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Physicochemical Properties and Microbial Count of Bacterial Survival in Freeze Dried Goat Milk Yogurt Powder

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ABSTRACT

Yogurt is a fermented milk product that has a semi-solid texture and has a short shelf life. It must be stored properly in temperature of 4ºC and below to prevent the microbial spoilage due to it high in moisture content and water activity. This study aimed to produce freeze dried goat milk yogurt powder with different percentage of honey and analyse the physicochemical as well as compare the microbial count of bacterial growth in fresh goat milk yogurt and reconstituted goat milk yogurt powder. The four formulations prepared were 6% of sugar (CY), 3% of honey with 3% of sugar (LHY), 4% of honey with 2% of sugar (MHY) and 6% of honey (HHY). The results showed each formulation has significant differences for the physicochemical analysis. The percentage of honey added into the yogurt was affected the pH value of the yogurt which have a range from pH 4.18 to 4.45. Meanwhile the results for colour analysis shown that the yellowness value of goat milk yogurt was increased as the percentage of honey added inside the yogurt was increased, as contributed by dark brown colour of honey. The bacterial survival in CY, LHY, MHY and HHY samples for fresh goat milk yogurt and reconstituted goat milk yogurt powder showed the significant different ($p<0.05$) with the range from 6.40 to 8.75 log cfu/ml and 5.79 to 8.07 log cfu/ml respectively. Therefore, it can be concluded that freeze drying was a suitable method to produce yogurt powder and LHY sample was the best formulation in producing the highest number of survival bacteria (log cfu/ml).

Keywords: Goat milk, freeze-drying, honey, yogurt powder, reconstituted

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INTRODUCTION

Yogurt is a type of dairy product consumed worldwide which is typically made from fermented cow's milk. Yogurt, a smooth coagulated dairy gel, is classified as a healthy food product due to its beneficial nutritional content, which can enhance the gut microbiota. Several types of yogurts are manufactured by using different process conditions and the composition of the milk base. Set yogurt is incubated in retail containers and keeping the gel structure undisturbed, stirred yogurt is incubated in the large fermentation vessels and stirred to obtain a smooth and viscous product before filling and packaging while Greek-style yogurt (GSY) is produced by the addition of milk solids whether wet or dry before fermentation (Li, 2021).

According to the Codex standard published by the Food and Agriculture Organization (FAO) lactic acid fermentation has been produced the yogurt through the action of the starter cultures, which are *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* (Chandan, 2017). Yogurt with these beneficial cultures is known as probiotics product that good for digestive system. Hence, freeze drying become an alternative and effective drying process to produce the product for a longer shelf life (Passot et al., 2012).

Honey is most appreciated and valued natural substance introduced to humankind since ancient times, not only used as a nutritional product but also used in modern medicine for human health care (Meo et al., 2017). Honey content of flavonoids and phenolic acids, which plays importance roles in human health with its properties of high in antioxidant and anti-inflammatory (Samarghandian et al., 2017). In food production, honey is act as a natural sweetening agent for the food product (Wan et al., 2021).

Drying is the most common method in the food processing industry for food preservation purpose. Drying is the process of water removal from food by evaporation or sublimation with the application of heat under controlled conditions. There are various methods of drying which include sun drying, solar drying, spray drying, oven drying, vacuum drying, freeze drying and explosive puff drying (Mills-Gray, 2015). The usage of methods is depending on the requirements to use the type of drying methodology to produce a good quality of products.

Freeze drying is the best drying method to produce yogurt powder that also known as lyophilization. Freeze drying is the method to reduce the water by sublimation at very low temperatures and pressures from heat-sensitive materials such as fruits and vegetables, and to obtain a high quality of the dried products (Jiang et al., 2013). The removal of water from yogurt causes the reduction moisture content and water activity of the product which can contribute to the longer shelf life. The product carried out by freeze drying is easy to rehydrate due to the quickly absorbing much water lost during process that it is a desirable characteristic for a high value product. Freeze drying method contributes a lot of benefit to the consumers and food manufacturers. In the yogurt production, freeze drying protect yoghurt microflora, since the drying process is performed at low temperatures (Santos et al., 2018).

