International Food Research Journal 19(2): 647-650 (2012)

Rheological characteristics and nutritional aspects of novel peanut-based kefir beverages and whole milk kefir

Bensmira, M. and *Jiang, B.

State Key Laboratory of Food Science and Technology, Jiangnan University, 1800 Lihu Avenue, 214122 Wuxi, Jiangsu, China

Abstract: In the current study, peanut-milk was used as the main raw material for kefir preparation. Rheological characteristic, textural properties, mineral elements and amino acid composition of kefir made from peanut-milk (PMK), 7/3 peanut/skimmed-milk (70% PMK) have been investigated using whole-milk kefir (WMK) as a control. Results showed that, PMK sample had the highest ($p < 0.05\%$) complex modulus (G^*), firmness and the lowest ($p < 0.05\%$) adhesiveness. However, both 70% PMK and WMK had high minerals and essential amino acids content.

Keywords: Peanut-milk kefir, whole-milk kefir; rheological characteristics, mineral composition, amino acids profile

Introduction

Kefir is a fermented milk beverage originated in Eastern Europe and is now enjoyed worldwide (Wouters *et al*., 2002). It history dates back to around 8000 B. C. to middle Ages. The Ossetians and Karbadinians are specifically mentioned as the first kefir manufacturers (Kurmann *et al*., 1992). Kefir distinguishes itself from the well known FM products, yoghurt, in that during its production the milk undergoes a dual fermentation process under the action of both lactic acid bacteria and yeast. While yoghurt can readily be made from the lactic acid bacteria present in fresh yoghurt, kefir can be produced by fermenting milk with commercial freeze-dried kefir starter cultures or kefir grains as well as the product obtained after the removal of grains. It can be made of any type of milk: cow, goat, sheep, coconut, rice and soy, but cow milk is commonly used. Traditionally, kefir is homemade but the former product has been commercialized in many countries (Farnworth, 2005). It has been reported (Tamime and Robinson, 1999; Bonczar *et al*., 2002), that the overall properties of fermented milk are influenced by the chemical composition of milk base.

Several researchers have been investigating animal-milk kefir, though works on peanut-milk kefir quality are quite inexistent. The aim of the present study was to evaluate rheological and textural properties, minerals and essential amino acids content of novel kefir products, one prepared from peanut-milk only; the other from (7/3) peanut/skimmed-milk and compare them to those of kefir made from whole-milk.

Materials and Methods

Materials

Freeze-dried kefir starter culture (BE010) was purchased from Wilderness Family Naturals (USA). Whole and skimmed-milk powder (Guangming, China) and the Spanish red-skinned peanut seeds were purchased from a local supermarket in Wuxi, China. Care was taken to ensure that good quality and mould-free seeds were selected.

Preparation of kefir working-culture

The resuscitation of freeze-dried starter culture and the preparation of working-culture were carried out as described by Bensmira *et al*. (2010).

Milks preparation

Peanut-milk was prepared using a method reported by Isanga and Zhang (2009); Bensmira and Jiang (2011). Briefly, sorted peanut seeds were roasted (130°C for 20 min), de-skinned, and weighed before being soaked in 0.5 g/100 ml $NaHCO_3$ for at least 12 h. After washing with water, the kernels were then mixed with water at a ratio of 1:5 [peanuts (g): water (ml)] and transferred to a blender, wherein they were blended for at least 5 min. Finally, the resultant slurry that formed was filtered using a three-layered cheese cloth in order to yield peanut-milk. Whole-milk powder was reconstituted at 43°C with moderate mixing at approximately 13 g/100 g total solid concentration and maintained at 43°C for at least 30 min to allow complete hydration of the powder before usage.

