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SENSORY AND PHYSICO-CHEMICAL PROPERTIES OF COMMERCIALLY AVAILABLE KEFIR **

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Abstract: The purpose of this work was to evaluate the quality of commercial kefir, obtained from the local market. Kefirs produced by eight manufacturers were analysed. Four of them were classified as factory with large scale of production and signed: D1, D2, D3, and D4. Three kefirs marked: M1, M2, M3 originated from the local dairy cooperatives. One evaluated product signed T1 was sold as cheap brand in hypermarket. Kefirs were evaluated for the sensory properties, chemical composition (fat, protein, total solids, solid non fat – snf), flow curve and area of hysteresis loop between upward and downward curve of stirred kefir. Flow curves were described by two rheological models: Ostwad de Waele, and Casson, the apparent viscosity was calculated as well. Most of the analysed kefirs were characterised by satisfactory sensory quality, but only the product D2 got the maximal note close to maximal 5.0. Unexpectively kefir D1 obtained from well known brand manufacturer was determined as the lowest sensory quality product. Fat content in evaluated kefirs showed that in three dairies the standardisation of fat was done imprecisely. The highest discrepancy between the fat level declared by producer and determined was stated in kefir T1. As a result of protein and snf levels analysis, it was concluded that manufacturers D2, D3 and M2 have done standardisation of those components, fortifying milk to 3.93-4.72% of protein and 9.72-11.7% snf. Kefirs D1 and D3 were characterised by the highest value of shear stress in the whole range of shear rate as well as other rheological parameters: consistency coefficient K, yield stress, Cassons viscosity, and apparent viscosity.

Key words: commercial kefir, quality, sensory properties, rheology,

Introduction and literature review

Kefir is fermented milk which originates from the Caucasus, where it has been manufactured for thousands of years. Traditionally kefir was produced from sheep milk by fermentative activity of kefir grains called also kefir fungi. Kefir grains are the products of lactic acid bacteria and yeast, and consist of the genera *Lactococcus*, *Lactobacillus*, *Kuyveromyces fragilis* and *Candida kefir*. Eventually kefir has a double fermentation, acid and alcoholic that causes the drink's particular taste (*Irigoyen et al*. 2003). In 20th century the production of kefir on a commercial scale was spread through Soviet Union to Eastern Europe countries such Poland, Czechoslovakia, Hungary and Scandinavian country (*Libudzisz & Piatkiewicz* 1990). Because of its exceptional healthy properties, the consumption of kefir grows in other European countries as well. The therapeutic value of kefir results from antimicrobial properties of lactic and acetic acids produced during fermentation process. Kefir yeast is capable of synthesis of the B group vitamins. Kefir consists of metabolites preventing the accumulation of cholesterol, promoting better assimilation of protein and calcium and regulating overall metabolism (*Wójtowski et al*. 2003, *Simova et al*. 2002).

There is a lot of consumer information concerning a low quality of commercial kefir. The main reason of this fact is that industry does not use a traditional technology with kefir grain like starter culture. Instead of kefir grains, a freeze-dried or frozen starter with different microorganism's composition is used. The result is that final product changes sensory properties such as: taste, flavour or consistency and decreased its therapeutic properties as well. The purpose of this work was to evaluate the quality of commercial kefir, obtained from the local market.

Materials and methods

Kefirs produced by eight manufacturers were analysed. Four of them were classified as factory with large scale of production and signed: D1, D2, D3, and D4. Three kefirs marked: M1, M2, M3 originated from the local dairy cooperatives. One evaluated product signed T1 was sold as cheap brand in hypermarket. All kefirs were bought on the local market, a long time before the expiration date. Cooled products were directly transported to a laboratory and analysed. The sensory assessment of kefir was carried out on a 5-point scale. The analysed attributes were: overall appearance, aroma, flavour, consistency. Each of these attributes was multiplied by the proper index of importance. This assessment was done by 5 trained panellists, whose sensory sensivity had been checked.