Milk is the important raw material in yogurt production and the nutritional content of yogurt produced mainly depend on the type of milk used. Cow milk is the most used for making yogurt. But goat milk become more popular for culturing yogurt because of its nutritional function and can produce a thinner finished yogurt than cow milk. Goat milk has nutraceutical health beverage, has a creamy texture, rich in vitamin and mineral and easy digestibility as compared to the cow milk (Lad et al., 2017). Lactose content in goat milk is slightly lower than cow milk, make it easily to pass through large intestinal and can prevent the symptoms of lactose intolerance. So that the lactose intolerance patients can enjoy the goat milk products without any consequences. Thus, the aim of this study is to produce goat milk yogurt powder with different percentage of honey by using freeze-drying method as well as to determine the microbiological properties and analyse the physicochemical properties of goat milk yogurt powder.

MATERIALS AND METHODS

Materials and chemicals

Plain yogurt which acts as a starter culture in this study, granulated sugar and gelatine were purchased from Supermas Retail SDN BHD. in Jerteh, Terengganu. Honey and fresh goat milk were purchased from a local supplier of Jerteh, Terengganu. The chemicals that had been used for the physicochemical analysis were sodium hydroxide, sodium chloride, and phenolphthalein.

Sample preparation

Yogurt preparation

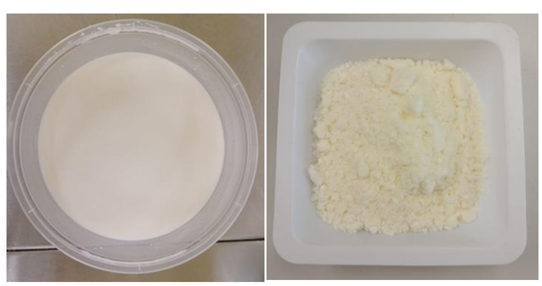
400 g of fresh goat milk was heated up to 95 °C for 5 minutes then mixed with 0.8 g sugar and / or honey as the sweeteners and 8.0 g gelatine as a stabilizer. The mixture was homogenised uniformly by using the spatula and then cooling process was carried out by put it onto the ice until the temperature of 45 °C was reached. After reached the temperature, the starter culture that contain live beneficial bacterial was added into the mixture and homogenised well. Next, the sample was transferred into 750 ml sterilized container and incubated in the incubator at 37 °C for approximately 24 hours. Fig.1 (a) was present the fresh goat milk yogurt after complete incubation time. Then, the sample was stored in the refrigerator at temperature of 4 °C. Table 1 was shown the four formulations had been prepared that included goat milk yogurt with 6% of sugar as a Control Yogurt (CY), 3% of honey with 3% of sugar as Low Honey Yogurt (LHY), 4% of honey with 2% of sugar as Medium Honey Yogurt (MHY) and 6% of honey as High Honey Yogurt (HHY).

Table 1. Formulation of goat milk yogurt powder.

Ingredients	CY (%)	LHY (%)	MHY (%)	HHY (%)
Goat milk	92.0	92.0	92.0	92.0
Granulated sugar	6.0	3.0	2.0	-
Honey	-	3.0	4.0	6.0
Starter culture	1.8	1.8	1.8	1.8
Gelatine	0.2	0.2	0.2	0.2
Total	100	100	100	100

Freeze-drying

The yogurt samples were put into the 50 ml Falcon tube and stored in the freezer at -25 ± 2 °C for 24 hours prior to freeze drying. Then, the samples had been transferred into the Freeze Dryer Alpha 1-4 L Dplus (Christ, Germany) operating at -50 °C in the condensation chamber under vacuum, at a minimum pressure of 0.04 mbar for 48 hours. The freeze-dried samples then were ground to obtain the fine powder as shown in Fig.1 (b). The samples were put into polyethylene terephthalate (PET) packaging material and stored in refrigerator at temperature of 4 °C for the analysis.



(a) **(b)**

Fig. 1. (a) Fresh Goat Milk Yogurt and (b) Goat Milk Yogurt Powder

Reconstitution of goat milk yogurt powder

Reconstitution of the goat milk yogurt powder had been carried out by adding distilled water into goat milk yogurt powder with ratio 3:1. The yogurt was put into the sterilized container and placed in refrigerator at temperature of 4 °C before further the microbial analysis.

