble components. Additionally, higher moisture content could cause clumping, slowing dissolution. The naturally hydrophobic nature of fat in cocoa powder may also contribute to extended dissolution times (Indiarto et al., 2022). Therefore, Kacip Fatimah extracts at all concentrations decreases the dissolution time of hot dark chocolate drink.

Sedimentation

Sedimentation is a common challenge in cocoa-based beverages, as it affects the overall consistency and texture (Sawale et al., 2017). Factors such as particle size, viscosity, and particle concentration play important roles in sedimentation behavior (Faiqoh et al., 2021). The consistent sedimentation values observed in all hot dark chocolate drink samples may be attributed to the uniform particle size across formulations. Additionally, Sawale et al. (2017) stated that cocoa powder typically contains large, dense, and insoluble particles, and reducing its content can help minimize sedimentation in chocolate-based beverages. Therefore, Kacip Fatimah extract does not improve the sedimentation of hot dark chocolate drink.

Viscosity

The viscosity of cocoa beverages is influenced by the interaction between dispersed solid particles and the dispersion phase (Faiqoh et al., 2021). Increasing the concentration of Kacip Fatimah powder extract lowers the viscosity of the hot dark chocolate drink. The reduction is likely due to the interaction of polyphenols in Kacip Fatimah extract with proteins and other macromolecules, which can disrupt hydrophobic interactions and alter protein structure, thereby decreasing water-binding capacity and overall viscosity (Yeop et al., 2021). Hence, incorporation of Kacip Fatimah extract reduced the viscosity of hot dark chocolate drink due to the presence of antioxidants.

Colour

Colour plays a crucial role in shaping consumer perception and influencing purchasing decisions in beverages (Faiqoh et al., 2021). The L* value indicates lightness, where 100 represents pure white and 0 represents pure black (Amrih et al., 2023). The a* value measures the red-green colour spectrum (positive a* = red, negative a* = green), while the b* value

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reflects the yellow-blue spectrum (positive b* = yellow, negative b* = blue) (Amrih et al., 2023). The presence of Kacip Fatimah powder extract increased both a* and b* values, indicating an enhancement in the reddish and yellowish tones of the hot dark chocolate drink, with higher concentrations of the Kacip Fatimah powder extract intensifying these effects (Indiarto et al., 2022). Therefore, the addition of Kacip Fatimah extract decreases the lightness value of dark chocolate drink in powdered and dissolved forms due to the increase in the red and yellow colour.

Sensory Evaluation

Indiarto et al. (2022) stated that the brown colour of chocolate drinks is primarily due to cocoa powder. During roasting, polyphenolic compounds form quinones, which react with free amino acids and polyphenol oxidase (PPO) enzymes to produce a characteristic brown hue. Flavonoid complexes developed during fermentation and the chemical changes from alkali treatment under heat and oxygen further enhance this cocoa colour. These findings suggest that the inclusion of Kacip Fatimah powder extract did not significantly affect the colour of the hot dark chocolate drink. Flavour is a key factor in consumer acceptance and quality perception of cocoa-based products. Bitterness in chocolate or cocoa powder primarily arises from naturally occurring compounds such as caffeine, theobromine, pyrazines, phenolics, certain peptides, and amino acids (Cempaka et al., 2021). This indicates that the addition of Kacip Fatimah extract positively influenced the overall acceptance of the hot dark chocolate drink which is preferred by consumers.

Conclusion

This study highlights the potential of Kacip Fatimah extract as a natural fortifying agent that enhances the antioxidant and physicochemical properties of cocoa-based beverages. The addition of Kacip Fatimah powder extract significantly increased the antioxidant activity of the dark chocolate drink powder. Moisture content and hygroscopicity of dark chocolate drink powder with Kacip Fatimah powder extract remained unaffected, while water activity increased with higher concentrations of the Kacip Fatimah powder extract. Total soluble solids of hot dark chocolate drink also increased as more Kacip Fatimah powder extract was added, whereas viscosity and pH decreased. Solubility showed no significant changes for all hot dark chocolate drinks with Kacip Fatimah powder extract, but dissolution time was significantly reduced with the extract's inclusion. In terms of colour, Kacip Fatimah powder extract improved the lightness (L*) of both powder and dissolved samples of dark chocolate drinks. Although the a* (redness) and b* (yellowness) values of the powders did not change significantly, the dissolved samples showed marked increases in both with higher levels of Kacip Fatimah extract powder. Sensory evaluation of hot dark chocolate drink with Kacip Fatimah powder extract revealed significant differences in sweetness and overall acceptability, yet all formulations were generally well-received by panellists. Among all, Formulation 3 (dark chocolate drink added with 120 mg of Kacip Fatimah powder extract) emerged as the most balanced, offering an optimal combination of physicochemical properties and antioxidant activity. Future work should assess bioavailability of active compounds and consumer perception of dark chocolate drink with Kacip Fatimah extract under commercial processing conditions.

