PHYSICAL AND CHEMICAL CHARACTERISTICS OF GOAT MILK POWDER WITH DIFFERENT DRYING METHODS AFTER STORAGE

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ABSTRACT

Processing kefir into powder form is an effort to extend shelf life, prevent contamination from unwanted bacteria, and facilitate storage. For this reason, a proper drying method is needed to produce a good quality kefir powder. There are three types of drying methods used in this study, namely drying with a cabinet dryer, freeze dryer, and spray dryer. The purpose of this study was to determine the effect of different types of drying methods on pH value, solubility, viscosity, total acid, and alcohol content of goat's milk kefir powder after storage for two months. This study used a completely randomized design method with different types of drying methods, namely T₁ (cabinet dryer), T₂ (freeze dryer), and T₃ (spray dryer). The data were analyzed using Analysis of Variance (ANOVA) with a confidence level of 95% and if it had a significant effect, it was continued with the Duncan Multiple Range Test. The results showed that the different drying methods did not show any significant effect ($p > 0.05$) on the pH value, solubility, viscosity, total acid, and alcohol content, so it could be concluded that the three types of drying methods did not affect physical and chemical quality of kefir powder that has been stored for two months.

Keywords: Cabinet dry; freeze dry; goat's milk; powdered kefir; spray dry

INTRODUCTION

Kefir is a fermented drink made by adding kefir grain to cow's milk, goat's milk, or buffalo's milk to form a distinctive taste (sour and alcoholic sensation) as a result of the activity of lactic acid bacteria and yeast on kefir grain (Farag *et al.*, 2020). Kefir grains are bacterial colonies consisting of lactic acid bacteria such as *Streptococcus*, *Lactobacillus sp.*, and several types of yeast that work symbiotically with other elements to form dense tissues to ferment lactose (Safitri & Swarastuti, 2013). Kefir is beneficial for health, namely as a probiotic that can suppress the growth of bacteria that causes digestive tract diseases. The manufacture of kefir in this study uses raw materials from goat's milk, this milk was chosen because it has a higher content of lactose, protein, carbohydrates, and solids compared to cow's milk (Rachman *et al.*, 2018). According to Moeljanto & Wiryanta (2002), cow's milk has the following nutritional content, 3.2% protein, 3.6% fat, 4.7% lactose, and 0.7% minerals, while goat's milk contains 3.4% protein, 3.8% fat, 4.1% lactose, and 0.8% minerals.

Based on these nutritional content, it shows that the nutritional content of goat's milk is higher than cow's milk. In addition, goat's milk also has smaller fat molecules and has a short chain of fatty acids, this makes goat's milk more digestible than cow's milk (Schettino *et al.*, 2017). Kefir has a shelf life of about 10 d when stored at 4°C, because this storage can inhibit the growth of pathogenic bacteria (Setyawardani & Sumarmono, 2015). This shows that kefir has a relatively short shelf life and should be stored at low temperatures. One of the efforts to extend shelf life, prevent

contamination from unwanted bacteria, and facilitate storage of kefir requires further processing into powder products. In principle, processing into powder products is to reduce the moisture content in the material to a certain extent so that chemical activity and microorganisms in the material can be inhibited (Imanningsih, 2013). To produce quality kefir powder, a proper drying method is needed.

There are various types of drying methods, but in this study three different drying methods were used, namely cabinet dryers, freeze dryers, and spray dryers. A cabinet dryer is a drying method using an oven in which there is a tiered shelf, equipped with a blower to disperse heat, and a thermocouple to maintain temperature (Mardiah *et al.*, 2017). The cabinet dryer was chosen because it has several advantages, including a fast drying process that saves time, does not experience significant changes in color and appearance, and is more hygienic because the dried product is completely protected from dust, insects, birds, and rain (Chaudhary *et al.*, 2020).

The second drying method used is the freeze dryer where the freeze dryer is one of the best drying methods for food products with the principle of eliminating the water content contained in the material as vapor by a sublimation process, but the freeze dryer also has a disadvantage, namely high production costs making it less economical (Jiang *et al.*, 2014). The next drying method is a spray dryer. This method was chosen because it is the most common drying method used for microencapsulation of foodstuffs, it is cheap and simple, and the drying process uses a spraying method with a high drying temperature so not all

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ingredients are suitable for this drying method (S. H. Anwar & Kunz, 2011). This study aims to determine the effect of different drying methods on pH, solubility, viscosity, total acid, and alcohol content in goat's milk powder kefir after two months of storage.

MATERIALS AND METHODS

This research was conducted in March - October 2019 at the Food Chemistry and Nutrition Laboratory and Food and Agricultural Products Engineering Laboratory, Faculty of Animal Husbandry and Agriculture, Diponegoro University, Semarang and at the Balai Penelitian Teknologi Bahan Alam - Lembaga Penelitian Indonesia, Yogyakarta.

