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Formulated Coconut Milk Drink: Physico-Chemical, Nutritional Properties and Sensory Characteristics

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Abstract | Coconut milk drink (CMD) is plant-based milk that has been formulated into ready-to-drink beverage in response to the changing lifestyles and the growing health concerns among people nowadays, which influenced people towards choosing dairy product alternatives. The aim of the research was to ascertain the physico-chemical, nutritional properties and sensory characteristics of formulated CMD. Formulated CMD contains coconut milk, water, carboxymethyl cellulose (CMC), glyceryl monostearate (GMS) and sodium benzoate. There were five treatments consisting of control without added sugar Control, CMD with 5% added sugar (CMD5), CMD with 6% added sugar (CMD6), CMD with 7% added sugar (CMD7) and CMD with 8% added sugar (CMD8). The physico-chemical properties, proximate analysis and sensory test of formulated coconut milk drink were conducted. The water and fat were the major components of CMD. The increased in sugar concentration significantly reduced the moisture content with a corresponding increase in the carbohydrate, fat and ash content of CMD. The pH reduced from 6.65 to 6.55, while total sugar content and total solid increased from 3.28 °Brix to 12.85 °Brix and from 15.90% to 22.50% respectively as the concentration of sugar increased. In terms of colour, the addition of sugar caused the increased in the lightness (L^*), reduced the redness ($+a^*$) with no significant effect on blue intensity ($-b^*$) of CMD. The addition of sugar improved the people's preference in terms of viscosity, sweetness, sourness, taste and overall acceptability as compared to Control sample. Although no significant difference in sensory evaluation were observed between CMD5, CMD6, CMD7 and CMD8 in all attributes, increasing trends of each attribute can be observed with CMD6 got the highest ratings for general acceptability, color, sweetness, and sourness, indicating that it was the most favored CMD during the analysis.

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Introduction

Consumer demand for dairy milk alternatives has increased around the world due to health concerns on antibiotic residual and cholesterol in dairy milk, increase in the population suffering from cow's milk allergy, lactose intolerance, hypocholesterolemia and preference for vegan diets (Aydar *et al.*, 2020). For this reason, there has been a surge of interest in shifting to more plant-based milk for better health. Innovative plant-based foods and drinks have been used as dairy milk alternatives in recent years. Products made from coconut milk are in greater demand in the food sector due to their high nutritional value, particularly when utilized in Malay cuisine. While several varieties of novel dairy goods made from coconut milk have been exploited as cow milk substitutes, there is still a paucity of studies on the use of coconut milk as a ready to drink beverage and the nutritional information of coconut milk drink especially in Malaysia market. Therefore, a scientific research and study on physico-chemical, nutritional values and organoleptic characteristics of formulated coconut milk drink are important and must be evaluated. Kamath (2020) suggested the coconut milk related drink products had the following optimization parameters, coconut meat: water ratio of 1:1.5 and 6% of sugar concentration. Carboxymethyl cellulose (CMC) can be added as a stabilizer to increase the stability of coconut milk emulsion, while sodium benzoate can be used to preserve it, according to Phungamngoen *et al.* (2004) and Khuenpet *et al.* (2016), Okafor *et al.* (2017).

In this study, condensed coconut milk from mature coconuts aged 13 months was utilized to standardize the content of coconut milk drinks. The bundle stock of coconut was gathered from the same farmer under control conditions. The content of the coconut kernel influences the composition and quality of the coconut milk produced (Chan *et al.*, 2016). Food additives such as stabilizers, emulsifiers, and antimicrobials were used throughout the formulation process to increase the stability, quality, bioavailability, and shelf life of the coconut milk drink (Romulo, 2022). The proportion of stabilizer and emulsifier has a considerable impact on the stability and viscosity of the coconut milk drink produced (Thanatrungueang and Harnsilawat, 2018). Therefore, 0.3% CMC stabilizer and 0.25% GMS emulsifier were added in this formulation as it were the most suitable percentage. Adding CMC and GMS to coconut milk and homogenizing it

improved its stability by reducing particle size, minimizing aggregates and lipid droplet formation, improving particle distribution, and creating a desirable texture and mouthfeel (Romulo, 2022). After homogenization, heat treatment at 65 °C to 70 °C was undertaken for 15 minutes to kill pathogenic microorganisms and inactivate enzymes. Peroxidase and polyphenol oxidase are examples of naturally occurring enzymes in coconut milk which can cause discolouration reaction of coconut milk which turns into slightly greenish. Besides, lipase enzyme which may contribute to the hydrolysis of triglycerides can give rise to strong off odours and distinctive soapy taste (Chan *et al.*, 2016). The optimization of temperature and time for the heating process is important to optimize the nutritional quality and shelf life of coconut milk drink (Romulo, 2022).

