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The effects of dextrin concentration as filler on physical, chemical, and microbiology properties of powdered goat milk kefir

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ABSTRAK

Penelitian bertujuan untuk mengetahui pengaruh perbedaan konsentrasi dekstrin terhadap sifat fisik, kimia, dan mikrobiologis dari kefir bubuk susu kambing. Penelitian dilakukan dengan menggunakan Rancangan Acak Lengkap (RAL) dengan lima perlakuan dan empat ulangan yakni penambahan *filler* dekstrin dengan konsentrasi 0% (T0), 2,5% (T1), 5% (T2), 7,5% (T3), and 10% (T4) (b/v). Kualitas kefir susu kambing bubuk yang dianalisis yakni kualitas fisik, kimia, and mikrobiologis produk. Data hasil pengujian dianalisis dengan aplikasi SPSS 26.0 menggunakan Analysis of Variance (ANOVA) yang dilanjutkan dengan Duncan Multiple Range Test (DMRT). Hasil pengujian menunjukan bahwa perbedaan konsentrasi dekstrin berpengaruh nyata (P<0,05) pada parameter kelarutan, total asam, rendemen, kadar air, kadar protein, pH, total padatan terlarut, karbohidrat, total bakteri asam laktat, khamir, dan mikroba, serta tidak berpengaruh nyata pada viskositas produk. Dapat disimpulkan bahwa semakin tinggi penambahan dekstrin pada produk menunjukan adanya peningkatan pada rendemen, kelarutan, total padatan terlarut, kadar air, karbohidrat, nilai pH, total mikroba, total khamir, dan total bakteri asam laktat produk, serta mengalami penurunan pada parameter kadar protein, dan total asam produk, dengan perlakuan terbaik yakni penambahan sebesar 10%.

Kata Kunci : *dekstrin, kefir bubuk, susu kambing*.

ABSTRACT

The purpose of the research was to study the effects of dextrin powder with a different concentration on the physical, chemical, and microbiology properties of the product. The research was conducted using a Completely Randomized Design (CRD) with five treatments and four replications, namely the addition of dextrin filler with a concentration of 0% (T0), 2,5% (T1), 5% (T2), 7,5% (T3), and 10% (T4) (w/v). The quality of powdered goat milk kefir that is analyzed are physical, chemical, and microbiology properties. The data were analyzed using SPSS 26.0 application using Analysis of Variance (ANOVA) followed by Duncan Multiple Range Test (DMRT). The test results show a significant difference in dextrin concentration (P<0.05) on solubility, total acid content, yield, water content, protein content, pH, total dissolved solids, carbohydrate, lactic acid bacteria, yeast, and microbe content of the product and shows no significant difference on the viscosity of the product. It can be concluded that the addition of dextrin can increase the yield, solubility, total dissolved solids, water content, carbohydrate, total microbe, lactic acid bacteria, and microbe but also decreased the pH value and the protein content, with the best treatment was the addition of dextrin of 10%.

Keywords: dextrin, goat milk, kefir powder.

INTRODUCTION

Kefir is a fermented product originated from the Caucasus mountain range that uses milk as raw material, both from cows, goats, or even sheep's and uses kefir grain as a starter for the fermentation process. Kefir grains as a starter for the fermentation process consist mainly of probiotic microbes such as lactic acid bacteria (LAB), acetic acid bacteria (AAB), and yeast (Mei *et al.*, 2014). The presence of probiotic components and metabolic products derived from lactic acid bacteria, acetic acid bacteria, and yeast produces some of the functional properties such as acetaldehyde and exopolysaccharide which can contribute to body health. According to Bengoa *et al.* (2019), the health effect of kefir product includes antimicrobial properties, anti-obesity, immunomodulation, and increasing bacterial flora inside the gut.

Kefir is a fermented product that has a very short shelf-life, where according to de Lima *et al.* (2018) that fermented goat milk using kefir grains has a shelf-life up to 28 days in 4ºC storage. This is however can be caused by relatively high water content in the product as well as high levels of the biological component inside the product. The drying and dehydration technique is one of the processing also preservation techniques that can prolong the shelf life of the kefir product. Dehydrated kefir is one of the processing methods that can prolong the shelf life of the product without the need for refrigeration (Teijeiro *et al.*, 2018). Changing the kefir product from a liquid state into a more stable powder product can extend the shelf life, simplifying the transportation and the storing the product (Isleroglu, 2019), besides drying of the kefir product can also maintain the probiotics content of the product (Zura-bravo *et al.*, 2019). However, the use of filler in powder products is necessary to maintain or even increase the quality of the kefir product.