Determination of moisture content

Moisture content of the samples were determined by using oven drying method, which had been approved by the AOAC international as the standardize method in determining the amount of moisture content in food sample. The crucibles were dried in a Memmert Universal Oven (Memmert, Germany) at 105 °C for 4 hours and it were let to be cooled in a desiccator until it reached room temperature. After reach the room temperature, the weight of the crucibles was recorded as (W1). Then approximately 3 g of sample was added into the crucible and weighed as (W2). The crucible was transferred into the oven drying and dried for overnight at 105 °C. Next, the crucible was removed from the oven drying and let to be cooled in the desiccator and weighed soon after reaching room temperature as (W3). The percentage of moisture had been calculated using the formula below:

$$\text{\% Moisture} = \frac{W2-W3}{W2-W1} \times 100 \qquad \textbf{Eqn. 1}$$

Where:

W1 = Weight of crucible (g)

W2 = Weight of crucible + weight of wet sample (g)

W3 = Weight of crucible + weight of dried sample (g)

Determination of pH

The yogurt sample (1 g) was dissolved with 10 ml distilled water in a beaker. Then, the pH was measured by immersed the electrodes of pH meter (Hanna Instruments PH211, Romania) in the samples solution and the pH readings had been recorded. The pH meter was calibrated with buffer solution at pH 4.0, 7.0 and 10.0 prior to analysis. The sample was repeated in triplicate for each formulation.

Determination of titratable acidity

The titratable acidity had been measured according to Sanett Matela et al., (2019). The yoghurt sample (10 g) was dissolved with 30 ml of distilled water in an Erlenmeyer flask and homogenized thoroughly. A few drops of phenolphthalein indicator were added in the mixed solution by using a transfer pipette. Then, the content was titrated with 0.1N sodium hydroxide (NaOH) solution to achieve a light pink colour that was persisted for about 10 to 15 seconds for complete neutralization. The volume of titrant used to neutralize the lactic acid was recorded and the analysis was performed in triplicate for each formulation. The titratable acidity was calculated based on the lactic acid which is the main organic acid in the yogurt samples by using the equation shown as below:

$$\text{Titratable acidity} = \frac{Volume\ of\ titrant \times N \times 90}{Weight\ of\ sample \times 1000} \times 100 \qquad \textbf{Eqn. 2}$$

Where,

N = Normality of titrant

90 = Equivalent weight for lactic acid

Determination of water activity

Water activity analysis of goat milk yogurt was carried out by using a AQUALAB 4TE water activity meter (Decagon Device, USA) at room temperature of 25 °C. Firstly, the instrument was calibrated using distilled water for its accuracy before measure the water activity of samples. The sample was loaded into a sample cup immediately until reach the mark to avoid the moisture pickup before loaded into the water activity meter. Then, the reading was taken when it became constant, and the sample was repeated in triplicate for each formulation.

Determination of total soluble solid

Refractometer Easy R40 (Mettler Toledo, Switzerland) was used to determine total soluble solid of goat milk yogurt. The instrument was calibrated using distilled water for its accuracy before measure the total soluble solid of samples. A few drops of goat milk yogurt were placed on the prism in between the measuring cell and the lid was closed. The reading appeared on the screen was directly recorded as total soluble solids as brix. The instrument was calibrated using distilled water for each sample and the sample was repeated in triplicate for each formulation.

Determination of colour

Chroma Meter CR-400 (Konica Minolta Sensing, Japan) was used to measure the colour of goat milk yogurt. The colour scale, L*, a* and b* were used, where the L* is the scale of lightness. It is ranging from 0 (black) to 100 (white). a* is an intensity of black represents greenness (+a*) and redness (-a*) while b* is an intensity of the white represents yellowness (+b*) and blueness (-b*). The Chroma Meter was analysed the spectrum of light produced that were reflected on the sample surface through colorimeter techniques. The reading of L*, a* and b* were taken and the sample was repeated in triplicate for each formulation.

