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Physicochemical, microbiological, and sensory evaluation of kefir produced from goat milk containing *Lacticaseibacillus casei* AP and/or oat milk during storage

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Abstract

This study combined the probiotic properties of *Lacticaseibacillus casei* AP with the prebiotic properties of oats to improve kefir products. *Lacticaseibacillus casei* AP, oat milk, or both were added to goat milk kefir. Physicochemical properties, microbiological evaluation, and sensory evaluation were done over the course of 14 days. The result showed that adding *Lacticaseibacillus casei* AP and oat milk together had positive (non-opposing) effects on the physicochemical, microbiological, and sensory properties of the kefir product until the end of shelf life. Compared to the control group, the viscosity of kefir increased by two times (13,630 vs. 6,716 mPa). The viscosity of goat milk that had been mixed with *Lacticaseibacillus casei* AP and oat milk and stored for 14 days also got thicker by 44%. Overall, *Lacticaseibacillus casei* AP and oat milk can be added to kefir simultaneously over time to improve its qualities.

Keywords: kefir; lactic acid bacteria; prebiotic; probiotic; oat milk.

Practical Application: Improving the physicochemical and sensory characteristics of kefir products during storage.

Supplementary table: The table can be seen on the following Google Drive link: https://drive.google.com/drive/u/2/folders/1bGxPXnKxVfHFarD801LRTu5YnBAnIoBv

1. Introduction

Kefir is derived from the Caucasus Mountains in Russia and is made of multiple lactic acid bacteria such as *Lactobacillus kefiranofaciens* and *Lactobacillus parakefiri* and yeast, in order to produce a kefir product with a low alcohol level. Kefir consumption is associated with functional benefits (Azizi et al., 2021). There have been reports that kefir has a lot of potential for preventing and treating cancer. The study found that the *Lactobacillus* strains found in kefir have good probiotic features, meaning they help protect the body against infection. It is also important that the probiotic candidates have antimicrobial activity against pathogenic bacteria and the ability to attach to cells (Sharifi et al., 2017). Nutritional components contained in kefir include carbohydrates, protein, minerals, vitamins, and bioactive compounds (Ahmed et al., 2013). In the fermentation process, microorganisms in the kefir grain are released and keep growing until the fermentation is completed (Schwan et al., 2016). However, the fermentation and yeast activities result in syneresis, which causes milk protein degradation and decreases viscosity (Alakali et al., 2008). The product of syneresis is whey (separated curd from kefir because water escapes the gel matrices), and excessive syneresis leads to a negative impact on nutrition and sensory quality (Barukčić et al., 2017).

Fermented milk products enriched with LAB have been reported to offer health benefits for humans (Nielsen et al., 2017). LAB species that produce high levels of exopolysaccharides (EPS) are associated with the high viscosity of fermented milk products (Han et al., 2016). Probiotic bacteria such as *Lacticaseibacillus casei* AP (Widodo et al., 2012a, 2012b, 2014) can produce exopolysaccharides (Maajid et al., 2022; Widodo et al., 2019), which can be used as a culture starter for milk fermentation (Widodo et al., 2017). An *in vivo* study using milk fermented with *Lacticaseibacillus casei* AP and offered to mice has resulted in a decrease in blood glucose and LDL (low-density lipoprotein), but increased HDL (high-density lipoprotein) (Widodo et al., 2019). The addition of *Lacticaseibacillus casei* AP will synthesize EPS, thus hypothetically capable of reducing syneresis, increasing viscosity of the product, and improving the probiotic level of the kefir product. Increased probiotic functionality can be achieved by adapting a fermentation technology that can produce a high level of probiotics in food supplements or fermented foods (Champagne et al., 2018). Kefir made with

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probiotic *Lactobacillus rhamnosus* GG is a probiotic food carrier with therapeutic effect (Mitra and Ghosh, 2020), so what was merely fermented by-product food now gains its status as functional food (Santos et al., 2019).

