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Effect of incubation temperature and caseinates on the rheological behaviour of Kefir

Georgia Dimitreli[a]*, Kleio D. Antoniou[b]

[a,b]*Department of Food Technology, ATEI of Thessaloniki, P.O. Box 14561, GR 54101, Thessaloniki, Greece*

Abstract

The effect of incubation temperature and the addition of caseinates on the rheological behaviour of kefir was studied by using a pneumatic tube viscometer of novel design. The results indicated that the incubation time increased as the incubation temperature was reduced and the casein concentration was increased. Kefir samples incubated at 25°C showed the highest values of viscosity, while the samples incubated at 30°C exhibited the lowest viscosity. The addition of caseinates caused the viscosity of the samples to increase and their flow behaviour index values to decrease. Kefir samples incubated at 30°C exhibited the highest flow behaviour index values.

Keywords: kefir; apparent viscosity; flow behaviour index

1. Introduction

Kefir is a fermented dairy product, slightly carbonated that contains small quantities of alcohol. The starter culture used for its production is a mass of lactic acid bacteria, acetic acid bacteria and yeasts held together by a matrix of proteins and polysaccharides named kefir grains [1]. Kefir grains are gelatinous and irregular in shape, having a white or lightly yellow color [2]. The microorganisms into the grains exist in a relatively stable and specific balance in a complex symbiotic relationship. During fermentation these microorganisms are multiplying by producing lactic acid and other compounds that contribute to flavour and body (polysaccharides) of kefir [3]. The main polysaccharide found in kefir and kefir grains is kefiran, an extra-cellular-polysaccharide that plays a significant role in regulating rheological properties [4].

Rheological properties of kefir are of major importance, since they affect the quality of the final product as well as its acceptance by the consumers. The major factors affecting rheological properties of

* Corresponding author. Tel.: +30-2310-013886; fax: +30-2310-791375.
E-mail address: dimitrel@food.teithe.gr.

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kefir are the chemical composition of the milk used for its production, the starter culture, the incubation temperature, the thermal processing of milk, etc [5]. Despite the importance of studying rheological properties of kefir, only a few reports are found in the literature regarding them [3; 6]. So far, most of the research done on kefir concerned its microbiology [7]. The objective of the present work is to evaluate the effect of incubation temperature and the addition of caseinates on the time needed for the pH to reach the 4.4 value and the rheological behaviour of kefir.

2. Materials & Methods

Manufacture of kefir samples: Kefir samples were prepared from homogenized and pasteurized full fat (3.5%) bovine milk with and without the addition of caseinates at varying concentrations (1%, 2% or 3%). Following thermal processing (85°C for 900 s) the milk was inoculated with kefir grains obtained from a household culture at a ratio of 3% (w/w) and incubated at 20°C, 25°C or 30°C until the pH dropped to 4.4. Caseinates were added to the milk before its thermal processing.

Rheological measurements: The apparent viscosity of the samples was determined using a capillary tube viscometer (TR-1 Rheometer, A.T.E.I., Thessaloniki, Greece). The instrument consists of a stainless steel cylindrical sample vessel (0.086 m height; 0.049 m internal diameter; maximum capacity of 0.05 L), an air chamber to which compressed air is supplied through an inlet valve and a pin shape stirrer consisting of four rods placed in a row. Four extra rods are attached to the bottom of the sample vessel in positions that they do not restrict the movement of the rods of the stirrer. Temperature control is achieved by means of a platinum resistance thermometer-proportional and an integral temperature controller [8]. A capillary tube with an inner diameter of 6.53×10^{-4} m and a length of 0.045 m was used for the rheological measurements. Kefir samples were introduced inside the sample vessel of the viscometer, under continuous stirring (0.83 rps), while the temperature was set to 20°C. To obtain the flow curves of the samples, the flow rate of the discharged fluid at the exit of the tube at varying pressures was determined.

Statistical analysis: Two-way ANOVA was applied to the experimental data, while the Tukey multiple comparison test determined whether statistically significant differences occurred among means. The statistical analysis of the experimental data was performed using Minitab 15.0 statistical software.

3. Results & Discussion

Table 1 shows the pH values of the samples as well as the time needed for the pH to reach 4.4. According to Anova, there is no significant difference to the pH values among the samples.

The time needed for the pH to reach the 4.4 value is significantly affected by both incubation temperature ($p<0.001$) and addition of caseinates ($p<0.001$).

Table 1. The pH values and the time needed for the pH to reach 4.4 of kefir samples

Incubation temperature (°C)	*Caseinates concentration (% w/w)*	*pH*	*Time ($s\times10^3$)*
20	0	4.42	73.50
	1	4.41	74.28
	2	4.42	82.20
	3	4.42	92.28
25	0	4.40	61.92
	1	4.41	65.34
	2	4.41	72.30
	3	4.42	72.84