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Influence of Maltodextrin Concentration on the Proximate, Chemical, and Microbiological Properties of Powdered Bovine Colostrum Kefir

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Incorporating filler during bovine colostrum kefir dehydration is necessary to protect microbial viability and produce desirable powder properties. This study investigated the effect of different concentrations of maltodextrin (0%, 2.5%, 5%, 7.5%, 10%) on powdered bovine colostrum kefir's

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proximate, chemical, and microbiological properties. Increasing maltodextrin concentration significantly affected (P<.05) proximate, chemical, and microbiological properties, except for alcohol content, of powdered bovine colostrum kefir. Higher maltodextrin concentration increased carbohydrate content, yield, total dissolved solids, solubility, titratable acidity, alcohol, lactic acid bacteria (LAB), yeast, and total microbes, but decreased water content, protein content, fat content, ash content, $a_{w,}$ and pH. The highest concentration of maltodextrin provided the highest count of LAB and yeast to 7.39 log CFU/g and 7.07 log CFU/g respectively, while maintaining the alcohol content of 0.042%, still under HALAL regulations. However, the highest yield and solubility, 38.60% and 46.12% respectively, were still relatively low due to bovine colostrum characteristics. Adding 10% (w/v) maltodextrin concentration was the best treatment that preserved LAB viability that complies with CODEX STAN 243-2003 [1], and had desirable powder properties.

Keywords: Bovine; colostrums; kefir; maltodextrin; spray dry.

1. INTRODUCTION

Bovine colostrum is the earliest secretion of postpartum cows characterized by viscous yellow-reddish liquid and less lactose than mature milk [2]. Bovine colostrum is rich with immune factors, growth factors, and bioactive peptides necessary for the newborns' growth and immunity [3]. Therapeutic effects due to bovine colostrum supplementation, mostly regarding respiratory and gastrointestinal tract, have been studied before, including reduction of intestinal permeability [4], neutralization of human respiratory syncytial virus [5], and prevention of upper respiratory tract infection and nasal swab microbiome [6]. Although recently bovine colostrum products have risen, product development and commercialization are still limited to preserving colostrum due to the high protein content that easily aggregates at processing temperature. Fermentation of bovine colostrum with kefir grain, a symbiotic culture of bacteria and yeasts, has been done before [7,8] and proven to expand colostrum functionality via increment of antimicrobial capacity [9], bioactive peptides with notable *in vitro* ABTS radical scavenging activity [10] and probiotic properties of kefir microbiota [11].

As kefir in its liquid state contains high nutrition and water content, which both supports microbial activity, it has low shelf life indicated by undesirable physical, chemical, and sensory changes. Dehydration of kefir is proposed to be a solution to increase shelf life and ease both distribution and storage [12]. Spray drying is an economical and efficient drying method utilized in many researches to preserve bacteria [13,14]. Adding maltodextrin is considered to maintain microbial viability from the drying temperature stress [15] and achieve desirable powder characteristics [16]. Several researches have been done on the efficacy of maltodextrin as a filler for dried products with bacteria [17,18]. To evaluate the efficacy of bovine colostrum kefir as a powdered product, the powder's properties and microbial viability must be studied.

2. MATERIALS AND METHODS

2.1 Preparation of Samples

2.1.1 Bovine colostrum kefir production

Bovine colostrum kefir was produced according to Nurhasanah et al. [19] with modifications. Bovine colostrum, procured from Ungaran, Semarang, was pasteurized at 60°C for 30 min [20]. Colostrum was cooled to room temperature (±28°C) and filtered inside the laminar air flow (1300 Series A2, Thermo Fisher Scientific, America). In a sterile environment, 10% (w/v) kefir grain concentration, procured from Omah Kefir, Ungaran, was added into the colostrum, stirred slowly, and then wrapped with plastic. Colostrum was fermented at room temperature for 24 hours, and then in a sterile environment, colostrum kefir filtrate was separated from the grains. Colostrum kefir was preserved at 4°C until spray drying.

2.1.2 Bovine colostrum kefir drying

Maltodextrin dextrose equivalent (DE) 10-12 (Lihua, China) was added to bovine colostrum kefir with different concentrations, specifically 0%, 2.5%, 5%, 7.5%, and 10% (w/v). The drying of bovine colostrum kefir followed Khalilian Movahhed and Mohebbi [21] with modifications. Bovine colostrum kefir samples with different concentrations of maltodextrin were homogenized with Ultra Turrax (T-25, IKA, German) at 4000 rpm for 4 minutes, then heated

and stirred with the magnetic stirrer (Cimarec, IKA, German) at 45°C and stirring level at 2 while being spray dried. The spray drier (B-290, Buchi, Swiss) used had Q flow at 60 mm, inlet temperature at 120°C, outlet temperature at 62-84°C, aspirator at 100%, pressure at -60 mbar, nozzle cleaner at 2, and feed at 1. The powder output was collected in pouch bags with silica gel and preserved at -18°C.