Kefir production

Peanut-milk was divided in to two batches: the

---

*Corresponding author.
Email: *bjiang@jiangnan.edu.cn*, *bensmiram@hotmail.com*
Tel: +86 510 85329055; Fax: +86 510 85919625

first one contained peanut-milk only and the second batch was a mixture of 70% peanut-milk with 30% reconstituted skimmed-milk powder at 12%. The mixed sample was then stirred and warmed at 43°C for 30 min. A total of 3% (w/v) of sucrose was added to the two batches as a sweetener. Whole-milk, peanut-milk, and 70% peanut-milk were each homogenised at 25 MPa [Homogeniser, (JHG-Q954)-P (60), Shanghai, China] and then pasteurised at 92°C for 15 min (Beshkova *et al*., 2002) using a water bath, cooled down to approximately 25°C, inoculated with the working culture at 3% (v/v) , and finally fermented at 28°C for 18 h.

Rheological analysis

Dynamic oscillatory measurements were performed with a Physica MCR 301 rheometer (Anton Paar, Tru Gop Ready, Österreich) as described by Bensmira *et al*. (2010). The complex modulus (G^*) was selected as a parameter for characterising the rheological property of the kefir samples.

Texture profile analysis

Texture profile analysis (TPA) was conducted using the Universal TA-XT2 Texture Analyser (Stable Micro Systems, Ltd., U.K.). The operating conditions were selected according to Wszolek *et al.* (2001). This texture analyser was connected to a computer, which measured the peak load (representing firmness) and adhesiveness of each sample. Textural measurements were evaluated for duplicate samples immediately after maturation at 4°C for 24 h.

Mineral elements

Ca, Mg, K, Na, Cu, Mn, Zn and Fe were determined by atomic absorption spectrophotometry (Spectr. AA 220, Varian-USA) using a parkin-Elmer.

Amino acid composition

Amino acids determination was carried out by adding 3 ml of 6 N HCl to accurately weighed kefir samples in a glass ampoule for hydrolysis at 110°C for 24 h. After cooling, the hydrolysed samples were diluted and filtered then 1 ml of each filtrate was evaporated. Then, 5 ml of 0.02 N HCl were used to dissolve the amino acids. To detect and quantify the amino acids, 2 ml of the resulting solution were injected into the Hitachi 835-50 Amino Acid Analyzer equipped with a 2.6 x 150 mm ion exchange column.

Statistical analysis

Analysis of variance (ANOVA) was carried out using SAS software (The SAS System for Windows, Version 8.1). The Duncan Multiple Range Test (DMRT) was used to determine the differences between data means at 5% significance level.

Results and Discussion

Dynamic rheology of kefir

Figure 1 shows the variation of complex modulus (G^*) for the kefir samples as function of frequency and milk kind. As can be seen, G^* values of peanut-milk (PMK) were significantly higher ($p < 0.05\%$) than those of 70% peanut-milk (70% PMK) and whole-milk (WMK). These results may be attributed to the high protein and fat contents in PMK (unpublished data). It has been reported (Peng *et al*., 2009) that yogurt containing 3.5% fat had higher rigidity modulus than those having 0% and 1.5% fat content. In addition, Ozer *et al*. (1999) assumed that the physical behavior of labneh (Concentrated Yogurt) was heavily dependent on the protein concentration. However, the statistical analysis did not reveal a significant difference ($p > 0.05$) between 70% PMK and WMK.

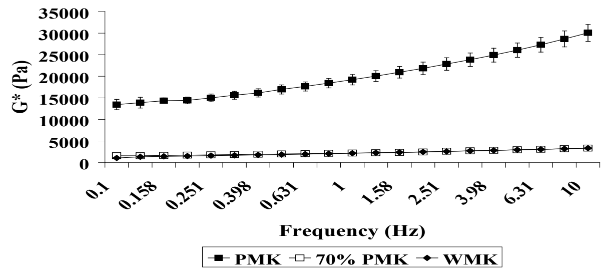

Figure 1. Mechanical spectra showing the frequency-dependence of complex modulus (G^*) for kefir prepared from: peanut-milk kefir (PMK): (■); 70% peanut-milk kefir (70% PMK): (□); and whole-milk kefir (WMK): (♦)