Determination of texture profile analysis

Yogurts had been analysed for texture parameters by using Texture Analyzer (TA. XT-plus Texture Analyzer Stable Micro System Co. Ltd). Texture profile analysis (TPA) like firmness, consistency, cohesiveness, and work of cohesion was measured. A sequential compression tests with back extrusion rig (A/BE-d35) probe with a diameter of 35 mm disc was performed at return distance of 80 mm, return speed at 20 mm/sec and contact force of 50 g to analyses the texture properties. Yogurt samples were compressed up to 100% of their original length. The firmness, consistency, cohesiveness and work of cohesion values were taken from the obtained profiles using the software. All the measurements had been carried out in triplicate for each sample.

Microbial count

Microbial count was carried out in triplicate to determine the counts of the microbial growth according to the IDF standard method by standard spread plate method. The culture media MRS agar base was used for enumeration of microbial growth in the sample such as *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. The serial dilution of samples was prepared by weighed 10 g of yogurt samples in the sterile stomacher bags under aseptic conditions. 0.1% sterile peptone water (90 ml) was added into the stomacher bags for 90 seconds before analysed by the stomacher, thereby obtaining a first dilution.1 ml of each dilution (10^{-3} to 10^{-8}) was transferred into the plates containing MRS agar by using sterile pipette and spread well by using sterile glass spreader. The prepared plates were incubated at 37 °C for 48 hours in an inverted position (aerobic condition). After incubation, the colonies were counted on plates with between 3 to 300 colonies and the CFU/g was calculated by using following equation:

$$\text{CFU/g} = \text{number of colonies} / \text{total dilution used} \qquad \textbf{Eqn. 3}$$

The results were expressed as a logarithm of colony forming units (Log CFU/g).

Statistical analysis

Data analysis had been conducted by using SPSS software version 20. The analysis of variance (ANOVA) tests and Paired T-Test has been used to evaluate the difference between the data. The means were separated by Tukey's post hoc test with significant differences was determined at ($p \leq 0.5$).

RESULTS AND DISCUSSION

Moisture content analysis

Table 2 was presented the means values for different formulations of goat milk yogurt. Moisture content of HHY was significantly higher than MHY followed by LHY and CY which were 82.45%, 81.84%. 79.91% and 79.15% respectively ($p \leq 0.05$). The increase approximately 1% of moisture content among the samples from CY to HHY. The addition of honey to goat milk yogurt significantly increased its moisture content since the moisture content of honey contributes in the capability to resist fermentation and granulation during storage. A similar observation was reported by Ahmat Azemi et al. (2021), which the increase of honey added had increased the moisture content of the yogurt. The moisture content for yogurt must be around 78.62% to 82.41% to get the best semi-solid texture and should be less than 84% because the higher moisture content of yogurt affects the texture and mouth feel (Sanett Matela et al., 2019). The yogurt become waterier when the moisture content higher than 84% and it can easily be spoiled by the microbial.

pH value analysis

As represented pH value in Table 2, CY, LHY, MHY and HHY were acidic which have a range from 4.18 to 4.45. The pH values of goat milk yogurt were reduced approximately 0.10 by the addition of honey. Table 3 showed the pH value for fresh goat milk. As shown in this table, the pH of fresh goat milk was low acidic, pH 6.57, near to neutral while honey was acidic with pH value of 3.62. Plain yogurt was act as starter culture in yogurt production that has pH 4.22. According to result in Table 2, the pH values were decreased significantly as the percentage of honey in the yogurt increased, with the lowest pH 4.18, being recorded for the production with 6% honey in HHY sample. A similar observation was reported by Ahmat Azemi et al. (2021), the lower pH of goat milk yogurt was contributed by honey. However, these range of pH value were acceptable for the yogurt product because the consumer tend to reject if the pH values below 4.0 (Santos et al., 2018).