2.2 Analysis

2.2.1 Proximate analysis

Powder samples were used for the proximate analysis. The determination of carbohydrate was proceeded with by difference method. According to Legowo et al. [22], water content was determined with gravimetric method. Protein content was determined with the kjeldahl method [23] with modifications. Protein content was determined with Buchi Kjel Line (Buchi, Swiss) through destruction, destilation, and titration. During the destruction, 0.5 g of sample, wrapped in filter paper, was put inside the digest tube and added with ¼ kjeldahl tablet and 10 ml of concentrated H_2SO_4 by turns, then digested at 400°C for 90 minutes. HCL 0.3N was used during titration.

Fat content was determined with soxhlet method according to Kim et al. [24] with modifications. Briefly, each samples weighed approximately 1 g (A) was wrapped in filter paper and dehydrated in the oven at 70°C for 15 hours (B), then extracted in Buchi fat extractor (E-500, Buchi, Swiss) with benzene as a solvent for 20 extraction cycles. Following the extraction, wrapped samples were laid out in a desiccator to evaporate the solvent, then dehydrated in the oven at 100°C for 1 hour before weighing (C). Fat contents were counted using the formula as follows.

$$\text{Fat content (\%)} = ((B-C)/A)*100\%$$

Ash content of samples was determined with the ashing method by Legowo et al. [22] with modifications. Crucibles were dehydrated in the oven at 105°C overnight. Succeedingly, crucibles were stored in a dessicator and weighed (X), then each samples weighed approximately 1 g (Y) was put inside each crucible. Samples were charred in a hotplate until it dissipated no more smoke and turned white, then heated in muffle furnace (Thermolyne, Thermo Fisher Scientific, America) at 550°C for 5 hours (Z) before weighing. Ash contents were counted as follows.

$$\text{Ash content (\%)} = (Z-X)/Y*100\%$$

2.2.2 Chemical analysis

Powder samples were used for the determination of yield [25]. Total dissolved solids (TDS) was determined according to Rizqiati et al. [25] with a digital refractometer (PAL-1, Atago, Japan). Water activity (a_w) was determined with a water activity meter (LabSwift-a_w, Novasina, COUNTRY) by prepping the powder samples in a cylindrical plastic container for measurement. According to Rizqiati et al. [25], solubility was determined with modifications in drying time of wrapped samples after filtrating, which was 3 hours followed by another 1 hour in the oven at 105°C. According to Atalar and Dervisoglu [13] with modifications, pH was determined by pH meter (PC 700, Eutech Instruments, Singapore) by dissolving 1 g of sample in 10 ml aquadest before inserting the probe to the sample solution. Titratable acidity was determined by titration [25] with 0.1 N NaOH.

Alcohol content was determined with the microdiffusion method according to Nahak et al. [26] with modifications. Preceding alcohol content determination, a standard curve was constructed. Two reagents of microdiffusion assay were reproduced according to Noriega-Medrano et al. [27] with modifications. Dichromate acid solution was made by dissolving 0.852 g of $K_2Cr_2O_7$ with 20 ml of aquadest, then added with 80 ml of concentrated H_2SO_4 slowly to avoid a rapid exothermal reaction. In contrast, sodium carbonate was made by dissolving 20 g Na_2CO_3 of in 100 ml of aquadest. Standard ethanol concentrations of 0%, 0.025%, 0.05%, 0.075%, and 0.1% (v/v) were prepared by diluting 0.5% ethanol stock solution in aquabidest. Ethanol and sodium carbonate solutions were pipetted each 1 ml in the sides of each conway while dichromate acid was pipetted 1 ml in the middle. The conways were incubated at 37°C for 2 hours. Afterwards, the reacted dichromate acid solutions from the middle of each conways were pipetted and diluted in a ten-fold serial of aquabidest, then the absorbances were read using a UV-Vis spectrophotometer (Cary 60, Agilent, America) with a maximum wavelength of 480 nm. The regression line equation of Y=-4.2128x+0.8107 was obtained from plotting the absorbances with the respective standard solution concentrations. Alcohol content determination of powdered bovine colostrum kefir samples was done by diluting powder samples with aquabidest (1:4), then repeating the

procedure by replacing standard solutions with the diluted samples. Alcohol contents were calculated by plotting the acquired absorbances to the regression and reversing the intial sample dilutions.

2.2.3 Microbiology analysis

Lactic acid bacteria (LAB), yeast, and total microbes were evaluated by total plate count method according to Sholichah et al. [28] with modifications. Powder samples were diluted in ten-fold dilutions with 0.85% NaCl. Samples at 10^{-4}, 10^{-5}, and 10^{-6} dilutions were pipetted 1 ml, each duplo, into petri dishes, then MRSA, SDA, and PCA media were respectively poured into the petri dishes for determination of total LAB, yeast, and total microbes. Samples for total LAB and total microbes were incubated anaerobically at 37°C for 48 hours [29], while samples for yeast were incubated aerobically at 30°C for 48 hours. Colonies of 30-300 were counted using the formula as follows.

