Research Article

Comparison of selected nutritional analysis of goat and cow milk kefir using Indonesian kefir grains

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ABSTRACT

Kefir is a fermented dairy beverage produced with kefir grains. It is high in probiotics and provides nutrition and health benefits. The effect of different level of kefir grains and incubation time on the chemical characteristics of goat and cow milk kefir was investigated. Kefir samples were prepared using 3 and 5% (w/v) kefir grains with incubation times of 12 and 24 hours. The addition of kefir grains significantly affected the pH, acidity, lactose, and protein content compared to control. There is no significant difference on pH, acidity, lactose, and protein in between both kefirs prepared in this study regardless of the treatments. The results showed that 5% (w/v) kefir grains with 24 hours incubation time was suggested to be the best milk kefir preparation for both goat milk and cow milk kefir.

Keywords: chemical characteristics; dairy milk; incubation time; kefir grain

1. Introduction

Kefir is a probiotic food that has proven to be beneficial to health and is currently of interest to the food industry. According to Nalbantoglu *et al.* (2014), kefir is considered a probiotic resource due to live microbial culture presence in the product. The probiotic resource in kefir helps in improving lactose digestion and tolerance in adults (Hertzler & Clancy, 2003) as well as functions as an antioxidant and antimutagenic (Liu *et al.,* 2005). Kefir is a dairy product characterised by its slightly foamy structure, the acidic flavor produced from yeast kefir grains, and a sparkling mouthfeel originating from constituents like acetic acid, ethanol, and carbon dioxide.

These properties are the consequence from lactose hydrolysis during fermentation led by yeasts (*Kluyveromyces*, *Candida*, *Saccharomyces* and *Pichia*) and various species of lactic acid bacteria (*Lactobacillus*, *Lactococcus*, *Leuconostoc*, *Streptococcus*), acetic acid bacteria, and other microflora contained in kefir starter culture (Wszolek *et al.,* 2001; Witthuhn *et al*., 2005; Park, 2010; Pogacic *et al*., 2013; Arslan, 2014).

Kefir physicochemical characteristics and nutritional compositions are varied from the origin of the protein source, kefir concentration, and incubation times (Motaghi *et al*., 1997; Otles & Cagindi, 2003; Chen *et al.,* 2009; Magalheis *et al.,* 2011; Gul *et al.,* 2015; Hidayat *et al.,* 2015). Kefir was made from different sources of milk, such as cow, sheep, goat, (Wszolek *et al.,* 2001; Purnomo & Muslimin, 2012), and buffalo

(Gul *et al.,* 2015). Other types of protein sources for kefir formation are also obtained from plant origin such as soymilk (McCue & Shetty, 2005), coconut, and rice milk (Otles & Cagindi, 2003). The kefir concentration varied from 2% to 10% (w/v) in cow, sheep, and goat milk study (Wszolek *et al.,* 2001), 3% to 7% (w/v) in pasteurized goat milk (Purnomo & Muslimin, 2012), and 2%, 3% and 5% (w/v) in cow milk (Kök-Tas *et al.,* 2013), 5% w/v in buffalo milk (Gul *et al.,* 2015). In addition, incubation times differ from 12 to 72 hours (Wszolek *et al.,* 2001; Purnomo & Muslimin, 2012; Kök-Tas *et al.,* 2013; Gul *et al.,* 2015).

Previously, the comparison of chemical analysis, proximate analysis of goat milk (Purnomo & Muslimin, 2012; Hidayat *et al.,* 2015), and protein profile of goat and cow milk kefir Rukmi *et al.* (2023) was investigated. Therefore, this current research will complement the chemical characteristics of goat milk and cow milk kefir prepared using Indonesian kefir grains. In South East Asia region, kefir drinks had gain popularity among fermented milk consumers (Sumarmono, 2022). Hence, the purpose of this study was to investigate the comparison of chemical characteristics and selected nutritional compositions from Saanen goat milk and Holstein-Friesian cow milk as raw materials with different kefir concentration and incubation times at room temperature (25°C).

2. Materials and Methods

2.1.1 Sample Preparation

The raw milk and inoculated milk samples with kefir grains were submitted to chemical analysis; pH, acidity (%), lactose (%), and protein (%) to determine the milk quality at different kefir concentrations (%) and incubation time (hour).