The chemical composition of kefir was done. Fat content was determined by the Gerber method (*PN-A-86130*, 1975). The protein content was determined by the Kjeldahl method (*PN-A-86130*, 1975) using a Buchi digestion system and distillation unit Buchi 322 (Switzerland). A multiplication factor of 6.38 was used to convert per cent nitrogen to per cent protein. The total solids (TS) were determined using an air oven by drying samples at 105 for 3.5 h. The solids non fat (SNF) was calculated as a difference between total solids and fat (*PN-A-86130*, 1975).

The rheological characteristic of kefir were assessed using rotary viscometer Rheotest RV2 (Germany) with controlled shear rate in coaxial cylinder system s/s_2 in the measuring range Ia. The analysis included the calculating of flow curves for shear rate from 1 to 437.4 s^{-1} and from 437.4 to 1 s^{-1}. At the shear rate $\gamma=9\ s^{-1}$ at rising curve, apparent viscosity of kefirs was calculated. Flow curves were described by Ostwad de Waele and Casson models, which include such parameters as consistency coefficient K, flow behaviour index n, yield stress τ_o, and Casson's viscosity η_c. The hysteresis loop areas were calculated. That analysis was done using programme US 200 (Physics Messtechnik GmbH, Germany).

Each physicochemical measurement was made in duplicate. The experiment was carried out in three replicates.

Results and discussion

The chemical composition and sensory properties of commercial kefir are shown in table 1. Most of the analysed kefirs were characterised by satisfactory sensory quality, but only the product D2 got the note close to maximal 5.0. Three of eight assessed kefirs (D1, M1, and T1) gained score below 3.5. Unexpectively kefir D1 obtained from well known brand manufacturer was determined as the lowest sensory quality product. The sensory properties of kefir distinguish these products from other fermented milks. The unique flavour and aroma of traditional kefir result from the metabolic activity of the original natural starter-kefir grains. The self-carbonated and distinctive flavour of kefir origin from the products of ongoing lactic acid and alcoholic fermentation such as lactic acid, CO_2, ethanol, diacetyl and other carbonyl flavour-forming compounds (*Beshkova et al*. 2003, *Yuksekdag et al*. 2004).

The percentage chemical composition of kefir depends on many factors such as kind of milk, type of grains and technological conditions. Analysed kefirs contain 1.11-2.55% of fat. The fat content in commercial fermented milks depend on type of products and is affected by standardisation process and ranged between 0 - 10%. Traditional kefir was manufactured from non-standardised milk and contains 3-4% of fat. The industrially manufactured kefirs in Poland contain usually 1.5-3.1% of fat (*Libudzisz & Piatkiewicz* 1990). Fat content in evaluated kefirs showed that in three dairies the standardisation of fat was done imprecisely. The highest discrepancy between the fat level declared by producer and determined was stated in kefir T1.

Table 1 Chemical composition and sensory assessment of commercial kefir

Type of kefir	Fat [%]	Protein [%]	Total solids [%]	Solids non-fat [%]	Sensory assessment [points]
D1	2.55 ±0.30	3.35 ±0.16	11.02 ±1.29	8.47 ±0.91	3.15 ±0.13
D2	1.44 ±0.18	4.68 ±0.20	11.16 ±1.08	9.72 ±0.93	4.96 ±0.07
D3	1.99 ±0.38	4.72 ±0.14	13.69 ±1.16	11.7 ±1.05	4.15 ±0.10
D4	1.11 ±0.20	3.30 ±0.25	9.69 ±0.99	8.58 ±0.85	4.60 ±0.08
M1	1.11 ±0.16	3.11 ±0.18	9.35 ±1.10	8.24 ±1.00	3.25 ±0.16
M2	1.88 ±0.25	3.93 ±0.19	10.29 ±1.20	8.41 ±0.96	4.25 ±0.09
M3	1.99 ±0.15	3.22 ±0.21	9.982 ±0.92	7.83 ±0.77	4.60 ±0.11
T1	1.44 ±0.31	3.10 ±0.26	10.51 ±1.05	9.07 ±0.97	3.25 ±0.21

As a result of protein, total solids and snf levels analysis it was concluded that manufacturers D2, D3 and M2 have done standardisation of those components, fortifying milk to 3.93-4.72% of protein and 9.72-11.7% snf. Obtained results revealed that most of dairies do not standardise protein, total solids or solids-non-fat in milk used for kefir production. In this case level of that parameter depends on quality of row milk. Milk fortification in protein or solids-non fat enhances the consistency, flavour and aroma of final product (*Ziajka* 2000).