The probiotic function of a product can be increased with prebiotics, which help improve the life of probiotics in the intestines. A prebiotic is a vital component for fermentation that brings health benefits and welfare to the host (Hazal Özyurt & Ötleş, 2014). The combination of probiotic and prebiotic is known as symbiotic, which, when incorporated into kefir making, will improve the product quality (Buran et al., 2021). While the most common prebiotics are *fructooligosaccharide* (FOS) and *galactooligosaccharide* (GOS), high levels of prebiotic (fiber and oligosaccharides) are found in whole grains like oats (*Avena sativa L.*), which has been extensively promoted due to its health benefits (Li et al., 2020). Oat contains soluble fiber in the form of oligosaccharides or polysaccharides that carry prebiotic effects. This physiological characteristic is generally associated with β-glucan, a non-starch polysaccharide that, according to Shen et al. (2012), is a prebiotic that stimulates the growth of bacteria but cannot be digested by enzymes in human intestines. Oat can relieve syneresis because it is a good food fiber (Ramirez-Santiago et al., 2010).

Although kefir is a fermented milk product in the category of functional food (bearing health benefits), some facts have shown that the microorganisms in kefir grain are not probiotic agents. Therefore, producing probiotic kefir will offer a significant contribution to the dairy industry. The novelty of this study was producing kefir with additional probiotics (*Lacticaseibacillus casei* AP) and prebiotics (oat milk) that can improve product quality during storage. This study aimed to analyze the effect of incorporating probiotics and prebiotics on their physicochemical, microbiological, and sensory properties.

2. Materials and methods

2.1. Materials

Fresh goat milk was supplied by a dairy goat farming community called "Susu Poang" (Yogyakarta, Indonesia); grain kefir was obtained from Kefira (Yogyakarta, Indonesia); and oat milk was made from oatmeal (Quacker Oats, Indonesia). The composition followed the nutrient content on the label, namely, 5% total fat, 0% cholesterol, 3% saturated fat, 8% protein, 7% total carbohydrate, 11% fiber, and 0% salt. Strain *Lacticaseibacillus casei* AP was observed in probiotic LAB isolated from the feces of <1-month-old babies in Indonesia who consumed milk (Widodo et al., 2012a, 2012b, 2014).

2.2. Production of starter Lacticaseibacillus casei *AP*

Lacticaseibacillus casei AP starter was made by preparing mother starter. A volume of 100 mL of skim milk 18% (w/v) was sterilized at 110 °C with 13 psi for 10 min. After the milk reached room temperature, *Lacticaseibacillus casei* AP inoculum was added, and then incubated at 37 °C for 12–18 h until curd was formed. The curd is the mother starter that would be used to make bulk starter. Exactly 3% (v/v) of the mother starter was inoculated into skim milk 18% (w/v), and then incubated for 12–18 h to produce bulk starter. The bulk starter yield was either directly inoculated into the milk or stored at 10 °C prior to use (Widodo et al., 2019).

2.3. Production of starter cultures of kefir

This study used the Russian method, which applied two stages of fermentation to make kefir (Shah, 2014). In the first stage, the culture starter was prepared by heating goat milk at 85 °C for 30 min, then cooling to room temperature. After that, 3% kefir grain was incorporated into the milk and allowed incubation for 18 h at room temperature (Wulansari et al., 2022a). After fermentation, the milk was strained to collect the kefir grains, or the kefir starter, which would be added at the stage of sample production.

2.4. Preparation of oat milk

Before making kefir, oat milk (16% w/v) was made using a method by Demir et al. (2021) with a slight modification. Exactly 16 g of oats were mixed with 100 mL pre-heated Aquadest, and then soaked for 15 min. Then, the mixture was homogenized for 2 min in a blender (LG brand) to mash all the whole particles. The composition of the oat milk was 1.78% fat, 12.4% solid non-fat (SNF), 0% lactose, 1.56% protein, 85.8% water, 11,399 mPa viscosity, and pH 6.6 (Wulansari et al., 2022b).

2.5. Production of sample

This study developed four samples of kefir.

- GMK (Goat's Milk Kefir) is a control sample made of goat milk + kefir starter;
- GMK+LC (Goat's Milk Kefir + *Lacticaseibacillus casei* AP) is goat milk + kefir starter + *Lacticaseibacillus casei* AP;
- GMK+OM (Goat's Milk Kefir + Oat Milk) is goat milk + oat milk + kefir starter;
- GMK+LC+OM (Goat's Milk Kefir + *Lacticaseibacillus casei* AP + Oat Milk) is goat milk + oat milk + kefir starter + *Lacticaseibacillus casei* AP.