CFU/ml= total colony x 1/dilution factor

2.2.4 Statistical analysis

Data obtained was analyzed using Statistical Product and Service Solutions (SPSS) 26.0 for Windows. One-way analysis of variance (ANOVA) procedure was used to determine difference in treatment means with a significance level of 0.05. Duncan's Multiple Range Test (DMRT) was used in the further analysis for mean separation.

3. RESULTS

3.1 Proximate Composition of Powdered Bovine Colostrum Kefir Samples

The addition of maltodextrin with different concentrations had a significant effect ($p<.05$) on the carbohydrate content, water content, protein content, fat content, and ash content of powdered bovine colostrum kefir samples (Table 1). Carbohydrate content of the samples ranged 10.78-27.64%, the water content of the samples ranged 2.47-4.25%, the protein content of the samples ranged 43.06-54.37%, the fat content of the samples ranged 24.07-27.02%, and the ash content of the samples ranged 2.77-3.57%. The highest content of carbohydrate was in 10% (w/v) maltodextrin treatment samples, whereas the highest content of water, protein, fat, and ash was in control samples. For the lowest content, it was vice versa.

3.2 Chemical Properties of Powdered Bovine Colostrum Kefir Samples

The addition of maltodextrin with different concentrations had a significant effect ($p<.05$) on the yield, TDS, a_w, solubility, pH, and TA, but insignificant on alcohol content (Table 2). Yield of the samples ranged 29.21-38.60%, TDS of the samples ranged 50.00-70.00%Brix, a_w of the samples ranged 0.334-0.391, solubility of the samples ranged 34.63-46.12%, pH values of the samples ranged 4.13-4.82, TA of the samples ranged 2.01-2.82%, and the alcohol content of the samples ranged 0.025-0.042%. Yield, TDS, solubility, TA, and alcohol content had the highest value in 10% (w/v) maltodextrin treatment samples, whereas a_w and pH had the highest value in control samples. For the lowest value, it was vice versa.

3.3 Microbiological Properties of Powdered Bovine Colostrum Kefir Samples

The addition of maltodextrin with different concentrations had a significant effect ($p<.05$) on the viability of LAB, yeast, and total microbes (Table 3). The LAB of the samples ranged 6.17-7.39 log CFU/g, yeast of the samples ranged 6.24-7.07 log CFU/g, and total microbes of the samples ranged 5.97-7.10 log CFU/g. The highest count of LAB, yeast, and total microbes was in 10% (w/v) maltodextrin treatment samples, whereas the lowest was in the control samples.

4. DISCUSSION

4.1 Proximate Analysis of Powdered Bovine Colostrum Kefir Samples

The increasing concentration of maltodextrin increased the carbohydrate content of the samples. Maltodextrin is a starch hydrolysis product that consists of D-glucose units connected by (1-4) glucosidic linkages, thus its addition will increase carbohydrate content. High degree of hydrolysis causes higher maltodextrin's DE value that increases the structure's hydroxyl groups [30], affecting water absorption capacity. In this study, increasing maltodextrin concentration decreased the water content of samples due to the increasing

Table 1. Proximate properties of powdered bovine colostrum kefir samples

Properties	Maltodextrin concentration (%w/v)					Method
	0	2.5	5	7.5	10	
Carbohydrate content (%)	10.78^{a}±0.71	15.23^{b}±0.69	16.05^{b}±1.03	20.80^{c}±0.44	27.64^{d}±1.03	By difference
Water content (%)	4.25^{a}±0.25	3.79^{b}±0.17	3.29^{c}±0.10	2.95^{d}±0.14	2.47^{e}±0.10	Gravimetry method
Protein content (%)	54.37^{a}±1.39	53.03^{a}±1.33	50.27^{b}±0.46	48.61^{c}±0.10	43.06^{d}±0.23	Kjeldahl method
Fat content (%)	27.02^{a}±1.13	26.34^{a}±0.77	25.14^{ab}±0.88	24.67^{bc}±0.43	24.07^{c}±0.82	Soxhlet method
Ash content (%)	3.57^{a}±0.16	3.54^{b}±0.06	3.32^{c}±0.31	2.96^{d}±0.13	2.77^{d}±0.08	Ashing with muffle furnace

**Values are means of four replicate readings with a standard deviation*

**Mean values having different superscript letters on the same column differ significantly at 5% significant level (p<.05)*