Textural characteristics of kefir

Figure 2 illustrates the effect of milk type on the textural properties (firmness and adhesiveness) of kefir samples. It is interesting to notice that, PMK sample had the highest firmness and the lowest adhesiveness ($p < 0.05\%$) than 70% PMK and WMK. This finding may derive from the high protein contents in kefir samples prepared with high concentrations of peanut milk. According to Tamime *et al*. (1999) and Sodini *et al*. (2004), milk protein content is important to the physical properties and perceived textures of fermented products.

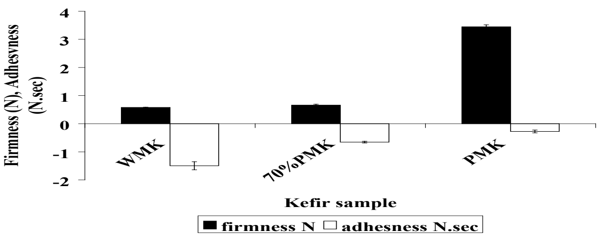

Figure 2. Firmness (■), and adhesiveness (□) of kefir prepared from: peanut-milk kefir (PMK); 70% peanut-milk kefir (70% PMK); and whole-milk kefir (WMK)

Mineral elements

As can be seen in Table 1, both PMK and 70% PMK have higher contents of Fe, Mn, and Mg than WMK. However, WMK had much higher contents of Zn, Na, K and Ca compared to other Kefirs (Table 2). These results, to some extent are similar to those reported by Isanga and Zhang (2009) for yoghurts prepared from cow and peanut-milk. Sunny-Roberts *et al*., (2004), reported that calcium supplied by fermented milk may be better absorbed and utilized than calcium made available in other forms.

Table 1. Mineral elements present in peanut-milk kefir (PMK), 70% peanut-milk kefir (70% PMK) and whole-milk kefir (WMK)

Mineral elements	Amounts (µg/g)		
	PMK	70 % PMK	WMK
Zn	3.15	3.07	5.86
Fe	3.09	3.07	1.60
Mn	1.94	1.60	0.21
Cu	0.48	0.61	0.78
Na	206	281	586
K	712	1063	1529
Mg	225	187	97.7
Ca	281	630	1018

Amino acid composition

Kefir samples contain different amounts of amino acids (Table 2). PMK and 70% PMK were richer in some amino acids such as Aspartate, Glutamate, Serine, Glycine, Arginine, and Phenylalanine than WMK. Additionally, the 70% PMK and WMK seem to have similar quantity of some amino acids like Threonine, Isoleucine and Leucine. In general, 70% PMK and WMK are composed of good protein quality due to their rich composition of essential amino acids. According to Rodwell and Kennelly (2003), amino acids must be available simultaneously in the correct proportion for protein synthesis to take place efficiently.

Table 2. Amino acid composition of peanut-milk kefir (PMK), 70% peanut-milk kefir (70% PMK) and whole-milk kefir (WMK)

Amino acids	Amounts (g/100g)		
	PMK	70 % PMK	WMK
Aspartate (Asp)	4.78	4.25	2.51
Glutamate (Glu)	8.54	8.72	7.35
Serine (Ser)	2.22	2.21	1.92
Histidine (His)*	0.96	1.05	0.95
Glycine (Gly)	1.73	1.41	0.59
Threonine (Thr)*	1.04	1.17	1.37
Arginine (Arg)*	4.72	3.68	1.00
Alanine (Ala)	1.52	1.43	1.06
Tyrosine (Tyr)	1.59	1.60	1.50
Cystein (Cys)	0.37	0.28	0.13
Valine (Val)*	1.84	1.99	2.06
Methionine (Met)*	0.38	0.49	0.70
Phenylalanine (Phe)*	2.24	2.06	1.48
Isoleucine (iIe)*	1.38	1.49	1.56
Leucine (Leu)*	3.05	3.28	3.38
Lysine (Lys)*	1.52	2.03	2.84
Proline (Pro)	2.37	2.67	3.42

*Essential amino acid.