GMK was made by heating goat milk at 85 °C for 15 min, allowing it cool to room temperature, and adding 3% (w/w) kefir starter, followed by an 18-h incubation at room temperature. In GMK+LC, following kefir starter inoculation, there was a 6-h incubation at room temperature, and then 4% (w/w) *Lacticaseibacillus casei* AP starter was added, followed by a 12-h incubation at room temperature (second fermentation) to produce lactic acid. GMK+OM was made by adding goat milk to the oat milk solution at a ratio of 75:25 (75% goat milk:25% oat milk) for pasteurization (85 °C; 15 min) and allowing it cool to room temperature. After that, the milk was inoculated with 3% (w/w) kefir starter and Incubated for an 18-h fermentation at room temperature. In GMK+OM+LC, goat milk was mixed with oat milk, then fermented with kefir starter (6 h) and *Lacticaseibacillus casei* AP (12 h) (Kwak et al., 1996; Widodo et al., 2019; Wulansari et al., 2022b).

2.6. Physicochemical properties

The proximate analysis was carried out to evaluate water content, protein content, and ash (AOAC, 2006). The acidity level was measured using the titration method with NaOH (Merck, Germany) and phenolphthalein as an indicator (Merck, Germany), and the results were expressed as the percentage of lactic acid. The pH value was measured using a pH meter (PT-70, Boeco, Germany) and calibrated with buffer pH 4 and 7 (Merck, Germany). Viscosity analysis was conducted using the methods by Mitra and Ghosh (2020), which have been modified to be compatible with the device used. Viscosity was measured using a *rotational viscometer* (NDJ-55 Viscometer, India). Following the manual, the rotating tin rod of the viscometer was put into a 15-cm tall container filled with a 300-mL sample, and the rotational viscometer would point to the viscosity value of the sample. The syneresis measurement would use a 15-g sample in an Eppendorf tube and be centrifuged (Eppendorf Sentrifuge 5804 R, Germay) for 20 min at a speed of 1,540 rpm at 4 °C to separate the solids from the liquid. The liquid was discarded, and the sediment inside the tube was weighed (Sari et al., 2019). The alcohol level was measured using Coway's microdiffusion analysis, modified by Nurliyani et al. (2015). The sample was measured at 480 nm using a spectrophotometer (Spektronik 200, Termo Scientific).

2.7. Microbiological analysis

Exactly 1 mL of sample was incorporated into 9 mL of NaCl with 10^{-9} diluted. 0.1 mL of each dilution was poured into a petri dish filled with specific media: total LAB was analyzed in 68.2 g/L modified deMan Rogosa and Sharpe Agar (MRSA) (Merck, Germany), TPC was in 22.5 g/L Plate Count Agar (PCA) (Merck, Germany), total probiotic in 68.2 g/L modified deMan Rogosa and Sharpe Agar (MRSA) (Merck, Germany) plus 44.5 g/L *bile salt* (Oxoid, United Kingdom), and total yeast in 48 g/L Malt Extract Agar (MEA) (Merck, Germany). The petri dishes were incubated at 37 °C for 48 h, except for (24 h), and then the colony formed in each sample was counted using a colony counter (Galaxy 330 Colony Counte, Taiwan) (Nurliyani et al., 2014).

2.8. Sensory evaluation

The sensory properties of the kefir sample were evaluated on days 1, 7, and 14 of storage by 20 untrained panelists from the Universitas Gadjah Mada, Indonesia. Sensory evaluation was performed on kefir samples stored on days 1, 7, and 14. The selected panelists have satisfied the criteria for this evaluation. The samples were given a three-digit random number and presented to the panelists along with one form of question. Panelists were given drinking water to wash down each sample. The sample kefir was evaluated based on color, alcoholic taste, texture, and overall level of acceptance using the nine-point hedonic scale (Bodyfelt et al., 1988). The sensoric score was coded from 1 to 9 with the following definition: dislike extremely, dislike very much, dislike moderately, dislike slightly, neither like nor dislike, like slightly, like moderately, like very much, and like extremely.

2.9. Statistical analysis

All treatments were repeated three times to obtain the mean values and standard deviation. Experiment with design using a factorial completely randomized design, which consists of two factors such as milk samples and storage time (milk samples (GMK, GMK+LC, GMK+OM, and GMK+LC+OM) and storage time factor (1, 7, and 14 days)). The data were subjected to two-way ANOVA analysis, followed by Tukey's multiple comparison tests with $P<0.05$ significance (Norman & Streiner 1996). Sensory evaluation data were subjected to a normality test (Shapiro-Wilk test), followed by a non-parametric test (Kruskal-Wallis) to identify the differences between samples, and finally, Mann-Whitney Advanced Test. All statistical analyses were performed using SPSS 16.0.