Table 2. Chemical properties of powdered bovine colostrum kefir samples

Properties	Maltodextrin concentration (%w/v)					Method
	0	2.5	5	7.5	10	
Yield (%)	29.21^{a} ±0.65	30.65^{b}±0.41	31.32^{b}±0.46	33.50^{c}±0.42	38.60^{d}±0.51	Yield test
Total Dissolved Solids (%Brix)	50.00^{a}±0.00	50.00^{a}±0.00	60.00^{b}±0.00	68.50^{c}±3.00	70.00^{c}±0.00	Refractometer
Water activity (a_w)	0.391^{a}±0.01	0.354^{b}±0.00	0.353^{b}±0.01	0.352^{b}±0.00	0.334^{c}±0.01	Water activity meter
Solubility (%)	34.63^{a}±0.99	38.00^{b}±0.82	40.35^{c}±0.46	44.61^{d}±0.90	46.12^{e}±0.67	Solubility test
pH	4.82^{a}±0.01	4.77^{b}±0.04	4.63^{c}±0.03	4.26^{d}±0.04	4.13^{e}±0.03	ph meter
Titratable acidity (%)	2.01^{a}±0.04	2.07^{a}±0.06	2.22^{b}±0.04	2.26^{b}±0.02	2.82^{c}±0.01	Titration
Alcohol (%)	0.025±0.01	0.0299±0.01	0.031±0.01	0.035±0.01	0.042±0.02	Microdiffusion method [19]

**Values are means of four replicate readings with a standard deviation*

**Mean values having different superscript letters on the same column differ significantly at 5% significant level (p<.05)*

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Table 3. Microbiological properties of powdered bovine colostrum kefir samples

Properties	Maltodextrin concentration (%w/v)					Method
	0	2.5	5	7.5	10	
Lactic acid bacteria (log CFU/g)	6.17^{a}	6.55^{a}	6.55^{a}	6.50^{a}	7.39^{b}	Total plate
Yeast (log CFU/g)	6.24^{a}	6.25^{a}	6.32^{a}	6.79^{ab}	7.07^{b}	count method
Total microbes (log CFU/g)	5.97^{a}	6.36^{a}	6.63^{ab}	6.69^{ab}	7.10^{b}	

**Values are means of four replicate readings*

**Mean values having different superscript letters on the same column differ significantly at 5% significant level (p<.05)*

hydrophilic groups. Maltodextrin DE 12 water absorption mechanism follows a type II isotherm with multilayer formation [31]. The water content in this study ranged from 2.47-4.25%, which complies to the standard water content in powdered milk. Reducing water content will increase the drying process stability, diminish hygroscopicity during processing and storage [32] and minimize rehydration time due to increasing surface area.

The increasing concentration of maltodextrin decreased the samples' protein content due to increasing carbohydrate content. The protein content in this study ranged from 43.06-54.37%, which is higher than that of powdered milk kefir with dextrin [33]. The high protein content is caused by bovine colostrum addition which generally has 15.0% protein, whereas mature milk 3.0%, mainly because of higher casein and immunoglobulin [34]. Protein quantity is also affected by kefir proteolytic activity during fermentation. Lactobacillus have extracellular proteolytic capabilities and peptide transport system, which allow it to hydrolyze protein, then either release more peptides or absorb them [35].

Increasing maltodextrin concentration decreased the fat content of samples due to the shifting proportion. Generally, bovine colostrum has higher fat content than mature milk with higher composition in palmitic, palmitoleic, and myristic acids [36]. During fermentation, LAB's lipolytic activity [7] may affect colostrum fat content. Likewise, increasing maltodextrin concentration also decreased the ash content of samples due to the shift in proportion. Ash is also utilized in metabolizing carbohydrates, fats, and proteins for cell growth, maintenance, and energy [37]. Additionally to the higher mineral content of bovine colostrum than mature milk [2], vitamin B1, B12, Ca, folic acid, and vitamin K levels increase during kefir fermentation [38].

4.2 Chemical Analysis of Powdered Bovine Colostrum Kefir Samples

Yield indicates production efficiency that compares the resulting products to raw materials. The increasing concentration of maltodextrin increased samples' yields. This study's yield range is higher than powdered goat milk kefir with dextrin [33]. The increasing yield is due to maltodextrin acting as solid enhancer, thereby adding volume and mass. The reduced water content due to maltodextrin addition is paramount to increasing glass transition temperature, thereby enabling the formation of the glassy matrix that retains sensitive materials and reduces transfer of oxygen [15]. Inversely, maltodextrin forms a rubbery viscous matrix below the glass transition temperature that supports material adherence to the wall of the drying chamber [16] thus lowering the yield.

As maltodextrin is characterized by high solubility [31], the increasing concentration of maltodextrin increased the samples' total dissolved solids (TDS) values as well. High TDS increases encapsulant viscosity for better protection [39] also encapsulation efficiency via increasing the resistance against collapse [15]. Furthermore, TDS increases production efficiency by reducing water content that will otherwise evaporated, however, an excessive amount may hinder the feed and spraying process [40]. An increase in maltodextrin concentration lowered water activity in this study. The a_w found in this study ranged 0.33-0.39, which is still under 0.61, the limit for microorganism growth [41] to maintain product stability.