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References

Abdullah, N., Chermahini, S. H., Suan, C. L., & Sarmidi, M. R. (2013). *Labisia pumila*: A review on its traditional, phytochemical and biological uses. *World Applied Sciences Journal*, *27*(10), 1297–1306. https://doi.org/10.5829/idosi.wasj.2013.27.10.1391

Abedini, A., Dakhili, S., Bazzaz, S., Moghaddam, S. K., Mahmoudzadeh, M., & Hashem Andishmand, H. (2023). Fortification of chocolates with high-value-added plant-based substances: Recent trends, current challenges, and prospects. *Food Science & Nutrition*, *11*(7), 3686-3705. https://doi.org/10.1002/fsn3.3387

Amrih, D., Syarifah, A. N., Sutakwa, A., & Izzati, N. K. (2023). Physicochemical characteristics of local cocoa powder. In Advances in intelligent systems research/Advances in Intelligent Systems Research (pp. 33–38). https://doi.org/10.2991/978-94-6463-338-2_5

Arifin, H. R., Djali, M., Nurhadi, B., Azlin-Hasim, S., Masruchin, N., Vania, P. A., & Hilmi, A. (2022). Corn starch-based bionanocomposite film reinforced with ZnO nanoparticles and different types of plasticizers. *Frontiers in Sustainable Food Systems*, *6,* 886219. https://doi.org/10.3389/fsufs.2022.886219

Barišić, V., Icyer, N. C., Akyil, S., Toker, O. S., Flanjak, I., & Ačkar. D. (2023). Cocoa based beverages – Composition, nutritional value, processing, quality problems and new perspectives. *Trends in Food Science and Technology*, *132*, 65–75. https://doi.org/10.1016/j.tifs.2022.12.011

Cempaka, L., Hakim, T. E. A., & David, W. (2021). Consumer acceptance on chocolate drink made with a mixture of commercial cocoa powder and unfermented cocoa powder. *Pelita Perkebunan*, *37*(2), 126–136. https://doi.org/10.22302/iccri.jur.pelitaperkebunan.v37i2.479

Chuchird, P., Pattarathitiwat, P., & Pongprajak, A. (2024). Formulation and evaluation of physical, chemical and sensory properties of instant functional beverage powder containing Pathum Thani fragrance rice, soy protein and milk powder. *Food Research*, *8*(3), 394–401. https://doi.org/10.26656/fr.2017.8(3).319

Dogan M., Toker O., Aktar T, Goksel. M. (2013). Optimization of gum combination in prebiotic instant hot chocolate beverage model system in terms of rheological aspect: mixture design approach. *Food and Bioprocessing Technology, 6*(3), 783– 794. http://dx.doi.org/10.1007%2Fs11947-011-0736-y

Faiqoh, K., Muhammad, D., & Praseptiangga, D. (2021). Ginger-flavoured ready-to-drink cocoa beverage formulated with high and low fat content powder: Consumer preference, properties and stability. *Food Research*, *5*(S2), 7–17. https://doi.org/10.26656/fr.2017.5(s2).004

Indiarto, R., Rahimah, S., Subroto, E., Putri, N. A. G., & Pangawikan, A. D. (2022). Antioxidant activity and characteristics of a cocoa drink formulated with encapsulated green coffee extract. *International Journal of Food Properties*, *25*(1), 2477–2494. https://doi.org/10.1080/10942912.2022.2144883

Ishak, I., Ab Ghani, N. N., Hisham, N. A. B., Fadzilah, F. N. H., Khaironi, J., Ahmad, F., Musa, N., & Kamarudin, W. S. S. W. (2025). Physicochemical characteristics, total

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 23 (December 2025) PP. 183-198
DOI 10.35631/IJIREV.723013
phenolic content, antioxidant activity, and sensory acceptability of panned keto dark chocolate with monk fruit and stevia as sugar substitutes. *Songklanakarin Journal of Science and Technology*, *47*(2), 134-140.

Ishak, I., Musa, N., Muhamad, A., Hisham, N. A. B., & Kamarudin, W. (2024). Effect of different cocoa mass levels on total phenolic content, antioxidant activity, and sensory acceptability of panned dark chocolate. *IOP Conference Series Earth and Environmental Science*, *1397*(1), 012025. https://doi.org/10.1088/1755-1315/1397/1/012025

Jensen, S., Rolin, C., & Ipsen, R. (2010). Stabilisation of acidified skimmed milk with HM pectin. *Food Hydrocolloids*, *24*(4), 291–299. https://doi.org/10.1016/j.foodhyd.2009.10.004

Karim, H. A., Sidek, H. J., & Mahmud, Z. (2019). Phytochemical screening, antioxidant activity and phenolic content of different plant parts of *Brucea javanica (L.*). *Jurnal Intelek*, *14*(2), 33–43. https://doi.org/10.24191/ji.v14i2.215