3. Results and discussion

3.1. Physicochemical analysis

The physicochemical properties of the kefir product presented in Supplmentary Table 1 demonstrate that the treatments significantly affected the level of alcohol, acidity, pH value, viscosity, and FFA ($P<0.05$). Goat milk kefir added with *Lacticaseibacillus casei* AP, oat milk, or both could increase the viscosity, alcohol level, and FFA while decreasing the acidity and pH value. Storage time significantly increased water, alcohol, and viscosity but decreased acidity and pH value ($P<0.05$).

Storage time significantly affected water content ($P<0.05$), which may probably be due to evaporation that occurred while kefir was stored. GMK+LC+OM sample showed the lowest protein content of other samples, which demonstrated a significant effect ($P<0.05$). The average protein level in this study was 4.11–4.92%, which was not far different from the previous study on kefir enriched with Moringa leaves (4.68–5.3%) (Endah et al., 2022), and kefir combined with colostrum (3.8–7.32%) (Setyawardani et al., 2020). Kefir product in this study had lower water content than that of cow milk kefir (89.08%) and soymilk kefir (91.77%), higher protein content (3.94-4.92%) than cow milk kefir (3.75%) and soymilk kefir 1.87%), and almost equal ash to that of cow milk kefir (0.64%) but higher than that of soymilk kefir (0.37%) (Yirmibeşoğlu & Öztürk, 2020).

The addition of *Lacticaseibacillus casei* AP, oat milk, or both, and kefir storage time have significantly ($P<0.05$) increased alcohol content. Similarly, the alcohol content of kefir enriched with Moringa oleifera leaves increased with storage life (Wulansari et al., 2022a). Kefir produced from red rice milk and *Lactobacillus bulgaricus* dan Candida kefir starter produced kefir that contained an average of 1.5% (Sulistyaningtyas et al., 2019), higher than that reported in the present study with an average of 0.44%. In the fermentation process, LAB will convert lactose into lactic acids and other compounds, then lactose fermented with yeast would produce a small amount of CO_2 and ethanol (Fakruddin et al., 2013). It showed that the addition of *Lacticaseibacillus casei* AP, oat milk, or both could produce kefir making with a lower level of alcohol.

GMK+OM sample produced kefir with the highest viscosity but was not statistically different from that of GMK+LC+OM sample. Compared to GMK (control sample) the increase of viscosity in GMK+OM and GMK+LC+OM was 117 and 102%, respectively. However, after 14 days of storage, a higher viscosity was observed in GMK+LC+OM rather than GMK+OM (44 and 12%, respectively). The viscosity of this study was higher than an average of 1.40–1.600 mPa's of goat milk kefir reported by Putri et al. (2020), which also demonstrated that storage time could increase kefir viscosity. It showed that the simultaneous incorporation of *Lacticaseibacillus casei* AP and oat milk had positive effects on the kefir products until the end of the shelf life. Therefore, it confirmed the research hypothesis that both *Lacticaseibacillus casei* AP and oat milk could increase viscosity and product quality.

Lacticaseibacillus casei AP is LAB with exopolysaccharide (EPS) properties (Maajid et al., 2022). EPS strain contributes positive effects on rheology properties and quality of fermented milk products (Badel et al., 2011), namely, increasing gel smoothness, viscosity, and stability of fermented milk (Gentès et al., 2011). It supports the evidence that *Lacticaseibacillus casei* AP can increase the viscosity of kefir products. Similarly, the addition of oat in this contributes to the improvement of viscosity, and previous studies (Ramirez-Santiago et al., 2010) have reported that fiber content in oat helped reduced syneresis. Oat is a fiber-rich cereal that contains more soluble fiber than the other grains (Singh et al., 2013). The soluble fiber in oat contains prebiotic agents in the form of oligosaccharides and polysaccharides. These physiological benefits are generally associated with β-glucan, which is a non-starch polysaccharide with (1→3) and (1→4) β-D-glucopyranosyl linkages (Shen et al., 2012). Accordingly, soluble fiber and β-glucan in oat contributes a positive effect on health (Bernat et al., 2015).

The addition of probiotic LAB with EPS properties (*Lacticaseibacillus casei* AP and oat milk) could increase the quality of the kefir product in terms of viscosity. Similar findings reported that incorporating prebiotics in the form of fructooligosaccharide (FOS) could improve dry matter content in kefir products (Buran *et al*., 2021). The samples and storage time of all treatments in this study did not show any syneresis.