Solubility refers to the ability of the powder to release encapsulated materials in a solvent, which indicates convenience. The increasing concentration of maltodextrin increased the samples' solubility values due to its hydrophilic groups. A similar result was found in a study regarding noni leaf powder, where 5-15% maltodextrin concentration resulted in 93.14-97.13% solubility [42]. The solubility found in this study ranged from 34.63-46.12%, which, according to Moghbeli et al. [43], is still inefficient. The low solubility of powdered bovine colostrum kefir may be due to the high-fat content of bovine colostrum [44] which consists more of the relatively insoluble long-chain fatty acids [45]. Solubility is also affected by the tendency of small particles to dissolve easily due to the increasing solvent diffusion, which is supported by the kefir fermentation process and spray dry atomizer.

The samples' pH values decreased with increasing maltodextrin concentration. Similar results were observed in other studies regarding yoghurt powder with maltodextrin addition [18,46]. The decreasing pH value is due to the preserved LAB viability with higher maltodextrin concentration. LAB utilizes lactose into lactic acid during anaerobic fermentation [11], hence the accumulating acid will lower pH. The measured pH value was higher than that of the colostrum

kefir liquid reported by Windayani et al. [9] due to the lesser lactose in bovine colostrum. Bovine colostrum contains minimum lactose to 1.2% that can increase during postpartum [47]. Furthermore, the varying pH value may be affected by the colostrum characteristics and the kefir grain's microbial composition [48]. The pH value is inversely proportional to titratable acidity (TA), measured through NaOH titration. TA ranges 2.01-2.82%, which complies with CODEX-STAN 243-2003 [1] standard on 0.6% as the minimum acid content. Aside from affecting flavor, lactic acid contributes to pathogen inhibition via inducing acidic condition.

The increasing concentration of maltodextrin didn't affect the samples' alcohol contents significantly. Ethanol, one of the main products and kefir's distinguishing characteristic [11], is produced via yeast anaerobic activity in converting pyruvic acid from glycolysis in anaerobic condition [49], hence it is paramount for halal certification. The alcohol content found in this study was lower than Windayani et al. [9] who reported 0,39% alcohol content of bovine colostrum kefir fermented for 24 hours with 10% grain. Kefir alcohol content is affected positively by kefir grain concentration and fermentation duration [50].

4.3 Microbiological Analysis of Powdered Bovine Colostrum Kefir Samples

The addition of maltodextrin maintained the viability of microorganisms as indicated by the increase of total LAB, yeast, and total microbes along with the rising concentration. The linear increase of LAB and yeast due to filler addition is similar to the result reported by Rizqiati et al. [33]. Their symbiotic associations could explain the linear relationship. Metabolism products of LAB provide energy for yeast, whereas yeast produce essential growth factors for bacteria, including vitamins and amino acids [11], and raising the environment pH suitable for LAB [51]. LAB of powdered bovine colostrum kefir with 10% (w/v) maltodextrin complies with CODEX STAN 243-2003 [1], which states that the minimum microorganisms in kefir is 10^7 CFU/g. Total microbes also counted the viability of acetic acid bacteria (AAB), which can oxidize ethanol to acetic acid aerobically [52].

The several first maltodextrin concentration treatments towards microbial viability in this study didn't have much statistical differences with the control samples due to the drying process. The spray drying process generates heat and mechanical stress that impact cellular injuries that reduce viability, such as denaturation of intracellular proteins, dehydration, and destabilization of cellular structure due to cytoplasm water content elimination [53]. Adding maltodextrin protects microorganism viability as maltodextrin quickly forms a glassy matrix at the beginning of drying to increase cell stability [15] and reduce surface mechanical stress [54]. The higher concentration of maltodextrin provides higher viscosity to better encapsulate and protect sensitive materials [39]. Moreover, maltodextrin has thermoprotectant capability [16], thus lessening the thermal degradation effect on the viability of microorganisms.

5. CONCLUSION

Increasing maltodextrin concentration significantly affected proximate, chemical, and microbiological properties, excluding alcohol content, of powdered bovine colostrum kefir. Addition of 10% maltodextrin concentration provided powdered bovine colostrum kefir with total LAB that complies with CODEX STAN 243-2003 [1] and desirable powder properties, thus being the best treatment.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Codex Alimentarius Comission. "Standard for Fermented Milks" (PDF). Archived (PDF). Archived (PDF) from the original on February 10, 2023.
2. Arslan A, Kaplan M, Duman H, Bayraktar A, Erturk M, Henrick BM, et al. Bovine colostrum and its potential for human health and nutrition. Frontiers in Nutrition. 2021;8:1-12. Available:https://doi.org/10.3389/fnut.2021.651721
3. Gomes RDS, Anaya K, Galdino ABS, Oliveira JPF, Gama MAS, Medeiros CACX, et al. Bovine colostrum: A source of

bioactive compounds for prevention and treatment of gastrointestinal disorders. NFS J. 2021;25:1–11.
Available:https://doi.org/10.1016/j.nfs.2021.10.001