The emergence of lactose intolerance, milk allergy, problems caused by high-cholesterol diets and ethical concerns about the consumption of dairy milk are driving up global demand for plant-based milks (Vanga and Raghavan, 2017). According to Vanga *et al.* (2015), cow's milk allergy is one of the most common allergies among children and babies. The study is centered on the potential application of formulated coconut milk drink due to the changing lifestyles and the growing health concerns among people nowadays, which influenced towards choosing dairy milk alternatives (Vanga and Raghavan, 2017). The findings from this study can contribute as a reference for the physico-chemical and nutritional composition of coconut milk drink in the future. Moreover, this study may provide insight into acceptance and preference for the formulated coconut milk drink as a beverage. Other than that, the formulated coconut milk drink also be an economical alternative and increase household income in developing countries and at the same time can be a good nutritional drink source wherein cow's milk supply is limited (Sethi *et al.*, 2016).

Materials and Methods

Preparation of formulated coconut milk drink

Concentrated coconut milk without addition of water was purchased from a same local retailer with control production in Besut, Terengganu. In this study, coconut milk was standardized to a maturity of 13 months, with the farmer regulating the composition of the coconut milk drink. The coconut supply was sourced

from the same farmer under controlled conditions. All the equipment that was used for the production and analysis from the Faculty of Bioresources and Food Industry, UniSZA. The formulation coconut milk drink was prepared according to the formulation illustrated in [Table 1](#).

The CMD formulation was prepared following the methodology described by [Okafor et al. \(2017\)](#). The stabilizer, consisting of CMC, was prepared by dissolving 0.3% CMC in 20 mL of hot water (100°C) and thoroughly stirring the solution with a spoon. The solution was then allowed to stand for five minutes. Subsequently, concentrated coconut milk was mixed with water and heated. Different sugar concentrations 5% (CMD5), 6% (CMD6), 7% (CMD7), and 8% (CMD8) were added to the samples at 60°C, with one sample serving as a control without added sugar. Each sample was stabilized with the pre-dissolved CMC, 0.2% GMS, and preserved with 0.13% sodium benzoate. Finally, the samples were pasteurized at 65°C to 70°C for 15 minutes and then homogenized for 3 minutes. The samples were filtered and stored at room temperature (28°C ± 2°C) for further analysis.

Proximate analysis

Proximate analyses of the formulated coconut milk drink were conducted to determine moisture content, ash, protein, fat, and carbohydrates using standard AOAC procedures ([AOAC International, 2000](#)), with results expressed as a percentage on a wet basis. Moisture content was measured using the oven drying method, ash by the combustion method, protein by the Kjeldahl method, fat by the Soxhlet method, and carbohydrates by subtracting the total percentages of moisture, ash, protein, and fat from 100% ([Okokon and Okokon, 2019](#); [Ramlee, 2019](#)). Each analysis was performed in duplicate with three samples per replication.

Physico-chemical analysis

The samples underwent physico-chemical analyses, including pH measurement, color analysis, total sugar content (expressed in degrees Brix), and total solid determination. Each analysis was performed in duplicate, with triplicate samples for each replication.

Determination of pH

The pH of the samples was determined using a tabletop pH meter (Hanna, Romania) following the protocol outlined by [Okafor et al. \(2017\)](#). Initially, the pH meter was calibrated with buffer solutions at pH 4 and pH 7. Subsequently, 20 mL of each sample was transferred to a beaker. The pH glass electrode was then immersed in the sample. Measurements were conducted at an ambient temperature of 30 °C ± 2 °C, with each sample analyzed in triplicate.

Colour analysis

The colour of the formulated coconut milk drink samples were measured using chromameter device (Konica Minalto, Japan). Chromameter was calibrated using white calibration plate and illuminants C ($y = 93.5, x = 0.3114, y = 0.3190$) ([Nielsen, 2010](#)). The device showed the results in terms of colour parameters which were L^* , a^* and b^* . L^* represents the lightness, a^* represents the change in hue from red to green and b^* represents the change in hue from yellow to blue. The readings were taken triplicate for each sample at different area to get average value.

Determination of sugar content

The sugar concentration was determined using a refractometer (Atoga, Japan) and reported in degrees Brix ([Oti, 2016](#)). Initially, a few drops of the sample were placed on the instrument's plate, and the start button was activated to acquire the Brix reading. The obtained value in °Brix indicates the sugar content of the sample. To obtain an average, each sample was measured three times.