Titratable acidity analysis

The titratable acidity is exhibited as percentage of lactic acid present in the goat milk yogurt samples. The addition of honey in the goat milk yogurt significantly affected the titratable acidity ($p \leq 0.05$) as shown in Table 2. The percentage of titratable acidity were found to be 1.14%, 1.02%, 1.12% and 1.29%, respectively for CY, LHY, MHY and HHY samples. The samples with addition of honey indicated increased in percentage of titratable acidity as the percentage of honey added increased. As reported by Choi et al. (2016), the normal fermented milk products have percentage titratable acidity within range of 0.7 to 1.2%. The result obtained shown that CY, LHY and MHY samples were in the range, but conversely to HHY sample that has higher percentage of titratable acidity, 1.29% due to the higher concentration of honey, 6%. The high percentage of titratable acidity had been contributed by the more availability of fermenting microbes in the sample (Sanett Matela et al., 2019).

Water activity analysis

Water activity is a measurement of the available water in a food matrix scaled from 0 to 1.0. Table 2 was expressed the water activity had significantly influenced by the addition of honey ($p \leq 0.05$). CY sample has the lowest water activity, 0.96 a_w as compared to other samples. Comparing the samples added with honey, LHY, MHY and HHY, there were no significant statistical different ($p \leq 0.05$) of water activity when the percentage of honey added increased. It shown that the percentage of honey addition was not affected the water activity of goat milk yogurt samples, since the water activity of honey was also low. However, Sert et al., (2011) had been reported that the increased of honey addition resulted in the decreased of water activity values.

Total Soluble Solid Analysis

Total soluble solid was measured in °Brix that also indicated the sugar content in a food product. Table 2 was indicated a significant statistical different ($p \leq 0.05$) in total soluble solid for CY, LHY, MHY and HHY samples from 13.55 to 14.60 °Brix. The goat milk yogurt of HHY sample had significantly higher total soluble solid than other samples. The total soluble solid was increased with honey addition and the results obtained were in line as reported by Kamal et al. (2019). Honey contents carbohydrates, monosaccharides, and disaccharides with a large quantity of glucose and fructose that comprise up 95% of its dry weight (Cianciosi et al., 2018). As reported by Othman et al. (2019), the sugar content is reduced during fermentation. Therefore, it could be noticed that the total soluble solid values of goat milk yogurt increased as the percentage of honey added increased, due to its high sugar content.

Table 2. Physicochemical properties of goat milk yogurt with different formulations.

Properties	Types of Samples			
	CY	**LHY**	**MHY**	**HHY**
Moisture Content (%)	79.15 ± 0.12^{d}	79.91 ± 0.06^{c}	81.84 ± 0.16^{b}	82.45 ± 0.14^{a}
pH Value	4.45 ± 0.00^{a}	4.39 ± 0.01^{b}	4.29 ± 0.01^{c}	4.18 ± 0.00^{d}
Titratable Acidity (%)	1.14 ± 0.02^{b}	1.02 ± 0.01^{c}	1.12 ± 0.01^{b}	1.29 ± 0.02^{a}
Water Activity (a_w)	0.96 ± 0.01^{b}	0.98 ± 0.00^{a}	0.98 ± 0.00^{a}	0.98 ± 0.00^{a}
Total Soluble Solid (°Brix)	13.55 ± 0.27^{b}	13.65 ± 0.16^{b}	14.55 ± 0.26^{a}	14.60 ± 0.36^{a}

Table 3. pH value of fresh goat milk, honey, and plain yogurt.

Sample	pH Value
Fresh Goat Milk	6.57 ± 0.02
Honey	3.62 ± 0.01
Plain Yogurt	4.22 ± 0.01

Colour analysis

Colour is the most important attribute used by consumers in choosing a food product. Table 4 was shown the colour analysis of goat milk yogurt which the progressive addition of honey resulted in significant statistical differences ($p \leq 0.05$) in lightness (L*), redness (a*) and yellowness (b*). The highest brightness value was measured in HHY sample produced with 6% addition of honey while the lowest value was in CY sample produced with 0% of honey. The L* values of goat milk yogurt were increased with honey addition. There were not significant statistical different ($p > 0.05$) for a* values between CY, LHY and MHY samples that indicated the redness. Conversely, HHY sample shown slightly higher value for a* as compared to other samples. In term of the b* values, HHY sample has the highest value followed by MHY, LHY and CY samples with 8.30, 7.33, 6.78 and 5.63 respectively. The b* values were increased with the addition of honey. The redness and yellowness of goat milk yogurt were increased significantly as the percentage of honey added increased, since honey has a natural brown colour.