4. Hałasa M, Maciejewska-Markiewicz D, Baśkiewicz-Hałasa M, Safranow K, Stachowska E. Post-delivery milking delay influence on the effect of oral supplementation with bovine colostrum as measured with intestinal permeability test. Medicina. 2020;56(10):495.
Available:https://doi.org/10.3390/medicina56100495
5. Nederend M, van Stigt AH, Jansen JHM, Jacobino SR, Brugman S, de Haan CAM, et al. Bovine IgG prevents experimental infection with RSV and facilitates human T cell responses to RSV. Front. Immunol. 2020;11(1701):1-9.
Available:https://doi.org/10.3389/fimmu.2020.01701
6. Alsayed A, Al-Doori A, Al-Dulaimi A, Alnaseri A, Abuhashish J, Aliasin K, et al. Influences of bovine colostrum on nasal swab microbiome and viral upper respiratory tract infections – A case report. Respiratory Medicine Case Reports. 2020;31:1-5.
Available:https://doi.org/10.1016/j.rmcr.2020.101189
7. Setyawardani T, Sumarsono J, Arief II, Rahardjo AHD, Widayaka K, Santosa SS. Improving composition and microbiological characteristics of milk kefir using colostrum. Food Science and Technology (Brazil). 2020;40:699–707.
Available:https://doi.org/10.1590/fst.31719
8. Kurniati T, Windayani N, Listiawati M. Total lactic acid, protein, fat, and carbohydrates in curd kefir and cow colostrum kefir. J. Biodiate. 2020;5(2):271–280.
Available:https://doi.org/10.15575/biodjati.v5i2.9668
9. Windayani N, Kurniati T, Listiawati M. Psychochemical and organoleptic characteristics of colostrum kefir as antibacterial. J. of Physics: Conference Series. 2019;1175(1):1-7.
Available:https://doi.org/10.1088/1742-6596/1175/1/012016
10. Cotârleț M, Vasile AM, Gaspar-Pintiliescu, Oancea A, Bahrim GE. Tribiotication strategy for the functionalization of bovine colostrum through the biochemical activities of artisanal and selected starter cultures. 2020;18(1):274-280.
Available:https://doi.org/10.1080/19476337.2020.1745287
11. Rosa DD, Dias MMS, Grześkowiak LM, Reis SA, Conceição LL, Peluzio MDCG. Milk kefir: Nutritional, microbiological and health benefits. Nutrition Research Reviews. 2017;30(1):82–96.
Available:https://doi.org/10.1017/S0954422416000275
12. Isleroglu H. Freeze drying and moisture adsorption kinetics of kefir powder. Italian J. of Food Science. 2019;31(3):514–530.
Available:https://doi.org/10.14674/IJFS-1382
13. Atalar I, Dervisoglu M. Optimization of spray drying process parameters for kefir powder using response surface methodology. LWT - Food Science and Technology. 2015;60(2):751–757.
Available:https://doi.org/10.1016/j.lwt.2014.10.023
14. Teijeiro M, Pérez PF, De Antoni GL, Golowczyc MA. Suitability of kefir powder production using spray drying. Food Research International. 2018;112:169-174.
DOI: 10.1016/j.foodres.2018.06.023
15. Anandharamakrishnan C, Ishwarya SP. Spray drying techniques for food ingredient encapsulation. 1st edn. West Sussex: John Wiley & Sons, Inc; 2015.
16. Kang YR, Lee YK, Kim YJ, Chang YH. Characterization and storage stability of chlorophylls microencapsulated in different combination of gum arabic and maltodextrin. Food Chemistry. 2019;272:337-346.
Available:https://doi.org/10.1016/j.foodchem.2018.08.063
17. Barbosa J, Brandão TRS, Teixeira P. Spray drying conditions for orange juice incorporated with lactic acid bacteria. International J. of Food Science & Technology. 2017;52(9):1951–1958.
Available:https://doi.org/10.1111/ijfs.13472
18. Masyhura MD, Faudi M, Surnaherman. Aplikasi maltodekstrin pada pembuatan yogurt bubuk biji nangka (*Arthocarpus lineus*). J. Andalas Agricultural Technology. 2021;25(1):73-80.
Available:https://doi.org/10.25077/jtpa.25.1.73-80.2021
19. Nurhasanah, Sadewi SM, Supriyato R, Laila A. Analisis kadar protein, lemak, dan total asam laktat dari fermentasi kefir berbahan baku kolostrum sapi. 2019. Analit: Analytical and Environmental Chemistry. 2019;4(2):30-41.