Table 1: Formulation of coconut milk drink.

Ingredients (%)	Treatment				
	Control	CMD5	CMD6	CMD7	CMD8
Water	75	75	75	75	75
Concentrated coconut milk	25	25	25	25	25
Carboxymeth-yl cellulose (CMC)	0.3	0.3	0.3	0.3	0.3
Glyceryl monostearate (GMS)	0.2	0.2	0.2	0.2	0.2
Sodium Benzoate	0.13	0.13	0.13	0.13	0.13
Sugar	0	5	6	7	8

Source: [Phungamngoen et al. \(2004\)](#), [Khuenpet et al. \(2016\)](#), [Okafor et al. \(2017\)](#), [Kamath \(2020\)](#).

Determination of total solid

Total solid was calculated by using the equation below as described by Okafor *et al.* (2017).

$$\text{Total solid} = 100\% - \text{percent moisture content}$$

Sensory evaluation

In this analysis, 50 panelists consisting of UniSZA students and staffs were randomly selected. The five treatments of formulated coconut milk drink consist of (Control, CMD5, CMD6, CMD7 and CMD8) were evaluated for colour, viscosity, sweetness, sourness, taste and overall acceptability as followed (Belewu *et al.*, 2014; Okafor *et al.*, 2017; Echem and Torporo, 2018).

The evaluation was carried out at the Sensory Laboratory of the Faculty of Bioresources and Food Industry (FBIM) at UniSZA. The samples were assessed using a 9-point hedonic scale as outlined by Everitt (2009). The scale was used to represent the degree of liking for the product attributes, where 1 indicated dislike severely, 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, and 9 like extremely. In this study, panelists were provided with five coded samples and instructed to taste and rate each sample sequentially from left to right based on its attributes. A Google form was used for data collection, where panelists recorded the three-digit code for each sample and rated the features according to their preferences. The panelists were provided with plain water to rinse mouth before start and in between evaluations.

Statistical analysis

The data were analyzed utilizing the Statistical Package for the Social Sciences (SPSS) software, version 14, with a significance threshold set at $p < 0.05$. Mean ranks and significance levels for proximate composition, physicochemical characteristics, and sensory data

were calculated using one-way ANOVA, and the comparisons were conducted using Tukey's test.

Results and Discussion

Nutritional composition of coconut milk drink

Moisture content: Moisture content plays a crucial role in determining the physical properties of coconut milk beverages, such as viscosity and color. Table 2 presents the moisture content of various coconut milk drink samples, revealing a significant difference ($p < 0.05$) in moisture content between the Control, CMD5, and CMD6 groups compared to CMD7 and CMD8. However, no significant difference ($p > 0.05$) was observed between CMD7 and CMD8. The Control sample exhibited the highest moisture content, with an average value of 84.10%, followed by CMD5, CMD6, CMD7, and CMD8. These findings align with previous studies by Alyaqoubi *et al.* (2015) and Okafar *et al.* (2017), moisture content of coconut milk directly expelled from coconut kernel without added water were 54% and 50% to 54%, respectively.

In the control sample, which did not contain added sugar, the highest moisture content was recorded. In contrast, samples CMD7 and CMD8, which had the highest sugar concentrations of 7% and 8%, respectively, exhibited the lowest moisture content. This observation aligns with the findings of Khan *et al.* (2016), who reported a decrease in moisture content in jam as sugar content increased. This phenomenon can be attributed to the hygroscopic nature of sugar, which allows it to bind with water molecules (Kabuo *et al.*, 2014). Hygroscopic substances have the ability to absorb moisture from their surroundings. Consequently, the addition of sugar likely enhances the hygroscopic properties in the coconut milk drink samples, resulting in reduced moisture content. The significant differences in moisture content among the samples indicate a notable effect of sugar

Table 2: Nutritional composition of coconut milk drink.

Sample	Moisture	Ash	Protein	Fat	Carbohydrate
Control	84.10 ± 0.15 ^d	0.26 ± 0.03 ^a	0.95 ± 0.02 ^{cd}	11.58 ± 0.24 ^a	3.10 ± 0.15 ^a
CMD5	79.34 ± 0.28 ^c	0.34 ± 0.02 ^b	0.97 ± 0.03 ^d	13.97 ± 0.14 ^b	5.37 ± 0.27 ^b
CMD6	78.70 ± 0.12 ^b	0.34 ± 0.02 ^b	0.92 ± 0.02 ^{bc}	14.32 ± 0.06 ^c	5.72 ± 0.18 ^b
CMD7	77.54 ± 0.38 ^a	0.35 ± 0.02 ^b	0.90 ± 0.03 ^{ab}	16.16 ± 0.22 ^d	5.04 ± 0.55 ^b
CMD8	77.45 ± 0.66 ^a	0.32 ± 0.04 ^b	0.87 ± 0.04 ^b	18.05 ± 0.17 ^e	3.32 ± 0.62 ^a