Table 4. Colour analysis of goat milk yogurt with different formulations.

Goat milk yogurt sample	Colour		
	L*	***a****	***b****
CY	71.85 ± 0.84 ^{d}	-2.86 ± 0.04 ^{a}	5.63 ± 0.07 ^{d}
LHY	79.28 ± 0.63 ^{c}	-2.89 ± 0.03 ^{a}	6.78 ± 0.15 ^{c}
MHY	83.34 ± 0.07 ^{b}	-2.8 ± 0.06 ^{a}	7.33 ± 0.09 ^{b}
HHY	86.46 ± 0.31 ^{a}	-3.15 ± 0.03 ^{b}	8.3 ± 0.14 ^{a}

Each value is expressed as mean ± standard deviation (n = 3). a-d Means with different lowercase superscripts differ significantly ($p \leq 0.05$) according to Tukey's test.

Texture profile analysis

Texture was the main property of foods especially for the fermented dairy products like yogurt. The structural arrangement and microstructure of protein network were the factors affected the texture properties of yogurt. Table 5 was shown the texture profile analysis (TPA) of goat milk yogurt samples, included firmness, consistency, and cohesiveness. Firmness was also called as hardness, is the most essential parameter for yogurt texture analyses that expressed as the force needed to attain the yogurt deformation. Table 4 shown that there was no significant statistical different ($p>0.05$) between CY, LHY, MHY and HHY samples with the force of 23.95, 22.77, 24.49 and 23.78 g respectively. This means the honey added into the goat milk yogurt was not considered as influence on the texture of the samples.

According to the result obtained, the yogurt firmness was changed with the addition of honey. As reported by Mousavi et al., (2019), the firmness of yogurt could be affected by the functional compound contents, the amount of starter culture as well as incubation temperature and time. The increased of functional compounds addition resulted in reduced of firmness. The firmness value of CY sample was higher than the samples contain honey due to honey consists of various complex functional compounds as compared to sugar. The method used in producing the yogurt whether by industrial or traditional method also the factor that give effect to the texture of yogurt (Yuzuncu & Altun, 2018). Since the goat milk yogurt samples were produced traditionally, it was thought these samples were not homogenized well during the sample preparation that caused the firmness of goat milk yogurt quite not stable.

Consistency is the texture parameter that related to the firmness, thickness, or viscosity of the liquid or semi-solid product. Table 5 was indicated that the addition of honey significantly influenced the consistency of the yogurt texture ($p \leq 0.05$). The CY sample was the most consistent than LHY, MHY and HHY samples, since it was made of 0% honey and 6% sugar. The addition of honey from 3% to 4 % and 6% had increased the consistency of yogurt texture due to the firm texture of honey.

Cohesiveness is also same as consistency, the important texture property for yogurt product to indicate the force of internal bond links, which the product could be deformed before it breaks (Yuzuncu & Altun, 2018). As could be seen from Table 5, concentration of honey had a significantly impact on the cohesiveness yogurt ($p \leq 0.05$) with range from – 17.76 to – 16.47 g. The highest value obtained in LHY sample while the lowest value was obtained in CY sample. The cohesiveness was expressed as the capability of the product to hold together (Chandra & Shamasundar, 2015). Hence, LHY sample has highest capability to hold together as compared to the others.

Table 5. Texture profile analysis of goat milk yogurt with different formulations.

Goat milk yogurt sample	Firmness (g)	Consistency (g.sec)	Cohesiveness (g)
CY	23.95 ± 0.44 ^{a}	419.23 ± 1.37 ^{a}	-17.76 ± 0.57 ^{b}
LHY	22.77 ± 0.15 ^{a}	400.14 ± 1.78 ^{b}	-16.47 ± 0.35 ^{a}
MHY	24.49 ± 1.69 ^{a}	408.7 ± 8.94 ^{ab}	-16.61 ± 0.25 ^{a}
HHY	23.78 ± 0.54 ^{a}	417.72 ± 7.64 ^{a}	-17.18 ± 0.25 ^{b}

Each value is expressed as mean ± standard deviation (n = 3). a-b Means with different lowercase superscripts differ significantly (p≤0.05) according to Tukey's test.