In all kefir samples, the acidity level in GMK+OM and GMK+LC+OM was lower than the other samples, and storage up to 14 days could significantly ($P<0.05$) decrease the acidity level. Setyawardani and Sumarmono (2015) reported kefir acidity in a range of 0.14–0.23%, and that storage time did not affect the kefir acidity. In contrast, the present study showed a higher acidity (1.26–1.66%) and that storage time affected kefir acidity. The increased acidity in probiotic kefir was due to hydrolysis lactose and nitrogen produced by LAB activities and proteolytic bacteria during storage and metabolite like phosphate, citric, and lactic (Ender, 2009).

The pH value of kefir sample in our study varied from 3.95 to 4.18, which is indicative of significant ($P<0.05$) decrease due to the addition of *Lacticaseibacillus casei* AP, oat milk, or both, as well as storage time. The range of pH in this study was not far different from that of previous study on kefir cow milk (4.42-4.43) and goat milk (4.43-4.18) (Buran et al., 2021), as well as kefir added with tomato juice (4.1-4.2) (Corona et al., 2016). Storage time was reportedly able to affect the decrease of pH value in kefir (Setyawardani & Sumarmono, 2015). The decreased pH affected by the addition of *Lacticaseibacillus casei* AP, oat milk, or both may be due to the starter activations that occurred after lactose degradability and the formation of acid, lactic acid and kasein coagulation, and therefore, decreasing pH value of the final fermented product.

The addition of oat milk could significantly reduce FFA in kefir ($P<0.05$). FFA is one of the vital parameters that affect the flavor and aroma of fermented milk. The estimated FFA values in this study were 3.78–4.98%, which was higher than 0.24–0.49% of goat milk kefir added with *Moringa oleifera* leaf powder (Endah et al., 2022), but lower than 5.11–8.59% (Setyawardani et al., 2017). FFA is derived from degradable milk due to the activities of microflora from the kefir grains. The addition of oat milk in samples GMK+OM and GMK+LC+OM has reduced the FFA because oat inhibits microflora activities in the process of degrading milk fat into FFA.

3.2. Microbiological characteristics

The treatments in this study demonstrated no significant ($P>0.05$) difference across parameters during storage (Table 2). This result showed that the addition of *Lacticaseibacillus casei* AP, oat milk, or both into goat milk kefir and stored for 14 days did not produce a negative effect (microbiological analysis) on goat milk kefir. The total average of Lab, total yeast, and probiotics across treatments during storage was 7.31, 7.91, 6.92, and 7.08 log CFU/mL, respectively. The average total LAB and TPC in this study were higher than those of Standard Codex No. 234 (7 log CFU/mL), and the total probiotic in this study met the minimum threshold, namely, 7 log CFU/mL.

Microbiological characteristics are among the most evaluated parameters in the study of fermented dairy products, like kefir. The total LAB of kefir made with 6% grain kefir was 7.25 log CFU/mL (Sulmiyati et al., 2019). Goat milk kefir made with additional *Moringa oleifera* leaf powder was reported to contain a total LAB, TPC dan Yeast of 6.17 log CFU/mL, 7.85 log CFU/mL, and 5.62 log CFU/mL (Endah et al., 2022). Kefir made of combined cow and goat milk contained 8.10 log CFU/mL total yeast and 9.44 log CFU/mL bacteria (Temiz & Kezer 2015). It was demonstrated that the findings of the present study were not significantly different from the previously reported ones.

Previous studies stated that kefir is a probiotic product with multiple functions (Leite et al., 2013; Otles and Cagindi, 2003). FAO/WHO (2006) defined a probiotic as a living organism, which when consumed in a proper amount, may offer additional health benefits that are stemmed from the probiotic in the hosts. However, the definition of probiotics is developing. Recently, the International Scientific Association of Probiotics and Prebiotics (Hill et al., 2014) recommended that probiotic is not only living organism but a "well-identified strain."

In other words, the kefir product is a probiotic product that is very dependent on the source of kefir grains. If the kefir grain source contains probiotic bacteria, it will produce probiotic kefir as long as the number of total probiotics reaches the total minimum. However, each kefir grain has its own biota diversity. It is because the origins of kefir grain, maintenance, and storage condition may affect the diversity of microbe in kefir grain (Schwan et al., 2016). Microbe diversity is responsible for the physicochemical properties and biological activities of each kefir product (Cruz Cabral et al., 2013). For this reason, it is important to develop a kefir product with enriched probiotics by incorporating *Lacticaseibacillus casei* AP, so that the number of probiotic bacteria is sufficient to claim the kefir yield as a probiotic kefir product.