Mean value with different subscript letters that differ significantly from each other ($p < 0.05$). (a-e) = Significant different ($p < 0.05$) of nutritional composition between samples.

concentration on the moisture percentage in coconut milk drinks. Therefore, higher sugar content in the formulation correlates with lower moisture content in the drink. Overall, incorporating sugar into a coconut milk drink formulation can decrease moisture content due to increased viscosity. Higher viscosity reduces the amount of free water available in the drink, contributing to lower moisture content. However, it is crucial to balance the amount of added sugar with the desired texture and flavor to ensure a high-quality product.

Ash content

The ash content is a measure of the total quantity of minerals present, whereas the mineral content measures the amount of individual inorganic components such as sodium, potassium, calcium, and chloride. Quantifying food ash and mineral content is crucial for nutritional labeling, quality assessment, microbiological stability, and food processing (McCelegns and Decker, 2009).

According to Table 2, the ash content of coconut milk drink samples was not significantly different ($p > 0.05$) between CMD5, CMD6, CMD7, and CMD8. The four samples of CMD5, CMD6, CMD7, and CMD8 showed significant differences ($p < 0.05$) from the Control. The mean ash content score for all samples ranged between 0.26% and 0.35%. According to Chan *et al.* (2016), the ash percentage of pure coconut milk ranged from 0.63% to 0.96% depending on variety, age, growth environment of the coconut, technique of preparation, and the extraction procedure. This showed that the ash content of the coconut milk drink formulated in this research was slightly lower than the ash content of pure coconut milk.

Furthermore, the results show that Control had the lowest ash content of the four samples, distinguishing it from the others. This indicates that the addition of sugar to the formulation of coconut milk drink greatly increased the ash level, as there is no significant difference. According to Lekjing *et al.* (2022), the addition of sugar increases ash content because white sugar contains few minerals such as zinc, iron, phosphorus, potassium, and calcium. According to Curi *et al.* (2017), white sugar includes a high concentration of cations and anions. These cations and anions interacted with the coconut milk drink, increasing its ash level. The amount of ash in the samples was connected to the number of minerals

present (Okokon and Okokon, 2019). Coconut milk contains nutrients such as potassium, iron, magnesium, and zinc (Sethi *et al.*, 2016). Potassium is necessary for a healthy cardiac rhythm. It is also important for normal muscle function. Iron is necessary for the formation of healthy red blood cells with proper hemoglobin concentrations. Magnesium is required for a healthy immune system as well as normal neuron and muscle function.

Protein content

Protein are organic substances made up of a few elements, including hydrogen, carbon, nitrogen, oxygen, and sulfur. It is an important constituent in food and beverages, serving as a major source of energy and an essential amino acid that can form structural components of many foods and contribute to certain functional properties such as stability, appearance, and texture (Onsaard *et al.*, 2005; Khuenpet *et al.*, 2016).

Table 2 shows the protein composition of the coconut milk drink samples. The data show that there are no significant differences ($p > 0.05$) in protein content between Control with CMD5 and CMD6. Furthermore, CMD6 showed no significant difference with CMD7, whereas CMD7 showed no significant difference with CMD8. The only significant change ($p < 0.05$) is between Control with CMD7 and CMD8, CMD5 with CMD6, CMD7 and CMD8, and CMD6 with CMD8. These findings suggest that varying sugar concentrations have no significant effect on the protein composition of coconut milk drinks. According to previous research, refined granulated white sugar did not contain any protein (Lekjing *et al.*, 2022). Hence, the addition of sugar did not affect the amount of protein in coconut milk drink.

The protein content obtains ranged between 0.87% to 0.97%. Conferring to the previous researches, the protein content for pure coconut milk without addition of water were varied in the range of 3.28% to 3.60% (Aydar *et al.*, 2020), 2.6% to 4.4% (Okafar *et al.*, 2017) and 2.14% to 2.97% (Chan *et al.*, 2016). In certain cases, the protein level of the coconut milk drink in this study was somewhat lower than that of pure coconut milk in earlier studies. This could be due to the dilution of coconut milk with water, the variety of coconut, its maturity, the processing conditions, and other reasons. Romulo (2022) found that cow milk had a protein level of 3.15%. Coconut milk drinks have a lower protein level than cow milk. This

is consistent with the remark of [Aydar et al. \(2007\)](#), who noted that the protein level of coconut milk is typically lower than that of cow's milk, distinguishing it from cow milk. Proteins in coconut milk have a significant impact on emulsion stability ([Alyaqoubi et al., 2015](#)). Coconut milk, which is essentially an oil-in-water emulsion, is stabilized by naturally occurring proteins called globulins and albumins. Based on solubility characteristics, at least 80% of the protein in coconut milk is classified as albumin and globulin, which are also the major proteins in coconut milk.