Raw Saanen breed goat milk and Holstein-Friesian breed cow milk were purchased from the farm located in Kundasang, Sabah. Indonesian kefir grains were originally purchased by a farm located in Sandakan, Sabah. Goat and cow milk kefir was prepared by pasteurizing 200ml of the sample at 80°C for 30 minutes and was cooled down to 25°C referred to Kök-Tas *et al.* (2018) with slight modification. Cooled milk was inoculated with 3% (w/v) and 5% (w/v) kefir grains incubated at 25°C for 12 hours and 24 hours to produce cow and goat kefir. At the end of the incubation, kefir grains were sieved and collected into high-density polyethylene bottles. All samples are stored in the chiller at 5°C until further analysis.

2.1.2 Chemical Analysis

The pH was measured at 25°C using a calibrated pH meter (Eutech Cyberscan pH 2700, Singapore) by directly submerging the probe into 50ml of homogenized kefir sample. The titratable acidity of kefir samples was determined using the titration method with 0.1N NaOH (AOAC, 2000). Lactose content was determined using Munson-Walker general method titration 906.03 (AOAC, 2000). The protein content of samples was measured using the Kjeldhal method 988.04 with a factor of 6.38 (AOAC, 2000).

2.2 Statistical analysis

All numerical data are means of triplicates ± standard error (SE). Data were analyzed using one-way ANOVA and Tukey-b's significant difference ($p<0.05$) for all chemical characteristics among kefir samples. T-test was used to determine chemical composition differences ($p<0.05$) between cow and goat milk kefir.

3. Results and Discussion

Results showed that pH content in goat and cow milk kefir decreased as the percent of kefir started to propagate after 12 hours. Motaghi *et al.* (1997), reported that goat milk kefir made by addition of 5% Iranian kefir grains with incubation times of 12 hours is 4.0, while this study reported the pH was higher at 4.70. Meanwhile, Purnomo & Muslimin (2012) reported pH of 4.92 and 4.86 at 18 hours incubation time.

Table 1 shows that pH values were lower with shorter incubation time. Magalhaes *et al. (*2011) reported that after 24 hours of the fermentation process, the pH was 4.42, which was close to the current result at pH 4.34. Magalhaes *et al.* (2011) discussed that the pH decrease was due to the increase of certain organic acids, ethanol, and other volatile compounds by the microbial population in grains and kefir.

A pH value less than 4.6 was a typical isoelectric point for goat milk kefir as mentioned by Lee & Lucey (2004). After incubation time, the pH and acidity values in this study were shown to be different from the controls, theoretically due to the occurrence of coagulation of denatured whey protein and casein followed by lactic acid production (Lee & Lucey, 2004). The lower the pH, the lower acidity % observed in both kefirs as agreed by Rukmi *et al*. (2023).

Table 1 Value of pH, acidity, lactose, and protein in goat and cow milk kefir from different kefir concentrations and incubation time.

Kefir concentration (w/v) %	Incubation time (hour)	Cow milk				Goat milk			
		pH	Acidity (%)	Lactose (%)	Protein (%)	pH (%)	Acidity (%)	Lactose (%)	Protein (%)
0 (Control)	0	6.53± 0.03	0.58± 0.02	5.23± 0.22	3.10± 0.04	6.42± 0.05	0.72± 0.01	4.89± 0.05	3.03± 0.04
3	0	5.51± 0.02^{a}	0.60± 0.02^{d}	4.63± 0.13^{a}	3.19± 0.03^{c}	5.48± 0.04^{a}	0.81± 0.01^{d}	4.67± 0.07^{a}	3.14± 0.05^{bc}
5		5.40± 0.03^{b}	0.66± 0.04^{c}	4.43± 0.05^{ab}	3.16± 0.02^{c}	5.52± 0.05^{a}	0.90± 0.04^{c}	4.54± 0.02^{ab}	3.01± 0.07^{c}
3	12	4.65± 0.09^{c}	0.69± 0.03^{c}	4.51± 0.07^{ab}	3.33± 0.06^{ab}	4.48± 0.07^{c}	0.91± 0.01^{c}	4.58± 0.05^{a}	3.26± 0.06^{b}
5		4.23± 0.06^{d}	0.74± 0.01^{ab}	4.40± 0.01^{ab}	3.38± 0.05^{ab}	4.70± 0.09^{ab}	1.02± 0.05^{b}	4.51± 0.05^{b}	3.29± 0.02^{b}
3	24	4.22± 0.10^{d}	0.83± 0.12^{a}	4.51± 0.10^{ab}	3.41± 0.08^{ab}	4.34± 0.04^{d}	1.21± 0.05^{a}	4.55± 0.07^{ab}	3.30± 0.06^{b}
5		4.06± 0.06^{e}	0.85± 0.15^{a}	4.27± 0.06^{bc}	3.43± 0.19^{a}	4.10± 0.03^{e}	1.21± 0.08^{a}	4.28± 0.02^{c}	3.40± 0.10^{a}

Means (triplicates ± SE) with different superscripts in the same column showed significant differences ($p < 0.05$).