Materials

The materials that used in this study were fresh goat's milk, kefir grain, distilled water, NaOH 0.1 N solution, and PP solution (phenolphthalein 1%). The equipment used is a cabinet dryer (Maksindo, MKS-FDH10), freeze dryer, spray dryer (BUCHI Mini Spray Dryer B-290), grinder (Maksindo MKS-ML300), pH meter (OHAUS Starter 2100), Viscometer Ostwald (Viscometer Ostwald 5 ml PYREX), oven (Mettler UN55), filter paper, titration device, desiccator, pycnometer and analytical balance (SHIMADZU ATY224).

Method

Research Stages

1. The Process of Making Kefir

Making kefir from goat's milk refers to (Kinteki *et al.*, 2019). Kefir grain is weighed as much as 50 g in 1 liter of fresh goat's milk or as much as 5% to the volume of goat's milk. Fresh goat's milk is pasteurized first at a temperature of 70°C for 15 s, then lowered to 30°C. Kefir grain is then putted inside the 1 liter of goat's milk and stirred slowly until blended. Milk is then incubated at room temperature or about 20-25°C for 24 h, then filtered to separate the kefir grain from the

product. Liquid kefir is stored at 4°C first before proceeding to the next process, namely the making of kefir powder.

2. The Process of Making Kefir Powder

Making kefir powder is done by using three different types of drying methods, namely cabinet dryers, freeze dryers, and spray dryers. Drying kefir with a cabinet dryer (Paramita *et al.*, 2015). This is done by pouring kefir into a baking sheet then put into a cabinet dryer (Maksindo, MKS-FDH10) at a temperature of 50°C for 24 h, then after drying the kefir is grind with a grinder and sieved to a size of 60 mesh to obtain a uniform size. Drying kefir with a freeze dryer (Yulvianti *et al.*, 2015) done by using a freeze dryer with a P setting of vacuum 0.06 mbar and T ice condenser freezer -45°C, then dried for 36 h.

Drying with a spray dryer Kefir (Pramitasari *et al.*, 2011) is carried out by drying kefir using a spray dryer (BUCHI Mini Spray Dryer B-290) with an inlet temperature of 110°C. The kefir powder that has been obtained is put into a ziplock plastic with food-grade silica gel in it. Then, all kefir powders from the three types of drying methods were stored at room temperature or about 20-25°C for two months.

Procedure of Analysis

pH Value Test (Azizah *et al.*, 2012)

Testing the pH value was carried out using a pH meter (OHAUS Starter 2100). The pH meter is turned on and waiting to be constant for 15-30 min. 1 g of powdered kefir was rehydrated with 10 ml of distilled water. The cathode on the pH meter is then immersed in the sample and left for a while until the test results are shown on the display instrument.

Solubility Test (AOAC, 2005)

Solubility testing was carried out with 1 g of powdered kefir samples weighed (a) is dissolved with distilled water as much 20 ml at 50°C temperature and filtered using

filter paper. The filter paper is oven heated at 105°C for 30 min and weighed (b). After filtering, the filter paper was re-oven at 105°C until a constant weight was obtained

and the sample was put into a desiccator for 15 min then weighed (c). Calculation of the solubility of powdered kefir can be calculated using the formula:

$$\text{Solubility} = 1 - \left(\frac{(c - b)}{a} \right) \times 100\%$$

Viscosity Test (Harjiyanti et al., 2013)

Viscosity testing was carried out using a Viscometer Ostwald (Viscometer Ostwald 5 ml PYREX). The density of water is measured first by weighing the empty pycnometer, as much as 10 ml of distilled water is put into the pycnometer and weighed again, then the rehydrated sample

is put into the pycnometer and weighed. Then, proceed with the sample that has been rehydrated and distilled water is inserted into the Ostwald pipe in turn and the water drop time is calculated until it reaches the lower tera mark using a stopwatch. Calculation of the viscosity of powdered kefir can be calculated using the formula:

$$\text{Viscosity} = \frac{\rho_{\text{sample}} \times t_{\text{sample}} \times \eta_{\text{water}}}{\rho_{\text{water}} \times t_{\text{water}}}$$

$$\rho_{\text{sample}} = \frac{m' - m}{v}$$

Where:

m = mass of empty pycnometer (g)

m' = mass of pycnometer + sample (g)

v = volume of pycnometer (ml)

η = viscosity of water

ρ = density of water (1 g / ml)

t = time (s)

Total Acid Test (Masykur & Kusnadi, 2015)