Figure 1 shows flow curves of evaluated kefirs. The rheological parameters of the model applied for the description of flow curves are presented in table 2. Excepting kefir D1 all curves have shape of hysteresis

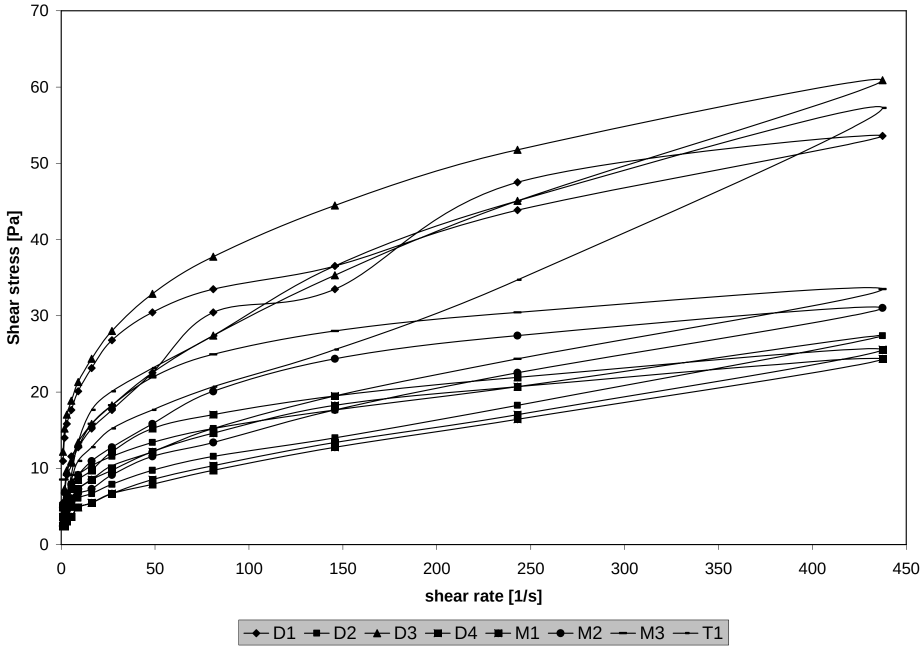

Figure 1. Flow curves of commercial kefir

loop. Kefirs D1, D3 and T1 were characterised by the highest value of shear stress in the whole range of shear rate as well as other rheological parameters: consistency coefficient K, yield stress, Cassons viscosity, and apparent viscosity. The highest value of hysteresis loop area was obtained for kefir T1 and D3. The hysteresis loop area can be interpreted as a measure of kefir structure breakdown during shear, and the slope of the flow curve indicates the resistance of kefir gel on the action of shear forces (*Rhom* 1992, *Jaros et al.* 2002). Although the highest value of rheological parameter, products D1, D3 and T1 got rather low score for consistency during sensory evaluation, which means that traditionally consumers use kefir as a drink with refreshing character and in this case it should not reveal to high viscosity.

Table 2. Rheological parameters of commercial kefir

Type of kefir	Ostwald de Waele model			Casson model			Hysteresis loop area [W/m^3]	Apparent viscosity [Pa·s]
	K [Pa·s^n]	η	R^2	τ_0 [Pa]	η_c [Pa·s]	R^2		
D1	11.71	0.24	0.9958	13.11	0.0424	0.9481	373.5	2.23
D2	3.29	0.35	0.9809	3.34	0.0399	0.8704	1044.7	1.01
D3	12.39	0.26	0.9983	1.87	0.0536	0.9539	2823.9	2.38
D4	4.40	0.30	0.9951	4.91	0.0289	0.9050	1875.6	0.95
M1	3.40	0.33	0.9980	3.72	0.0318	0.9206	1519.9	0.81
M2	4.41	0.33	0.9955	4.87	0.0415	0.9087	1809.7	1.01
M3	7.52	0.26	0.9908	8.51	0.0309	0.8943	2566.6	1.42
T1	4.80	0.41	0.9968	4.84	0.0971	0.9190	3009.2	1.48