Available:http://dx.doi.org/10.23960%2Faec.v4i2.2019.p30-41

20. Nguyen DC, Currie AJ, Ren S, Bering SB, Sangild PT. Heat treatment and irradiation reduce anti-bacterial and immune-modulatory properties of bovine colostrum. Journal of Functional Foods. 2019;57:182-189.
Available:https://doi.org/10.1016/j.jff.2019.04.012
21. Movahhed MK, Mohebbi M. Spray drying and process optimization of carrot–celery juice. Journal of food Processing and Preservation. 2016;40(2):212-225.
Available:https://doi.org/10.1111/jfpp.12598
22. Legowo AM, Nurwantoro, Sutaryo. Analisis Pangan. Semarang:Badan Penerbit Universitas Diponegoro;2005.
23. Seo WD, Kim JY, Song YC, Cho JH, Jang KC, Han SI, et al. Comparative analysis of physicochemicals and antioxidative properties in new red rice (*Oryza sativa* L. cv. Gunganghongmi). J. Crop Sci. Biotechnol. 2013;16:63–68.
Available:https://doi.org/10.1007/s12892-012-0057-3
24. Kim SL, Berhow A, Kim JT, Chi HY, Lee SJ, Chung IM. Evaluation of soyasaponin, isoflavone, protein, lipid, and free sugar accumulation in developing soybean seeds. J. Agri. Food Chem. 2006;54:10013–10010.
Available:https://doi.org/10.1021/jf062275p
25. Rizqiati H, Nurwantoro Febrisiantosa A, Shauma CA, Khasanah R. Effect of soy protein isolate on physical and chemical characteristics of kefir powder. Journal of Food and Agroindustry. 2020; 8(3):111-121.
Available:https://doi.org/10.21776/ub.jpa.2020.008.03.1
26. Nahak BRH, Aliah AI, Karim, SF. Analysis of alcohol content in traditional alcoholic beverages with UV-Vis spectrophotometry method. Journal of Science and Health. 2021;3(4): 448-454.
Available:https://doi.org/10.25026/jsk.v3i4.360
27. Noriega-Medrano LJ, Vega-Estrada J, Ortega-Lopez J, Ruiz-Medrano R, Cristiani-Urbina E, del Carmen Montes-Horcasitas M. Alternative non-chromatographic method for alcohols determination in Clostridium acetobutylicum fermentations. Journal of Microbiological Methods. 2016;126:48-53.
Available:https://doi.org/10.1016/j.mimet.2016.05.001
28. Sholichah K, Bintoro VP, Rizqiati H. Analisis karakteristik kefir optima dengan menggunakan bibit praktis terhadap nilai pH, total BAL, total padatan terlarut dan organoleptik. J. Food Technology. 2019; 3(2):286-291.
Available:https://doi.org/10.14710/jtp.2019.23725
29. Sachindra NM, Sakhare PZ, Yashoda KP, Narasimha Rao D. Microbial profial of buffalo sausage during processing and storage. Food Control. 2005;16:31-35.
Available:https://doi.org/10.1016/j.foodcont.2003.11.002
30. Negrão-Murakami AN, Nunes GL, Pinto SS, Murakami FS, Amante ER, Petrus JCC, et al. Influence of DE-value of maltodekstrin on the physicochemical properties, antioxidant activity, and storage stability of spray dried concentrated mate (*Ilex paraguariensis* A. St. Hil.). LWT - Food Science and Technology. 2017;79: 561–567.
Available:https://doi.org/10.1016/j.lwt.2016.11.002
31. Castro N, Durrieu V, Raynaud C, Rouilly A. Influence of DE-value on the physicochemical properties of maltodekstrin for melt extrusion processes. Carbohydrate Polymers. 2016;144:464–473.
Available:https://doi.org/10.1016/j.carbpol.2016.03.004
32. Fabra MJ, Marquez E, Castro D, Chiralt A. Effect of maltodextrins in the water-content–water activity–glass transition relationships of noni (*Morinda citrifolia* L.) pulp powder. Journal of Food Engineering. 2011;103(1):47-51.
Available:https://doi.org/10.1016/j.jfoodeng.2010.09.018
33. Rizqiati H, Nurwantoro N, Susanti S, Prayoga MIY. The effects of dextrin concentration as filler on physical, chemical, and microbiology properties of powdered goat milk kefir. J. of the Indonesian Tropical Animal Agriculture. 2021;46(2):145–153.
Available:https://doi.org/10.14710/jitaa.46.2.145-153
34. Palyford RJ, Wiser MJ. Bovine colostrum: its constituents and uses. Nutrients. 2021;13(1):1-23.
Available:https://doi.org/10.3390/nu13010265