Fillers are food additives that are mainly composed of hydrocolloid component and used to maintain or improve the quality of the food product. The most commonly used filler are maltodextrin (Mishra *et al.*, 2014), skim milk powder (Koç *et al.*, 2010), and also starch and dextrin (Santos *et al.*, 2018). Dextrin is an oligosaccharide component that is produced from the hydrolysis of starch. Dextrin is a soluble fiber that can be applied to a lot of product (Knapp *et al.*, 2010), it can also bound free water and organic materials on the product (Sitohang and Saragih, 2017) so that it can affect the physical and chemical quality of the product. Dextrin also has the ability to encapsulate microbes so that it can increase the viability of lactic acid bacteria (Anand *et al.,* 2018), microbe, and yeast from the dried product, namely powdered kefir.

The use of other types of filler such as soy protein isolate (SPI) has been recently conducted by Rizqiati *et al.* (2020) resulting in a low solubility with high water content, therefore it is necessary to use other types of filler such as dextrin. The use of dextrin might be able to increase the solubility of the product with a relatively low change in its viscosity. According to Indonesia National Standards, dextrin has a 97% solubility in cold water with 3-4ºE viscosity value (SNI 01-2593-1992). The use of dextrin about 0.5 – 4.5% could increase product solubility by around 98.67 – 99.40% (Hakim and Chamidah, 2013). Mulyani *et al.* (2015) stated that dextrin could bind free water in the product resulting in an optimal evaporation process and prolong the food shelf life. Therefore the purpose of this research was to determine the effects of different dextrin concentrations on the physical, chemical, and microbiological properties in order to produce and prolong the functional goat milk kefir powder product.

MATERIALS AND METHODS

This research was conducted using the Completely Randomized Design with 5 treatments and 4 replications. The materials that were used in this study are fresh goat milk, dextrin, sodium hydroxide 0.1 N, Sodium hydroxide 45%, hydrochloric acid 0.1 N, sulfuric acid, selenium catalyst, boric acid, n-hexane, phenolphthalein, MRMB reagents, Mann de Rogosa agar Merck (Semarang, Indonesia), potato dextrose agar Merck (Semarang, Indonesia), plate count agar Merck (Semarang, Indonesia), Physiological Natrium solution 0.85%, and filter paper.

The process of making goat milk kefir

Goat milk kefir was made based on the modification method of Erdogan *et al.* (2019). Tools used in this study were sterilized using boiling water. Fresh goat milk obtained from a farm in Ungaran, Indonesia was pasteurized at 75ºC for 15 seconds and then lowered to room temperature. Pasteurized goat milk then was poured inside a sterile plastic jar and 5% (w/v) kefir grain with a microbial density of lactic acid bacteria (10^7 CFU/g) and yeast (10^6 CFU/g) was added into the milk. The milk that has been added with kefir grain then was closed and sealed using plastic wrapping. The milk was then incubated for 24 hours at room temperature. The kefir product that has been incubated then was strained with a plastic strainer to separate the grain from the kefir product. The product was then stored at 5°C.

The process of making goat milk kefir powder

The process of making goat milk kefir powder refers to the method of Rizqiati *et al.* (2020) with modification. Firstly, dextrin was added to the goat milk kefir with different concentration, namely 0% (T0), 2.5% (T1), 5.0% (T2), 7.5% (T3), and 10% (T4) (w/v). Kefir was then homogenized using a homogenizer at a speed of 12000 rpm until homogeneous and transferred into a stainless steel tray. The trays were then put inside a cabinet dryer and dried at a temperature of 55°C for 24 ± 2 hours. The dried kefir product was then scraped and ground using a grinder for 45 seconds then sifted with a 40 mesh.

Physical analysis

Physical analysis of the product including yield refers to the method of Nusa *et al.* (2015), solubility refers to the method of Fazaeli *et al.* (2012), viscosity refers to the method of Dwiloka *et al.* (2020) using a viscometer Ostwald, and total dissolved solids refers to the method of Ishartani *et al.* (2018) using a digital refractometer.