Conclusion

Most of the analysed kefirs were characterised by satisfactory sensory quality, but only one product got score close to maximal. Fat content in evaluated kefirs showed that in three dairies the standardisation of fat was done imprecisely. Obtained results revealed that most of dairies do not standardise protein, total solids or solids-non-fat in milk used for kefir production. Rheological and sensory analysis showed that consumers prefer kefir with not to high viscosity what means that they use it's as a drink with refreshing character.

SENZORNE I FIZIČKO-HEMIJSKE OSOBINE KEFIRA NA TRŽIŠTU

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Rezime

Postoji mnogo informacija za potrošače koje potvrđuju slab kvalitet kefira koji se može nabaviti na tržištu. Glavni razlog je činjenica da se u industriji ne koristi tradicionalna tehnologija proizvodnje kefira pomoću starter kulture kefir grain like starter culture. Umesto toga koriste se hladno sušene ili zamrznute starter kulture sa različitim sastavom mikroorganizama. Kao rezultat dobijemo finalni proizvod kod kojeg dolazi do promena u senzornim osobinama kao što su ukus, aroma i konzistencija.

Cilj ovog rada je ocena kvaliteta kefira koji se može nabaviti na tržištu (komercijalnog kefira), u našem slučaju sa lokalnog tržišta. Analiziran je kefir koji je proizvelo 8 proizvođača. Četiri je bilo klasifikovano kao industrijski, znači u proizvodnji velikog obima, i obeleženi su oznakama: D1, D2, D3, i D4. Tri kefira su označena: M1, M2, M3 i proizvedeni su u lokalnim zadrugama za proizvodnju i preradu mleka. Jedan ocenjivani proizvod je dobio oznaku T1, a prodavan je kao najjeftiniji u hipermarketu. Ocenjivane su senzorne osobine kefira, hemijski sastav (mast, protein, ukupne čvrste materije, čvrste bezmasne materije - snf), kriva toka i area of hysteresis loop deo histerezis luka između gornje i donje krive izmešanog kefira. Krive toka su opisane korišćenjem dva reološka modela: Ostwad de Waele i Casson, takođe je rađena kalkulacija očigledne viskoznosti.

Većina analiziranih kefira su imali zadovoljavajuće senzorne karakteristike, jedino je proizvod D2 dobio najvišu ocenu, skoro maksimalnih 5.0. Tri od osam ocenjivanih kefira (D1, M1 i T1) su dobili ocenu ispod 3.5. Neočekivano, kefir D1 od veoma poznatog proizvođača, je dobio najniže ocene senzornog kvaliteta. Sadržaj masti u ocenjivanim kefirima je pokazao da se u tri mlekare standardizacija masti radi neprecizno. Najveće neslaganje između nivoa masti na deklaraciji proizvođača i nivoa utvrđenog u ispitivanju je bilo kod T1 kefira. Kao rezultat analize proteina i nivoa čvrste bezmasne materije zaključeno je da proizvođači D2, D3 i M2 su uradili standardizaciju ovih komponenti, učvršćujući mleko na nivou od 3.93-4.72% proteina i 9.72-11.7% čvrste, bezmasne materije. Kefiri D1 i D3 su imali najveće vrednosti reoloških parametera: koeficijent konzistencije K, Cassons viskoznost I očigledna viskoznost. Iako su imali najviše vrednosti reoloških parametara, ovi proizvodi su imali dosta niske ocene konzistncije u okviru senzorne ocene, što znači da tradicionalno potrošači koriste kefir kao osvežavjuće piće I u tom slučaju nije neophodna visoka viskoznost.

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