From Table 1, the value of acidity (% lactic acid) increased as the percentage of kefir increased in both milk and longer incubation time. The highest acidity number of samples was found in goat milk kefir which used 5% of kefir grains within 24 hours of being fermented. According to Park (2010), the minimum acidity number expressed as lactic acid content in goat milk kefir was 0.6-0.8 %, whereas this study ranged from 0.60-0.85 % and 0.81-1.21 % for cow milk kefir and goat milk kefir respectively. Motaghi *et al.* (1997) found that the acidity number of their sample was in the range of 1.18-2.45 %, showing that this study had lower acidity while fulfilling minimal requirements for kefir titratable acidity. Compared to Purnomo and Muslimin (2012), the addition of kefir grains reached minimal acidity only after 21 hours of incubation time. As in Table 1, the lactose content of cow and goat milk kefir decreased with a higher amount of kefir grains added as well as longer incubation time as compared to the pasteurized cow and goat milk. Pasteurized goat milk (4.89%) is lower than cow milk (5.23%) was caused by smaller fat globules, contains more short and medium-chain fatty acids and more friable proteins when acidified, and has better digestibility than cow milk (Park *et al.,* 2007). The reduction of lactose content agreed with previous research from Gracia-Fontan *et al.,* (2006) and Purnomo and Muslimin (2012).

However, after 12 and 24 hours of incubation, both cow milk and goat milk kefir slightly had the same amount of lactose after kefir addition. According to Ismaiel *et al.* (2011), lactose is the most effective nutrient for the growth of kefir grains microorganisms compared to other sugar complex polysaccharides. The differences in results are based on the goat and cow milk quality used, kefir grains microorganisms' composition, temperature, and incubation time.

According to Setyawardani and Sumarmono (2015), the acceptable amount of kefir protein should be more than 2.8% The amount of protein from cow (3.10%) and goat milk (3.03%) was comparable with Wszolek *et al.* (2001) with the range of 3.17-3.39 % and 28.5-29.1 % for cow milk and goat milk respectively. Upon fermentation, the protein amount decreased as also reported by Chen *et al.* (2005). Therefore, the suggested lower protein content in kefir might be due to the release of enzymatic lipase, protease, and lactase from microflora in the kefir grains.

In the comparison of chemical compositions for the lowest pH and lactose, as well as the highest acidity and protein in this study (Table 1), it was shown that there was no significant difference ($p>0.05$) between cow milk and goat milk. The incubation time for 12 hours and 24 hours had significantly affected the pH of both milk kefir. Nevertheless, the lactose content in cow milk kefir only had slight differences among time incubation as compared to goat milk kefir. This occurrence could have resulted from the limitation of lactic acid bacteria and acetic acid production from high yeast content (Collar, 1996).

Table 2 p-values of chemical compositions in goat and cow milk kefir from 5 w/v % kefir concentration and 24 hours incubation time.

Chemical composition	Cow milk kefir	Goat milk kefir	p-value
pH	5.06 ± 0.06	5.10 ± 0.03	p>0.05
Acidity (%)	0.85 ± 0.15	1.21 ± 0.08	p>0.05
Lactose (%)	4.27 ± 0.06	4.28 ± 0.07	p>0.05
Protein (%)	3.43 ± 0.19	3.40 ± 0.10	p>0.05

Hidayat *et al.* (2015) suggested to apply 5% w/v kefir while Rukmi *et al.* (2023) agreed 24 hours should provide sufficient time to produce acceptable kefirs using Indonesian grains. Therefore, from Table 2, the chemical difference between kefir samples during incubation did not show any significant difference ($p>0.05$) although there are differences observed regarding different amounts of kefir and incubation time in kefir production (Table 1).

4. Conclusion

The addition of grain kefir in goat and cow with 5% (w/v) grains with 24 hours incubation time produce the lowest pH and lactose content, as well as the highest acidity and protein content of milk kefir. However, there was no significant difference ($p>0.05$) in pH, acidity, lactose, and protein between cow milk kefir and goat milk kefir prepared in this study. Therefore, 5% (w/v) kefir grains with 24 hours incubation time is suggested to be used for both cow milk and goat milk kefir.

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