Fat content

The determination of fat content in coconut milk drink is crucial because fat is one of the main components of coconut milk. [Table 2](#) shows the fat content of several coconut milk drink formulations. The samples showed substantial differences ($p < 0.05$) from one another. The average fat content values ranged from 11.58% for control to 18.05% for cmd8. The study found that raising the sugar concentration had a significant ($p < 0.05$) effect on the fat content of coconut milk drink.

The fat level of the coconut milk drink observed in this investigation was consistent with the findings of [Nadeeshani \(2015\)](#), who stated that the total fat content of coconut milk varied from 5.88% to 21.83%, depending on the concentration of coconut milk. According to [Romulo \(2022\)](#), cow milk contains 3.27% fat, the majority of which is saturated fatty acids. Although coconut milk has a considerably higher fat content than cow milk, fat in coconut milk may not cause heart disease even when ingested at more than 60% of calorie consumption ([Lekshmi et al., 2016](#)). It's because coconut contains phytochemicals, which may have health benefits. Coconut milk includes fat, primarily in the form of medium chain saturated fatty acids (MCFAs), which are plentiful in breast milk, particularly lauric acid ([Alyaqoubi et al.,](#)

[2015](#)). The body converts this fat into monolaurin, a molecule with antiviral and antibacterial properties that can remove several disease-causing organisms. Lauric acid has also been shown to drastically lower cholesterol and triglyceride levels, lowering the risk of heart disease and stroke ([Edem and Elijah, 2016](#)).

Carbohydrate content

[Table 2](#) shows substantial differences ($p < 0.05$) in carbohydrate content between Control and CMD8, compared to CMD5, CMD6, and CMD7. However, no significant difference was found between Control and CMD8, or between CMD5, CMD6, and CMD7. Sugar may raise the carbohydrate content of coconut milk drink because it contains glucose, which is one of the constituent elements of carbohydrate polymers ([Nissa et al., 2019](#)). The carbohydrate content of the coconut milk drink in this study ranged between 3.10% and 5.72%. This is consistent with the findings of [Lad et al. \(2016\)](#), who revealed that coconut milk contains 2% to 5% carbohydrate. Whereas, carbohydrate in coconut milk drink were slightly lower than carbohydrate reported in cow milk by [Romulo \(2022\)](#), where the carbohydrate of cow milk was 4.78%.

Physico-chemical properties of coconut milk drink

pH: pH is defined as the negative logarithm of hydrogen ion concentration in a solution, represented as $\text{pH} = -\log_{10}(\text{H}^+)$ ([Satyam, 2021](#)). The pH readings of coconut milk drinks are crucial because they reveal the acidity and alkalinity of the coconut milk. [Table 3](#) shows the mean pH values for coconut milk drinks. The study found significant variations ($p < 0.05$) in pH values between Control and CMD5, CMD6, CMD7, and CMD8. There were no significant differences ($p > 0.05$) between CMD5 and CMD7, or CMD6 with CMD7 and CMD8. Control had the greatest pH value at 6.65, whereas CMD8 had the lowest with the pH value of 6.55.

Table 3: *Physico-chemical properties of coconut milk drink.*

Sample	pH	Total sugar content	Total solid	Color		
				*L	*a	*b
Control	6.65 ± 0.02 ^d	3.28 ± 0.02 ^a	15.90 ± 0.15 ^a	57.43 ± 0.54 ^a	0.89 ± 0.02 ^c	-0.59 ± 0.38 ^a
CMD5	6.60 ± 0.01 ^c	9.75 ± 0.03 ^b	20.66 ± 0.28 ^b	61.71 ± 0.38 ^b	0.85 ± 0.03 ^c	-0.32 ± 0.76 ^a
CMD6	6.57 ± 0.01 ^{ab}	10.93 ± 0.09 ^c	21.30 ± 0.12 ^c	63.67 ± 0.29 ^c	0.73 ± 0.03 ^b	-0.51 ± 0.19 ^a
CMD7	6.59 ± 0.03 ^{ab}	11.69 ± 0.03 ^d	22.46 ± 0.38 ^d	66.53 ± 0.34 ^d	0.65 ± 0.05 ^a	-0.43 ± 0.27 ^a
CMD8	6.55 ± 0.01 ^a	12.85 ± 0.04 ^e	22.55 ± 0.66 ^d	69.00 ± 0.47 ^e	0.64 ± 0.02 ^a	-0.34 ± 0.05 ^a

Mean value with different subscript letters that differ significantly from each other ($p < 0.05$). (a-e) = Significant different ($p < 0.05$) of physico-chemical properties between samples.