Chemical analysis

Chemical analysis of the product proximate analysis refers to the method of AOAC (2000), namely water content analysis using gravimetry method, crude protein content using Kjeldahl method, and carbohydrate content using the by-difference method. Another chemical analysis of the product was total acid content refers to the method of Atalar and Dervisoglu (2017) using titration, and pH analysis refers to the method of Yildiz-Akgul *et al.* (2018) using pH meter.

Microbiology analysis

Microbiology analysis of the product including total microbe of the product refers to the method of Setyawardani *et al.* (2020) using plate count agar as media, total yeast refers to the method of Al-Baarri *et al.* (2020) using potato dextrose agar as media and total lactic acid bacteria refers to the method of Rahayu and Andriani (2018) using Mann de rogosa agar as media.

Statistical analysis

Data were analyzed using One-way ANOVA followed by the Duncan Multiple Range Test (DMRT) using SPSS 26.0 statistic software with a significance level of 0.05.

RESULTS AND DISCUSSIONS

Physical analysis

The results showed that the addition of dextrin has a significant difference ($p<0.05$) on the yield of the product (Table 1). The increase of dextrin concentration increased yield of the product, with yield ranging between 13.00 – 21.25%. This is in accordance with Sudaryati *et al.* (2016) which stated that the use of maltodextrin combined with Na-CMC resulted in a yield ranges between 34.2 - 45.2%. The increase in the total yield of the product was due to an increase in the total solids of the product. The addition of dextrin to the product can increase the total solids content of the product which can

Table 1. Physical Properties Analysis Goat Milk Kefir Powder

Dextrin Concentration (%)	Yield (%)	Solubility (%)	Viscosity (cP)	Total Dissolved Solids (°Brix)
0	13.00 ± 0.00^{a}	13.84 ± 7.30^{a}	1.65 ± 0.26^{a}	4.20 ± 0.00^{a}
2.5	14.75 ± 0.50^{b}	27.78 ± 8.46^{b}	2.00 ± 0.12^{ab}	5.30 ± 0.18^{b}
5	18.00 ± 0.00^{c}	41.60 ± 6.11^{c}	2.02 ± 0.21^{ab}	5.92 ± 0.22^{c}
7.5	19.50 ± 1.00^{d}	51.62 ± 6.12^{cd}	2.06 ± 0.20^{b}	6.25 ± 0.30^{c}
10	21.25 ± 0.96^{e}	55.32 ± 6.89^{d}	2.17 ± 0.32^{b}	6.60 ± 0.28^{d}

Values are given as mean ± standard deviation and different superscript shows a significant difference at 0.05 level.

increase the mass and the yield of the product (Suparno, 2018). The increase in water content of the product can also increase the yield of the product.

The addition of dextrin also showed a significant difference ($p<0.05$) to the solubility of the product. The higher the dextrin level, the higher the solubility of the product, with the range of solubility between 13.84 – 55.32% (Table 1). The increase of solubility in the product was due to the content and the type of fillers that were used. According to Hakim and Chamidah (2013) that dextrin was one of the filler with high solubility. The increase of product solubility was caused by the relatively high hydrophilic component from the dextrin hydroxyl group. The high hydrophilic component of a compound can increase the water absorption and the rehydration power of the product (Hidayat *et al.*, 2012). High dextrose equivalent (DE) from the filler that was used can also affect the resulting solubility rate. According to Kurniawati (2015) the higher the DE value of a filler, the more hygroscopic and resulting in a higher solubility. In addition, Jayasundera *et al.* (2011) stated that high solubility was the key determinant to produce a good quality powdered product.

The addition of different concentrations of dextrin into the goat milk kefir powder also shows a significant difference ($p<0.05$) to the total dissolved solids content of the product, which ranges between 4.20 – 6.60 ºBrix (Table 1.). The higher concentration of dextrin showed a higher total dissolved solid in the product. The simple sugar component in dextrin and also its high solubility rate was one of the causes that increases the total dissolved solids content of the product. Dextrin is an oligosaccharide component that is water-soluble so that it can increase the resulting total dissolved solids (Mangku and Rudianta, 2019). The hydrolysis process by organic acid inside the product can also increase the simple sugar content of the product so it also is able to increase the resulting total dissolved solids of the product. The milk's total dissolved solids such as lactose also can increased the total dissolved solids of the product. Augustin *et al.* (2011) stated that dissolved solids in milk were lactose and minerals that were soluble in water.