Conclusion

In conclusion, rheological and textural properties of 70% PMK were not significantly different from those of WMK which was regarded as control. The mineral composition was high in both 70% PMK and WMK with K, Na, and Ca compared to PMK. In general, amino acid composition of PMK was lower than that of both 70% PMK and WMK.

References

Bensmira, M., Nsabimana, C. and Jiang, B. 2010. Effects of fermentation conditions and homogenization pressure on the rheological properties of Kefir. LWT - Food Science and Technology 43(8): 1180-1184.

Bensmira, M. and Jiang, B. 2011. Effect of some operating variables on the microstructure and physical properties of a novel Kefir formulation. Journal of Food Engineering (article in press).

Beshkova, D. M., Simova, E. D., Simov, Z. I., Frengova, G. I. and Spasov, Z. N. 2002. Pure cultures for making kefir. Food Microbiology 19(5): 537-544.

Bonczar, G., Wszolek, M. and Siuta, A. 2002. The effects of certain factors on the properties of yoghurt made from ewe's milk. Food Chemistry 79(1): 85-91.

Farnworth, E. R. 2005. Kefir: A complex probiotic. The Food Science and Technology Bulletin 2(1): 1-17.

Isanga, J. and Zhang, G. 2009. Production and evaluation of some physicochemical parameters of peanut milk yoghurt. LWT - Food Science and Technology 42(6): 1132-1138.

Kurmann, J. A., Rasic, J. L. and Kroger, M. 1992. Encyclopaedia of fermented fresh milk products: An international inventory of fermented milk, cream, buttermilk, whey and related products. New York: Van Nostrand Reinhold.

Ozer, B. H., Stenning, R. A., Grandison, A. S. and Robinson, R. K. 1999. Rheology and microstructure of Labneh (Concentrated Yogurt). Journal of Dairy Science 82(4): 682-689.

Peng, Y., Serra, M., Horne, D. S. and Lucey, J. A. 2009. Effect of fortification with various types of milk proteins on the rheological properties and permeability of nonfat set yogurt. Journal of food science 74(9): 666-673.

Rodwell, V. W. and Kennelly, P. J. 2003. Amino acids and peptides. In Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (Eds). Harper's illustrated biochemistry, p. 14-20. New York: McGraw-Hill Companies, Inc.

Sodini, I., Remeuf, F., Haddad, S. and Corrieu, G. 2004. The relative effect of milk base, starter, and process on yogurt texture: A review. Critical Reviews in Food Science and Nutrition 44(2): 113-137.

Sunny-Roberts, E. O., Otunola, E. T.and Iwakun, B. T. 2004. An evaluation of some quality parameters of laboratory-prepared fermented groundnut milk. European Food Research and Technology 218(5):

452-455.

Tamime, A. Y., Muir, D. D., Shenana, M. E., Kalab, M. and Dawood, A. H. 1999. Processed cheese analogues incorporating fat-substitutes 2. Rheology, sensory perception of texture and microstructure. LWT - Food Science and Technology 32(1): 50-59.

Tamime, A. Y. and Robinson, R. K. 1999. Yoghurt science and technology. 2nd edn. New York: CRC Press.

Wouters, J. T. M., Ayad, E. H. E., Hugenholtz, J. and Smit, G. 2002. Microbes from raw milk for fermented dairy products. International Dairy Journal 12(2-3): 91-109.

Wszolek, M., Tamime, A. Y., Muir, D. D. and Barclay, M. N. I. 2001. Properties of Kefir made in Scotland and Poland using bovine, caprine and ovine milk with different starter cultures. LWT - Food Science and Technology 34(4), 251-261.