3.3. Sensory evaluation

In the sensory evaluation, a group of panelists based their evaluation on multiple categories: color, aroma, acidity, alcohol hint, texture, and customer acceptance (Table 3). Different statistic values were observed in color parameters for kefir stored between 0 and 7 days, and acceptability of kefir stored for 7 days ($P<0.05$). Panelists preferred kefir in samples GMK and GMK+LC in terms of color (0–7 days of storage) than oat-enriched kefir in samples GMK+OM and GMK+LC+OM. It is probably because the oat has made the color of the kefir product turn brownish than the white kefir without the oat. Similarly, the highest and lowest acceptance level was observed in GMN and GMK+OM, respectively (7 days of storage). This significant data showed that the panelists preferred the color of kefir in GMK samples, as indicated by their overall level of acceptance.

Statistical differences were observed in the storage time for color in sample GMK+LC+OM and in acidity and overall acceptance in sample GMK+AP ($P<0.05$). Fourteen days of storage was able to improve the acceptance level of color in sample GMK+LC+OM. Meanwhile, acidity and overall level of acceptance showed that storage time can decrease the level of acceptance to acidity and overall acceptance of the GMK+AP sample. However, the majority of sensory parameters showed a non-significant effect across storage time, which proved that kefir combined with oat milk, *Lacticaseibacillus casei* AP, or both, and observed on days 0, 7, and 14 of storage is acceptable.

This result is supported by previous studies that in addition to aroma, structure, and kefir starter; the type of milk and storage time are the main contributing factors to the quality of sensory characteristics of kefir (Wszolek et al., 2001). The type of milk used in the present study was goat milk and a combination of goat milk and oat milk. Oat milk was incorporated as a source of prebiotics. A previous study has reported that incorporating isomaltooligosaccharide (IMO) as a prebiotic agent has successfully produced control kefir with a higher acceptance level than prebiotic-enriched kefir (Tratnik et al., 2006).

The addition of *Lacticaseibacillus casei* AP and oat milk in this study was to reduce syneresis and increase the viscosity of kefir products. Table 1 shows that the level of viscosity increases with the addition of oat milk and *Lacticaseibacillus casei* AP. While a previous study reported that panelists preferred kefir with a higher viscosity (Buran et al., 2021), the present study demonstrated that increased viscosity did not significantly affect the texture parameter. It is probably because of the different kefir grains used in this study from those of Buran et al. (2021). Kefir grain affects the sensory quality of goat milk kefir (Shi et al., 2018).

Prebiotic properties of oat milk and probiotic agents of *Lacticaseibacillus casei* AP are expected to improve the functional characteristics of kefir products. Studies on developing functional properties of kefir products have immensely taken place in order to improve kefir quality, including the combination of walnut and sucrose (Cui et al., 2013), the combined buffalo and goat milk (Gul et al., 2018), and skim milk substituted with insulin (Glibowski and Zielińska, 2015). It is expected that this product development research can increase the functionality of kefir products, which eventually increases the interest to purchase and consumption to reflect a good level of customer acceptance (Larosa et al., 2021).

Conclusion

Data presented in this study showed that the addition of *Lacticaseibacillus casei* AP and oat milk can improve the viscosity of goat milk kefir during storage. Simultaneous incorporation of *Lacticaseibacillus casei* AP and oat milk did not impose a negative effect on physicochemical, microbiological, and overall sensory properties till the end of 14 days of storage. The result showed that *Lacticaseibacillus casei* AP as a probiotic lactic acid bacteria can be fermented simultaneously with bacteria from kefir grain; oat milk can be used as a fermentation media in kefir making when combined with goat milk in a ratio of 25:75; the addition of *Lacticaseibacillus casei* AP and oat milk in preparing goat milk kefir did not impose antagonistic characteristics, thus no negative effects on all parameters; 14 days of storage is evidently safe for product consumption. In brief, these findings demonstrated the feasibility of incorporating *Lacticaseibacillus casei* AP and oat milk in the product development of goat milk kefir.

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2nd column, 1st paragraph, 7th line

Where it reads:

Insulin

It should read:

Inulin