This test was carried out by the titration method. 1 g of powdered kefir is rehydrated with 10 ml of distilled water then put into a 100 ml volumetric flask. The

sample is then added 2 drip of 1% PP indicator and was titrated with 0.1 N NaOH solution until a constant pink color was obtained. Calculation of total acid can be calculated using the formula:

$$\text{Total Acid (\%)} = \frac{\text{ml NaOH} \times N \text{ NaOH} \times \text{BE Lactic Acid (90)}}{\text{Sample Weight} \times 1000} \times 100\%$$

Alcohol Content Test (Azizah et al., 2012)

The alcohol content test was carried out using the distillation method. A total of 100 ml of rehydrated samples were put into a Kjeldahl flask and added with 100 ml of distilled water, then distilled until a distillate was obtained as much as 50 ml. Weighed the

empty pycnometer, pycnometer filled with distilled water, and pycnometer filled with distillate. The alcohol content of goat's milk powder kefir is obtained from the conversion of alcohol density. Calculation of the density of alcohol can be calculated using the formula:

$$\text{Density of Alcohol} = \frac{(\text{Pycnometer Weight} + \text{Distillate Weight}) - \text{Empty Pycnometer Weight}}{(\text{Pycnometer Weight} + \text{Aquadest Weight}) - \text{Empty Pycnometer Weight}}$$

Research Design

The manufacture of goat's milk powder kefir is designed using a Completely Randomized Design (CRD) with different drying methods, namely the cabinet dryer, freeze dryer, and spray dryer. The data from the test results were analyzed using Analysis of Variance (ANOVA) with a confidence level of 95% and if it had a significant effect then it was continued with the Duncan Multiple Range Test. Data analysis was performed using the SPSS application for Windows 25.0.

RESULTS AND DISCUSSION

The pH value

Based on Table 1, it can be seen that the difference in the drying method of kefir goat's milk powder that has been stored for two months does not show any significant effect ($p > 0.05$). Powdered kefir in the three types of drying methods after being stored for two months at room temperature did not experience a significant change in pH value. According to Magra *et al.* (2012), kefir has decreased pH value during fermentation then the pH value will be constant after the 7th d of fermentation, this happens because

at low pH the activity of lactic acid bacteria decreases and yeast can inhibit the formation of lactic and acetic acids so that the kefir pH value remains constant and don't get more acidic. Kefir has a low pH value due to the activity of lactic acid bacteria which converts the sugar in milk (lactose) into lactic acid during the fermentation process (Fernandes *et al.*, 2017). The quality requirements for kefir powder are based on the pH value according to research conducted by Teijeiro *et al.* (2018) that kefir drinks have a typical pH value ranging from 4 to 4.4. The pH value produced in powdered kefir with these three drying methods has not met the standard pH value in this study. Kefir, which has a lower pH value, increases its solubility, viscosity, total acid, and alcohol content. The pH value has an inverse relationship with total acid, where the more kefir acid, the lower the pH value and the total acid value will increase (Djali *et al.*, 2017). Febrisiantosa *et al.* (2013) stated that the pH value is also related to the viscosity of kefir, where the lower the pH value and the higher the total acid value of kefir, the viscosity will increase. This is due to the activity of microorganisms in kefir, namely lactic acid bacteria and yeast.

Tabel 1. Results Analysis of pH Value, Solubility, Viscosity, Total Acid and Alcohol Powdered Goat's Milk Kefir After Two Months During Storage

Treatment	pH Value ^{ns}	Solubility (%) ^{ns}	Viscosity (cP) ^{ns}	Total Acid (%) ^{ns}	Alcohol ^{ns}
T ₁	5,15 ± 0,41	41,46 ± 4.95	1,37 ± 0,08	0,66 ± 0,39	0
T ₂	4,90 ± 0,34	41,96 ± 6.75	1,45 ± 0,15	0,60 ± 0,35	0
T ₃	4,90 ± 0,31	37,16 ± 5.49	1,46 ± 0,19	0,70 ± 0,29	0

Keterangan:

Data displayed as the mean value of 7 repetitions

ns: *not significant*

T₁, T₂, T₃ is a type of drying method, namely cabinet dryer, freeze dryer, spray dryer

Solubility

Based on Table 1, it can be seen that the difference in drying methods for kefir goat's milk powder that has been stored for two months does not show any significant effect ($p > 0.05$). Powdered kefir that has been stored for two months at room temperature has relatively low solubility, namely around 37.16% to 41.96% because

in its manufacture it does not use fillers that can increase solubility. Tontul & Topuz (2017) states that the solubility of powder products is influenced by the use of fillers where carbohydrate-based fillers such as maltodextrin and gum arab can increase product solubility, while protein-based fillers such as soy protein isolates have low solubility. In addition, protein solubility is

also influenced by protein denaturation due to heat treatment during drying and due to acidic conditions during fermentation.