The pH readings of the coconut milk drink in this investigation corroborated [Aidoo et al. \(2010\)](#) conclusion that vegetable or plant milk was somewhat acidic, with a pH range of 6.33–6.97. Furthermore, the pH values of coconut milk drink are substantially lower. The addition of sugar lowered the hydrogen ion concentration of the coconut milk drink samples, making them more acidic. This finding is backed by [Tamuno and Monday's \(2019\)](#) research, which discovered that adding sugar reduced the pH of milk products. The pH readings of the coconut milk drink in this investigation corroborated [Aidoo et al. \(2010\)](#) conclusion that vegetable or plant milk was somewhat acidic, with a pH range of 6.33–6.97. Furthermore, the pH values of the coconut milk drink are in the same range as the pH values of fresh cow's milk (6.5–6.7), as reported by [Tulashie et al. \(2022\)](#).

Colour

Color is a significant qualitative element of food products that may be used to identify product quality and affect consumer choices and preferences ([Pathare et al., 2012](#)). Table 3 shows that the L^* values for coconut milk drinks ranged from 57.43 for Control to 69.00 for CMD8. The L^* values of all examined samples differed significantly ($p < 0.05$). L^* values represent the degree of lightness from dark to light colour. L^* gives an index of luminosity and thus, the higher the L^* value, the lighter the sample on a scale between black and white ([Akeem et al., 2018](#)). The L^* values of coconut milk drink significantly increased as the concentration of sugar increased indicating there was significant effect of sugar concentration on the lightness of coconut milk drink produce. CMD8 was the lightest compared to other samples while Control possessed the darker and reddest colour among the samples.

The range of L^* values obtained of coconut milk drink samples was in line to 50.23 to 80.60 L^* values reported for UHT skim coconut milk by [Khuenpet et al. \(2016\)](#) and 56.69 to 88.09 L^* values reported for few commercial fermented and acidified milk beverages by [Hassim et al. \(2020\)](#). According to [Khuenpet et al. \(2016\)](#), the fat content of coconut milk affects its lightness, with lower fat content resulting in reduced lightness. Previous research on the color of oil-in-water emulsions (fat 0–20%wt) found that the lightness of the samples increased with the fat level. This is due to the fact that fat can increase light dispersion and reflection ([Chanamai](#)

and [McClements, 2000](#)). This is in agreement with the finding of this study as Control that had the lower fat content value possessed the lowest lightness while CMD8 that contain high fat content gives the highest lightness compared to other samples.

Subsequent, for the a^* value, there were no significant difference between Control and CMD5 and between CMD7 and CMD8. The significant difference ($p < 0.05$) can be detected between CMD6 with Control and CMD5, between CMD6 with CMD7 and CMD8 and between Control and CMD5 with CMD7 and CMD8. Negative a^* linked with green colour and positive a^* characterize the red colour. This represent that the low concentration of sugar in CMD5 not significantly affect the redness of the coconut milk drink while the high concentration of sugar in CMD8 gives the similar range of redness value with CMD7. The a^* value of coconut milk drink samples ranged from 0.64 to 0.89. These values contradicted with the reported a^* values for dairy milk as reported by [McClements et al. \(2019\)](#) which in the range of -4.8 for skim milk, -2.1 for full fat milk and -0.2 for cream milk. The negative values obtained for the parameter a^* indicated a green colouration of the dairy milk while the positive a^* values indicated the redness colouration of coconut milk drink. The difference in the intensity of a^* value of coconut milk drink with dairy milk can be due to the size of fat globules and percentage of fat in the milk ([Walstra et al., 2006](#)).