Magwaza, L. S., & Opara, U. L. (2015). Analytical methods for determination of sugars and sweetness of horticultural products—A review. *Scientia Horticulturae*, 184, 179–192. https://doi.org/10.1016/j.scienta.2015.01.001

Pourhaji, F., Mohebbi, M., Tehrani, M. M., & Avami, A. (2022). Optimization of sugar free dark chocolate product compatible for ketogenic diet and investigating its physicochemical, textural, thermal and sensory properties. *Iranian Food Science and Technology Research Journal*, *18*(6), 99–112 https://doi.org/10.22067/IFSTRJ.2022.74665.1135

Radzali, S. A., Markom, M., & Md Saleh, N. (2022). Parameter effects and optimisation in supercritical fluid extraction of phenolic compounds from *Labisia pumila*. *Separations*, *9*(12). 385. https://doi.org/10.3390/separations9120385

Rongtong, B., Suwonsichon, T., Ritthiruangdej, P., & Kasemsumran, S. (2018). Determination of water activity, total soluble solids and moisture, sucrose, glucose and fructose contents in osmotically dehydrated papaya using near-infrared spectroscopy. *Agriculture and Natural Resources*, *52*(6), 557–564. https://doi.org/10.1016/j.anres.2018.11.023

Samanta, S., Sarkar, T., Chakraborty, R., Rebezov, M., Shariati, M. A., Thiruvengadam, M., & Rengasamy, K. R. R. (2022). Dark chocolate: An overview of its biological activity, processing, and fortification approaches. *Current Research in Food Science*, *5*, 1916–1943. https://doi.org/10.1016/j.crfs.2022.10.017

Sawale, P. D., Patil, G. R., Hussain, S. A., Singh, A. K., & Singh, R. R. B. (2017). Effect of incorporation of encapsulated and free Arjuna herb on storage stability of chocolate vanilla dairy drink. *Food Bioscience*, *19*, 142–148. https://doi.org/10.1016/j.fbio.2017.07.005

Setiadi, P. A., Saputro, A. D., Nurkholisa, Z., Hardiyanto, Y. F., Bintoro, N., & Karyadi, J. N. W. (2021). Physical characteristic of instanised chocolate beverage powder produced with palm sugar and sucrose as sweeteners. *IOP Conference Series Earth and Environmental Science*, *653*(1), 012038. https://doi.org/10.1088/1755-1315/653/1/012038

Sioriki, E., Lemarcq, V., Alhakim, F., Triharyogi, H., Tuenter, E., Cazin, C. S., Nolan, S. P., Pieters, L., Van De Walle, D., & Dewettinck, K. (2021). Impact of alkalization conditions on the phytochemical content of cocoa powder and the aroma of cocoa drinks. *LWT*, *145*, 111181. https://doi.org/10.1016/j.lwt.2021.111181

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 7 Issue 23 (December 2025) PP. 183-198
DOI 10.35631/IJIREV.723013

Schmidt, S. J., & Fontana, A. J. (2007). Appendix E: Water activity values of select food ingredients and products. *Water Activity in Foods*, 407–420. https://doi.org/10.1002/9780470376454.app5

Tapia, M. S., Alzamora, S. M., & Chirife, J. (2020). Effects of water activity (a_w) on microbial stability as a hurdle in food preservation. In Barbosa-Cánovas, G. V., Fontana Jr. A. J., Schmidt, S. J., & Labuza, J. P. (Eds.) *Water activity in foods: Fundamentals and applications* (pp. 323-355). Hoboken, New Jersey: John Wiley & Sons Inc. https://doi.org/10.1002/9781118765982.ch14

Timilsena, Y. P., Phosanam, A., & Stockmann, R. (2023). Perspectives on saponins: Food functionality and applications. *International Journal of Molecular Sciences*, *24*(17), 13538. https://doi.org/10.3390/ijms241713538

Tušek, K., & Benković, M. (2024). Development of novel honey- and oat-based cocoa beverages—A comprehensive analysis of the impact of drying temperature and mixture composition on physical, chemical and sensory properties. *Molecules*, *29*(19), 4665. https://doi.org/10.3390/molecules29194665

Yeop, A., Sandanasamy, J., Pang, S. F., & Gimbun, J. (2021). Stability and controlled release enhancement of *Labisia pumila's* polyphenols. *Food Bioscience*, *41*, 101025. https://doi.org/10.1016/j.fbio.2021.101025

Zakaria, A. A., Noor, M. H. M., Ahmad, H., Hassim, H. A., Mazlan, M., & Latip, M. Q. A. (2021). A review on therapeutic effects of *Labisia pumila* on female reproductive diseases. *BioMed Research International*, *2021*, 1–9. https://doi.org/10.1155/2021/992819