Denatured protein due to heat treatment will change the folds of the milk protein structure so that the outer layer is hydrophobic or in other words, increases its hydrophobicity (Wijayanti *et al.*, 2014). Wang *et al.* (2014) and Nalu *et al.* (2019) added that proteins that have high hydrophobicity have difficulty interacting with water, causing a decrease in solubility and precipitation.

Several factors can affect the solubility of powdered milk products, including the content of lactic acid in milk, heat treatment of milk, drying methods, and protein content in milk (Sharma *et al.*, 2012). According to Sulieman *et al.* (2014), the requirement for a good powder product is that it has a high level of solubility when dissolved in water it will form a stable suspension and dissolve completely or form a solution. Low pH values and increased total acid can reduce the solubility of kefir and increase its viscosity.

Viscosity

Based on Table 1, it can be seen that the difference in drying methods for kefir goat's milk powder that has been stored for two months does not show any significant effect ($p > 0.05$). Powdered kefir that was dried using all drying methods and then rehydrated would produce a relatively low viscosity ranging from 1.37 to 1.46 cP. This occurs because the storage temperature affects the viscosity of kefir, where storage at high temperatures produces low viscosity while frozen storage produces high viscosity (Samantha *et al.*, 2015).

In addition, the drying process can also affect the viscosity of kefir, wherein the drying method the cabinet dryer uses a temperature of 50°C and the spray dryer uses an inlet temperature of 110°C. This causes the protein contained in milk to experience denaturation due to heat. Manassero *et al.* (2016) argue that proteins that are subjected to high temperatures will

experience denaturation, causing a decrease in viscosity. Supported by Wang *et al.* (2014) which states that denaturation of protein due to heat causes an increase in protein hydrophobicity which causes the protein to become insoluble.

Another factor that causes a low viscosity on kefir is that no filler is added during the manufacturing process. Yana & Kusnadi (2015) states that the more filler concentrations are added, the viscosity will increase. The pH value can also affect the solubility of milk protein (casein), where the pH value that has reached the casein isoelectric point will cause the casein aggregate to become weak so that it can affect the viscosity of kefir (Purbasari *et al.*, 2014).

Total Acid

Based on Table 1, it can be seen that the difference in the drying method of goat's milk powder kefir that has been stored for two months does not show any significant effect ($p > 0.05$). Kefir powder in the three types of drying methods after being stored for two months at room temperature did not experience a significant change in total acid.

The quality requirement for kefir based on total acid according to World Health Organization and Food and Agriculture Organization of the United States (2011) regarding the standard of fermented drinks is a minimum of 0.6%. The total acid produced in powdered kefir by these three drying methods has met the total kefir acid standard that has been set.

The total acid produced in kefir is due to the activity of lactic acid bacteria with the help of the β -D-galactosidase enzyme to convert glucose into lactic acid which can lower pH and increase acidity (Rossi *et al.*, 2016). Nagovska *et al.* (2018) stated that the longer the storage, the higher the total acid formed, this is due to an increase in the growth of lactic acid bacteria so that more lactic acid is produced. The higher the total acid, the pH value and solubility of milk protein will decrease and the viscosity increases.

Alcohol Content

Based on Table 1, it can be seen that the difference in the drying method of kefir goat's milk powder that has been stored for two months does not show any significant effect ($p > 0.05$). This happens because the powdered kefir before storage also produces zero alcohol content. The zero or negative alcohol content in powdered kefir with the three different types of drying methods is due to the high temperature in the manufacture of powder kefir, where the method cabinet dryer uses a temperature of 50°C and the spray dryer uses an inlet temperature of 110°C. The heating process with high temperatures can inhibit the fermentation process of microorganisms so that the alcohol content produced will also decrease (Mardiyah, 2017). Likewise, in the method freeze dryer, this drying uses low temperatures so that the activity of microorganisms can be inhibited (Ayuti *et al.*, 2016). Sinurat *et al.* (2019) stated that alcohol production in kefir is influenced by pH, total acid content, fermentation time, type of substrate, temperature, and the microorganisms used. The lower the pH value and the higher the total acid produced, the higher the activity of microorganisms, so that the amount of alcohol produced will also increase. The alcohol content in kefir is due to the activity of *Saccharomyces cerevisiae* in converting simple sugars in this case lactose into alcohol and CO₂ gas (Anwar *et al.*, 2012).

CONCLUSION

Based on the results obtained, it can be concluded that the differences in drying methods do not affect the pH, solubility, viscosity, total acid, and alcohol content of kefir goat's milk powder that has been stored for two months at room temperature.

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