35. Dallas, DC, Citerne F, Tian T, Silva VLM, Kalanetra KM, Frese SA, et al. Peptidomic analysis reveals proteolytic activity of kefir microorganisms on bovine milk proteins. Food Chem. 2017;197(A):274-284. Available:https://doi.org/10.1016/j.foodchem.2015.10.116
36. O'Callaghan TF, O'Donovan M, Murphy JP, Sugrue K, Mannion D, McCarthy WP, et al. Evolution of the bovine milk fatty acid profile – from colostrum to milk five days post parturition. Int Dairy J. 2020;104:104655. Available:https://doi.org/10.1016/j.idairyj.2020.104655
37. Farag MA, Jomaa SA, El-Wahed AA, El-Seedi HR. The many faces of kefir fermented dairy products: quality characteristics, flavour chemistry, nutritional value, health benefits, and safety. Nutrients. 2020;12(2):1-23. Available:https://doi.org/10.3390/nu12020346
38. Kabak B, Dobson ADW. An introduction to the traditional fermented foods and beverages of turkey. Critical Reviews in Food Science and Nutrition. 2011;51(3): 248-260. Available:https://doi.org/10.1080/10408390903569640
39. Rajabi H, Ghorbani M, Jafari SM, Mahoonak AS, Rajabzadeh G. Retention of saffron bioactive components by spray drying encapsulation using maltodextrin, gum Arabic and gelatin as wall materials. Food Hydrocolloids. 2015;51:327-337. Available:https://doi.org/10.1016/j.foodhyd.2015.05.033
40. Marques GR, Borges SV, de Mendonca KS, de Barros Fernandes RV, Menezes EGT. Application of maltodextrin in green corn extract powder production. Powder Technology. 2014;263:89-95. Available:https://doi.org/10.1016/j.powtec.2014.05.001
41. Tapia MS, Alzamora SM, Chirife J. Effects of water activity (a_w) on microbial stability as a hurdle in food preservation. In: Barbosa-Canovas GV, Fontana Jr AJ, Schmidt SJ, Labusa TP, editors. Water activity in foods: Fundamentals and applications. 2nd ed. West Sussex: John Wiley & Sons, Inc;2020. Available:https://doi.org/10.1002/9781118765982.ch14
42. Yuliawaty ST, Susanto WH. Effect of drying time and concentration of maltodekstrin on the physical chemical and organoleptic characteristic of instant drink noni leaf *(Morinda citrifolia*). J. Food and Agroindustry. 2015;3(1):41–51.
43. Moghbeli S, Jafari SM, Maghsoudlou Y, Dehnad D. Influence of pectin-whey protein complexes and surfactant on the yield and microstructural properties of date powder produced by spray drying. J. of Food Engineering. 2019;242:124–132. Available:https://doi.org/10.1016/j.jfoodeng.2018.08.025
44. Borad SG, Singh AK. Colostrum immunoglobulins: Processing, preservation and application aspects. International Dairy J. 2018;85:201–210. Available:https://doi.org/10.1016/j.idairyj.2018.05.016
45. Wilms JN, Hare KS, Fischer-Tlustos AJ, Vahmani P, Dugan MER, Leal LN, et al. Fatty acid profile characterization in colostrum, transition milk, and mature milk of primi- and multiparous cows during the first week of lactation. J. of Dairy Science. 2022;105(3):2612–2630. Available:https://doi.org/10.3168/jds.2021-20880
46. Djali M, Marta H, Harnah S. Characteristics of mustard greens powdered yogurt with maltodextrin coating material. J. Agricultural Postharvest Research. 2016;13(1):28-35.
47. Morrill KM, Conrad E, Lago A, Campbell J, Quigley J, Tyler H. Nationwide evaluation of quality and composition of colostrum on dairy farms in the United States. J. of Dairy Science. 2012;95(7):3997–4005. Available:https://doi.org/10.3168/jds.2011-5174
48. Sulmiyati, Said NS, Fahrodi DU, Malaka R, Maruddin F. The Physicochemical, microbiology, and sensory characteristics of kefir goat milk with different levels of kefir grain. Tropical Animal Science Journal. 2019;42(2):152-158. Available:https://doi.org/10.5398/tasj.2019.42.2.152
49. Draphco CM, Nhuan NP, Walker TH. Biofuels Engineering Process Technology. USA: The McGraw Hill Companies, Inc; 2008.
50. Setyawardani, T, Rahardjo AHD, Sulistyowati M, Wasito S. Physiochemical and organoleptic features of goat milk kefir made of different kefir grain concentration on controlled fermentation. Animal Production. 2014;16(1):48-54.

51. Farnworth ER, Mainville I. Kefir: A fermented milk product. In: Farnworth ER, editor. Handbook of fermented functional foods. Boca Raton, USA: CRC Press; 2003.
52. Gomes RJ, de Fatima Borges M, de Freitas Rosa M, Castro-Gomez RJH, Spinosa WA. Acetic acid bacteria in the food industry: Systematic, characteristics, and applications. Food Technology & Biotechnology. 2018;56(2):139-151. Available:https://doi.org/10.17113/ftb.56.02.18.5593
53. Moreira MTC, Martins E, Perrone IT, de Freitas R, Queiroz LS, de Carvalho AF. Challenges associated with spray drying of lactic acid bacteria: Understanding cell viability loss. Comprehensive Reviews in Food Science and Food Safety. 2021; 20(4):3267-3283. Available:https://doi.org/10.1111/1541-4337.12774
54. Siemons I, Politiek RGA, Boom RM, van der Sman RGM, Schutyser MAI. Dextrose equivalence of maltodekstrins determines particle morphology development during single sessile droplet drying. Food Research International. 2020;131:1-10. Available:https://doi.org/10.1016/j.foodres.2020.108988

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