Next, for the b^* values, it can be identified that no significant difference exists between all of the tested coconut milk drink samples. Negative b^* represent blue colour while positive b^* represent the yellow colour ([Walstra et al., 2006](#)). The output for the b^* values indicated that the addition of sugar not significantly affect the blue and yellow intensity of coconut milk drink. The negative b values obtained for the parameter b^* showed a blue colouration of the coconut milk drink. The findings in this work were consistent with a study by [Khuenpet et al. \(2016\)](#) on UHT skim coconut milk, which indicated that UHT skim coconut milk treated with CMC and Montanox 60 had a negative b^* value. The negative b^* values of coconut milk drink were caused by the inclusion of CMC stabilizer and GMS emulsifier, which were likely to diminish the yellowness of the samples. It is because the emulsifier and stabilizer helped to uniformly disperse fat and other particles in the

emulsion, resulting in a lower overall yellowness of the sample (Khuenpet *et al.*, 2016). In the other hand, the b^* values of coconut milk drink were in contrast with the b^* values for dairy milk of which in the range of 4.1 to 8.8 as stated by McClements *et al.* (2019). It is because, the intensity of the yellow colour in dairy milk influenced by higher intake of green feed, large fat globules as well as the present of carotene and xanthophylls present in the dairy milk (Walstra *et al.*, 2006).

Total sugar content

The total sugar content in the products is also important as the properties of foods and beverages like sweetness, stability, appearance, and texture hinge on the type and concentration of carbohydrates present. The determination of total sugar content is important to identify the difference in refractive index of coconut milk drink that had added with different sugar concentration. Furthermore, determining the overall sugar concentration in the coconut milk drink is significant since it might impact sensory qualities such as sweetness, sourness, taste, and viscosity.

Table 3 shows the total sugar content of all five samples. Table 3 shows significant differences ($p \leq 0.05$) in °Brix readings across all coconut milk drink samples. The CMD8 had the highest mean °Brix score, followed by CMD7, CMD6, and CMD5, with readings of 12.85 °Brix, 11.69 °Brix, 10.93 °Brix, and 9.75 °Brix, respectively. Control obtained the lowest °Brix reading of 3.28. The variations in sugar values seen in coconut milk drink samples were to be expected given the inclusion of various sugar concentrations. The result indicates that CMD8 had the highest total soluble solids in the solution while Control had the lowest value. Control sample which not added with any sugar gives the 3.28 °Brix reading as it naturally contains reducing sugars and sucrose as reported by Tulashie *et al.* (2022).

Total solid

Total solids refer to the amount of solids remaining after heating the sample to constant weight at 105°C. This may include fat, protein, lactose and mineral matter (Mauer and Bradley, 2017). The determination of total solid in food products is one of the most commonly used quality control tests. Total solids testing is one of analytical procedures used prior to packaging and distribution for some fresh fluid dairy products.

Table 3 shows substantial ($p < 0.05$) changes in total solids between Control, CMD5, and CMD6, with mean values of 15.90%, 20.66%, and 21.30%. However, CMD7 and CMD8 showed no significant difference, with mean values of 22.46% and 22.55%, respectively. The increase in the total solid of coconut milk drink can be seen as the concentration of sugar added increases, suggesting that the addition of sugar and varying sugar concentrations have a major impact on the total solid. This conclusion was consistent with a previous study by Begum *et al.* (2020), who found that the total solid was directly proportional to the concentration of sugar. However, the insignificant in total solid between CMD7 and CMD8 can be due to the similar average of moisture content between these two samples which were 77.54% and 77.45% respectively. The total solid contents attained in consistent with the total solid content of coconut milk obtained by Chan *et al.* (2016) which was in the range of 12.7% to 25.3%.

Sensory attribute

According to Lawless and Heyman (2010), sensory assessment is a scientific process for eliciting, measuring, analyzing, and interpreting responses to items as perceived by the senses of smell, sight, touch, taste, and hearing. Sensory evaluation is a critical component of any food research or product development endeavor.

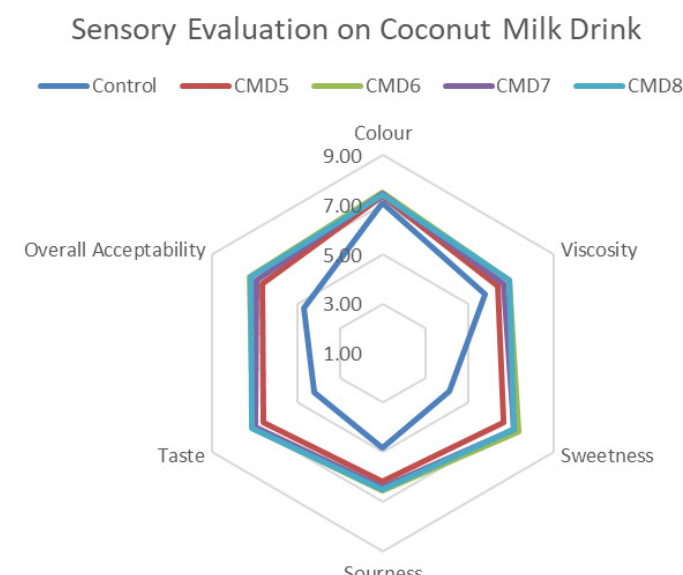


Figure 1: The sensory evaluation of coconut milk drink samples.