Microbial count

Food processing possibly effect the survival of bacterial growth especially in the dairy product. So that the microbial count was carried out to analyses the bacterial survival in fresh goat milk yogurt and reconstituted goat milk yogurt powder, since goat milk yogurt powder was obtained from freeze drying process. According to the Regulation of Probiotics in Malaysia, the probiotic cultures added must remain viable and the viable count shall not be less than 10^6 cfu/ml during the shelf life of the product. The bacterial count in fresh goat milk yogurt and reconstituted goat milk yogurt powder were significantly ($p<0.05$) affected by the addition of honey and freeze-drying process as shown in Table 6. The total plate count (TPC) in this fresh goat milk yogurt for CY, LHY, MHY and HHY samples were ranged from 6.40 to 8.75 log cfu/g while in the reconstituted goat milk yogurt for CY, LHY, MHY and HHY samples was ranged from 5.79 to 8.07 log cfu/g. The different for TPC of bacterial growth between both treatments, which fresh goat milk yogurt and reconstituted goat milk yogurt powder, were 0.61 and 0.68 log cfu/g for the minimum and maximum range respectively. This was indicated that freeze-drying process had slightly affected the bacterial growth during processing. There was significant difference ($p<0.05$) between the treatments as shown in Table 6. The same results were found by Santos et al., (2018), which the growth of lactic acid bacteria in the fermented milk was slightly reduced after treated by freeze drying. Freeze-drying is the sublimation of water under vacuum had been chosen for drying bacteria, since it applied low temperature and pressure as well as could retain the starter culture and probiotic bacteria at the high level (Sohail et al., 2013).

Table 6 shown the goat milk yogurts with the addition of honey was statistically significant ($p<0.05$) to the bacterial growth. The TPC of LHY sample was highest as compared to CY, MHY and HHY samples in both treatments. It was exhibited that the combination of sweetener with 3% honey and 3% sugar provide the maximum sources of carbohydrate to the bacteria for survive. Meanwhile the used of 6% sugar with 0% honey in CY sample give the better bacteria survival than the increased addition of honey to 4% and 6% in MHY and HHY samples that were resulted in the decreased of bacteria count. Regarding the chemical composition of honey, it was contained a complex chemical composition such as water, carbohydrates, fructose, glucose, maltose, sucrose, proteins, vitamins, amino acid, and minerals (Cianciosi et al., 2018) while sugar only contained the simple chemical composition of fructose and glucose. Honey also a concentrated solution, leave a little amount of water molecules available for microbial. This condition causes the microbial survival weak. Therefore, the percentage of honey used in MHY (4%) and HHY (6%) samples were not suitable for the bacterial growth since honey only could be used as a substituted sweetener, not a main sweetener.

Table 6. Microbial count of bacterial growth.

Goat milk yogurt sample	Fresh goat milk yogurt (Log CFU/g)	Reconstituted goat milk yogurt powder (Log CFU/g)
CY	7.50 ± 0.02 ^{Ab}	7.42 ± 0.02 ^{Bb}
LHY	8.75 ± 0.00 ^{Aa}	8.07 ± 0.01 ^{Ba}
MHY	6.70 ± 0.02 ^{Ac}	6.34 ± 0.01 ^{Bc}
HHY	6.40 ± 0.01 ^{Ad}	5.79 ± 0.01 ^{Bd}

Each value is expressed as mean ± standard deviation (n = 3). A-B for column and a-b for row means with different uppercase and lowercase superscripts differ significantly (p≤0.05) according to Tukey's test and Paired T-Test.

CONCLUSION

The goat milk yogurts powder produced from freeze drying with different percentage of honey were shown the statistically significant different for the physicochemical analysis and microbial count. The formulation of 3% honey with 3% sugar in the yogurt could produce the satisfactory for the physicochemical properties and good condition for bacteria survival. Freeze drying was the suitable method in producing yogurt powder due to the used of low temperature that could preserve the bacteria in the yogurt.

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