The addition of dextrin with different concentration didn’t give a significant difference ($p>0.05$) to the viscosity of the resulting product (Table 1). This was however due to the low viscosity properties of the dextrin itself. According to Yulinery and Hidayat (2012), dextrin was a result of starch hydrolysis with a low viscosity rate. The resulting viscosity of the goat milk kefir powder was between 0.166 – 0.217 cP. The increase of viscosity in the product was caused by the amount of water that was bound by the dextrin component inside the product. Juntarasakul and Maneeintr (2018) stated that higher water content resulted in lower product viscosity. Total dissolved solids content can also increase the viscosity of the product. According to Purwanegara *et al.* (2017) the higher the total dissolved solids content inside the product, the higher the viscosity produced. The fermentation process of the kefir product can also increase the viscosity of the product, where the clumping of protein due to the acid content during the fermentation process can increase the resulting viscosity.

Chemical analysis

There was a significant effect ($p<0.05$) from the addition of dextrin with different concentrations to the water content of resulting goat milk kefir powder (Table 2). The water content that is produced from the goat milk kefir powder product ranges between 4.99 – 7.39%. According to SNI 01-2970-2006 (2006) the maximum water content of powdered milk products is 5%. The increase in water content along with the addition of dextrin is thought to be caused by the high bound water content in the product as well as the differences in the drying techniques used. Inappropriate temperature, drying, and contact time between air and the surface of the product can lower the evaporation rate of the product (Phisut, 2012). A high level of bound water inside the product is due to the dextrin component that has hydrophilic properties. Hydrophilic properties are due to the active hydroxyl group inside the product that facilitates water bonding inside the product (Wongphan and Harnkarnsujarit, 2020). According to Moser *et al.* (2017), dextrin with DE values below 20 has film-forming properties that can be used as an encapsulation agent. The formation of a thick film layer along with the increasing concentration of dextrin addition can also inhibit the evaporation level.

The addition of dextrin with different concentrations also showed a significant difference ($p<0.05$) to the carbohydrate content. The higher the concentration of dextrin added to the product also resulted in a higher carbohydrate

Table 2. Chemical Analysis of Goat Milk Kefir Powder with The Addition of Dextrin

Dextrin Concentration (%)	Water Content (%)	Carbohydrate (%)	Protein Content (%)	Total Acid Content (%)	Acidity Level (pH)
0	5.65 ± 1.17^{ab}	40.83 ± 1.42^{a}	25.02 ± 1.61^{c}	7.88 ± 1.09^{d}	4.68 ± 0.03^{a}
2,5	4.99 ± 0.85^{a}	52.05 ± 2.16^{b}	20.70 ± 2.53^{b}	6.38 ± 0.16^{c}	4.69 ± 0.01^{ab}
5	5.00 ± 0.90^{a}	61.01 ± 3.57^{c}	17.28 ± 2.94^{ab}	5.77 ± 0.50^{bc}	4.71 ± 0.00^{abc}
7,5	6.64 ± 1.43^{ab}	65.41 ± 3.02^{d}	15.28 ± 2.94^{a}	4.98 ± 0.12^{ab}	4.71 ± 0.01^{bc}
10	7.39 ± 1.13^{b}	71.00 ± 3.68^{e}	13.20 ± 2.95^{a}	4.37 ± 0.12^{a}	4.73 ± 0.02^{c}

Values are given as mean ± standard deviation and different superscript shows a significant difference at 0.05 level

content that ranges between 40.83 – 71.00 % (Table 2). The increase in carbohydrate content was caused by the dextrin compound that is a carbohydrate. According to Kawai and Hagura (2012) dextrin is one of the carbohydrate polymers that is commonly used, so the higher the addition of dextrin will result in higher carbohydrate content of the product. Lactose is the major carbohydrate content of milk produced by mammals, so that lactose content also other simple sugar inside the product can affect the resulting carbohydrate content of the product.

The protein content of the product also shows a significant difference ($p<0.05$) with the addition of dextrin with different concentrations. The higher the concentration of dextrin added to the product will result in lower protein content of the product that ranges between 13.20 – 25.02 % (Table 2.). The resulting protein content of the product was still in accordance with the standard, where according to the (CODEX STAN 243, 2003) that the minimum protein content of the kefir product is 2.7%. According to Kumar *et al.* (2016) cows and goat milk protein consist of 80% casein and 20% whey protein. The decrease of protein content in the product was due to the low protein content in dextrin with a high enough yield so that the protein contained inside the product was a protein derived from the goat milk itself. Denaturation of protein during the drying process can also lower the protein content of the product. According to Truong *et al.* (2014) that denaturation can occur in temperature ranges between 61-75.9°C for β- lactoglobulin, α-lactalbumin, and bovine serum albumin.