Figure 1 depicts the sensory score for the color, viscosity, sweetness, sourness, taste, and overall acceptability of coconut milk drinks, as assessed by 50 panelists using a nine-point hedonic scale. The results show that there

was no significant difference ($p>0.05$) in the degree of resemblance between the colors of all five samples. The mean average color for all examined samples was 7.36, suggesting that the majority of panelists liked the color of the coconut milk drink, which may be classified as moderate in lightness (L^*), somewhat red ($+a^*$), and slightly blue ($-b^*$) based on color analysis in this study. Because of the identical intensity of b^* values in the coconut milk drink, all samples had a similar color similarity score, as shown in Table 3.

In term of viscosity, it can be identified that there were significant differences between Control with CMD6, CMD7 and CMD8. In a while, CMD5 shared similar score with Control and with CMD6, CMD7 and CMD8. CMD5, CMD6, CMD7 and CMD8 were the most preferred coconut milk drink in terms of viscosity as compared to Control. The high moisture content of Control and the absence of sugar make the Control samples felt watery and the aroma and sweetness were underwhelming as compared to the other four samples.

In terms of sweetness, sourness, taste and overall acceptability, CMD5, CMD6, CMD7 and CMD8 had similar sensory acceptance and possessed the highest mean scores for these attributes as compared to Control. Regarding to the sweetness, Control was modestly preferred as it gives tasteless and have a strong coconut flavour. This can be due to the lower °Brix value of Control as compared to the other samples. CMD6 was the most favored among the sweetened coconut milk drink samples as it gave moderate sweetness with a Brix reading of 10.93 °Brix. Similar observation reported for the coconut milk beverages fortified with flaxseed oil studied by Kamath (2020) which found that the highest score was obtained by the sample prepared with 6 % of sugar concentration.

Next, in terms of sourness, it can be affected by the pH values of the coconut milk drink. The pH values of Control samples that slightly differ and higher than other four samples make it less preferred for the sourness. For the taste, it can be affected by the creamy, sweetness and coconut flavour of the samples. Therefore, CMD5, CMD6, CMD7 and CMD8 which had the higher fat content as compared to Control were highly preferred for the taste. For the overall acceptability, coconut milk drink samples with added sugar were most preferred as compared

to Control. This could be related to the fact that sugar enhances the taste and flavour of foods. This is consistent with a study conducted by Tamuno and Monday (2019), who discovered that cashew nut milk with sugar was favored for all sensory characteristics above plain cashew nut milk. This indicates that the coconut milk drink is better flavored with sweeteners like sugar for consumer acceptance.

Although the sweetness, sourness, taste and overall acceptability among CMD5, CMD6, CMD7 and CMD8 were insignificant, increasing trends for all attributes of coconut milk drink were observed with different concentration of sugar added. Among all samples, CMD6 had the highest scores for colour, sweetness, sourness and overall acceptability, indicating the most preferred coconut milk drink during the analysis

Conclusions and Recommendations

In conclusion, the physicochemical, proximate composition, and sensory properties of the coconut milk drink acquired from this study indicate that the coconut milk drink may have good nutritional value and can be eaten as a non-dairy milk alternative to dairy milk. Adding sugar to coconut milk drink decreases moisture content and pH ($p<0.05$), while increasing carbohydrate, fat, ash, total sugar, and solid content. Furthermore, in terms of sensory acceptance, adding sugar increases the viscosity, sweetness, sourness, flavor, and overall acceptability of the coconut milk drink when compared to plain coconut milk. It can therefore be supplemented with protein or blended with other protein-rich foods such as peas and soybeans. Furthermore, future research should be undertaken to discover the bioactive molecule contained in coconut milk drink, as well as the elements that contribute to the ideal chemical composition of coconut milk drink, in order to determine its nutritional worth.

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Novelty Statement

Understanding the role of coconut milk drink in

managing body weight issue as well as other diseases. Thus, new knowledge will be generated regarding the MCTs composition in coconut milk drink and its role in weight reduction. Last, development of formulated coconut milk drink for healthy conscious.

Author's Contribution

Norsyasya Shari, Nur Nabilah Husin and Noroul Asyikeen Zulkifli: Write the paper.

Zalilawati Mat Rasid, Maaruf Abdul Ghani and Noroul Asyikeen Zulkifli: Supervised and reviewed the manuscript.

All authors read and approved the final version.

Conflict of interest

The authors have declared no conflict of interest.

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