The addition of dextrin with different concentration gave a significant difference ($p<0.05$) on the total acid content of the resulting product (Table 2). The total acid content of the product relatively decreased along with the increasing concentration of dextrin, with the total acid content ranging from 4.37 – 7.88%. The resulting kefir product minimum total acid content is 0.7% (CODEX STAN 243, 2003), so the product is still in accordance with the standard that has been set. The decrease of total acid content in the product was due to the decreasing amount of organic acid inside the product because of the ongoing hydrolysis. According to Raghavan and Emekalam (2001) the use of acid can cut the glycosidic bond and the addition of water molecules through the hydrolysis process. The hydrogen atom addition process to the hydroxyl group in the saccharide component during the hydrolysis process can result in a shorter saccharide chain and lower the organic acid content inside the product.

Different levels of dextrin also gave a significant difference ($p<0.05$) to the level of acidity (pH) of the product. The increase of concentration addition of dextrin into the product resulted in an increased level of acidity, ranging from 4.68 – 4.73 (Table 2). The pH of the goat milk kefir was between 4.36 – 6.71 (Purnomo and Muslimin, 2012), so in this case the product was still in accordance with the normal pH of kefir. The increase of pH in the product was due to an increase in the hydroxyl group inside the product. Retnaningsih and Tari (2014) stated that high hydroxyl content from an oligosaccharide compound can neutralize the acid content inside the product. The increase in pH level of the product was also caused by the low acid content inside the product, where Rathore *et al.* (2012) stated that the decrease in pH level was due to the increased concentration of lactic acid in the product.

Microbiology analysis

The concentration of dextrin added into the product shows a significant difference ($p>0.05$) to total yeast, microbes, and lactic acid bacteria of the product (Table 3). The amount of yeast in goat milk kefir powder product ranges from $3.19 \times 10^2 - 6.38 \times 10^2$ CFU/g, the amount of microbe produced ranges between $7.15 \times 10^4 - 7.20 \times 10^5$ CFU/g, and the number of lactic acid bacteria produced ranges from $9.09 \times 10^4 - 1.73 \times 10^5$ CFU/g. The increasing amount of microbes is due to the encapsulation ability where according to Anand *et al.* (2018) polydextrose and dextrin have the ability to protect bacteria during the drying process. According to Teijeiro *et al.* (2018) that the amount of yeast on kefir product namely 10^6 - 10^7 CFU/ml with the standard amount of lactic acid bacteria is 10^8 CFU/ml. The low number of microbes, yeast, and lactic acid bacteria was caused by the less than optimal encapsulation process in the product produced. The heating process that was given during the drying process also can reduce the resulted number of microbes in the product. According to Kristanti (2017) that heating process can lower the number of microbes in the product. The optimal temperature for the growth of yeast is 25 – 30ºC, however the optimal temperature for lactic acid bacteria growth ranging between 37 – 42ºC, so the heating process with a temperature up to 55ºC can lower the amount of microbe that was in the product.

Table 3. Microbiology Analysis of Goat Milk Kefir Powder with The Addition of Dextrin

Dextrin Concentration (%)	Microbiology Parameters (CFU/g)		
	Total Yeast	Total Microbes	Total Lactic Acid Bacteria
0	3.19×10^{2a}	7.15×10^{4a}	9.09×10^{4a}
2.5	4.06×10^{2b}	1.72×10^{5b}	1.20×10^{5b}
5	4.15×10^{2c}	2.03×10^{5c}	1.23×10^{5c}
7.5	5.63×10^{2d}	4.05×10^{5d}	1.44×10^{5d}
10	6.38×10^{2e}	7.20×10^{5e}	1.73×10^{5e}

Values are given as mean ± standard deviation and different superscript shows a significant difference at 0.05 level

CONCLUSION

The treatment of addition of dextrin with different concentrations resulted in a significant difference in solubility, total soluble solids, total acid, yield, water content, protein content, carbohydrate content, pH level, total microbe, lactic acid bacteria, and yeast of the product. Meanwhile, there was no significant difference in the viscosity of the product. The best treatment is the addition of 10% of dextrin.

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