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EXAMINATION OF THE USE OF UF LACTIC ACID WHEY RETENTATE IN SOUR CREAM MAKING

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Abstract: The use of ultra-filtered lactic acid whey retentate was investigated for making of sour cream. The utilization of lactic acid whey is limited due to its' special properties, so the logical utilization way is to use it in fermented products. First, we concentrated lactic acid whey collected from cottage cheese making by ultrafiltration (UF), then UF Whey Retentate (UFWR) was added (by 2, 5 and 10%) into fat standardized cream for sour cream making. We investigated the texture and sensory properties of the sour cream samples compared with the industrial products. Generally, we can state that the use of small portion of UF whey retentate did not result noticeable changes and did not reduce the sensory value of sour creams. Higher UF whey retentate addition improved some texture properties of experimental samples, but the summarized evaluation of UFWR addition was not unequivocal. Control samples showed better results. Based on my results, the sample what contained 5% UF whey retentate had good texture and acceptable sensory properties. Furthermore, more than 5% UF lactic acid whey retentate (coming from our own ultrafiltration process) resulted remarkably worse sensory properties than the other samples. Further investigation is needed to find the optimal composition and sensory properties of UFWR. Furthermore, we have to perform technological investigation to reach higher concentration factor using pre-treatment of whey and to avoid the precipitation of whey proteins during high temperature pasteurization of cream, cream mixed with UFWR or diafiltered whey retentate. We guess that the use of one stage diafiltration would already decrease the unfavourable sensory properties of lactic acid whey retentate.
Keywords: lactic acid, ultrafiltration (UF), UF Whey Retentate (UFWR), sour cream

INTRODUCTION

Major part, actually 65-90% of milk, become side products (or waste) in cheese and casein production. By some estimation, 62 billion litres of whey are produced each year world-wide [1] causing significant problems for producers considering environmentally aspects. But whey contains valuable organic compounds (as proteins, lactose, fat) and minerals. Actually, the beneficial effect of whey proteins and other compounds on human health are well-known [2], [3], [4], [5], [6], [7], [8], [9]. Therefore, this extremely huge amount of whey is a big problem and there is need to reduce its polluting effect and to produce valuable products. By today, the utilization of whey has arrived to the separation and purification of different special compounds from the simple use as the feed for animals. Whey proteins and serum proteins seem to be the most valuable components of whey, but the other compound are also good raw materials (e.g. lactose) for the further utilization. The simplest utilization is to produce flavoured whey drinks as "Riska Shake" produced by Alföldi Tej Ltd., Hungary. But, usually the sensory properties, low pH and the low solid content make whey difficult to use it in other products. Consequently, the taste and smell ameliorate, and the reducing of moisture content can open up new perspectives for the lactic acid whey utilization.

Many researcher published results from the use different membrane filtration techniques for whey concentration [10], [11], [12], [13], [14], [15]. Very important results were published related to the enhancement of membrane techniques to reach higher efficiency and to the removal of lactic acid from lactic acid whey [16]. This objective can be reached with the use of vibration [17], with sonication [18], with electrical methods [19], [20], with diafiltration [21] or with optimization of the condition of the filtration [22]. As a result of the development of whey membrane filtration process, much utilization form can be used in food and

medicine industry. There are many results have published in different area (including the use of lactic acid whey) as the purification of whey proteins [23], fractionation of bioactive peptides from whey [24], the enzyme recovery from solutions [25], [26], the production of lactic acid [27], and the stabilization of different emulsions as well [28], [29]. Other applications as follows, the improve of foaming properties [30], stabilization of different whey protein drinks [32], bacterial production of hyaluronic acid [33], improving of bread properties [33], not to mention of the traditional possibilities as the production of ordinary whey powder and different whey cheeses (e.g. Ricotta). A complex, fully utilization system of acid whey was presented in [34].

Our objective was the investigation of ultra-filtered lactic acid whey retentate (UFWR) use with low concentration factor in the production of sour cream in order to reduce the amount of whey as wastewater. The low concentration factor of whey can be justified by lower expenses comparing to ultrafiltration with two or three stages diafiltration or reverse osmosis. Other aim was to explore the effect of UFWR addition (as milk substitute) on the texture and sensory properties.

MATHERIALS AND METHODS

Ultrafiltration

A simple ultrafiltration was performed in batch system without diafiltration, using VSEP-LP vibration ultrafilter (New Logic Research, Inc., Emeryville, California 94608, USA). Conditions: pressure: 8.0 bar; Temperature: 40°C; Membrane: PAN (poli-akril-nitril); Cut off value: 10 kDa (Figure 1). Ultrafiltration was performed using a simple batch system without special pre-treatment of lactic acid whey, so the concentration factor was fairly low (1.8).

Figure 1. VSEP ultrafilter

Chemical investigation

A Bentley 150 milk analyzer (Benleyinstrument Inc. Chaska, Minnesota 55318 USA), was used for the determination of whey composition, ultrafiltered retentate and permeate at 40°C. Data were expressed in m/m%. Composition of the different experimental media is presented in Table 1. We did not reach remarkably protein increment and lactose was enriched, probably due to the different complex molecule formation.

Table 1. Composition of whey, permeate and Uf retentate (m/m%; concentration factor: 1.8)

	Fat	True protein	Crude protein	Lactose	Total solids
Whey (Feed)	0.15	0.59	0.90	3.67	6.49
Permeate	0.40	0.49	0.63	3.27	5.61
Retentate	0.44	0.88	1.32	5.52	8.66

Experimental sour cream making

After the addition of different percent (2%, 5%, 10%) of UFWR into milk (without pH buffering) and after fat standardization to 16 m/m%, cream was heated to 60°C for homogenization at 150 bar pressure with Gaulin Lab 60 homogenizer (Graafdijk-Oost 23, 2973 XB, Molenaarsgraaf, Netherlands).

a)

b)

Figure 2. The homogenizer (a) and the packaging machine (b)

Then homogenized cream was pasteurized at 72°C with 1 minute holding and then it was cooled to 26°C in order the inoculation. The gentle pasteurization condition is explained by the heat sensitivity of whey proteins fortified in cream. Inoculation rate was 2 ml/3000ml cream, from a 20% culture solution using DI-PROX® M 272 freeze-dried starter (Bioprox Ltd. 92532 Levallois-Perret Cedex, France).

Then different samples were packed in cups with a semi-automatic packaging machine (Junior Handy type, Zootechnika Ltd. Gödöllő, Hungary). After packaging, the samples were fermented in a thermostat (Labor MIM, Hungary) at 26°C for reaching 4.6 pH measured with Orion 4Star instrument (Thermo Fischer Scientific Inc., Singapore). Then samples were cooled in a refrigerator and were stored until the investigations.

Texture properties

Brookfiled LFRA CT3 texture analyser (Brookfield Engineering Laboratories, Inc., Middleboro, Massachusetts, USA, 02346) was used for the determination of hardness, adhesiveness and adhesive force of sour cream samples.

Measuring conditions: simple compression test was used with 12 mm diameter plastic cylinder (penetration target: 20 mm; penetration force: 50 mN; speed: 0.5 mm/s). Measures were performed in three replicates using five parallel samples. Every sample was measured in three place of the surface.

Whey leakage ratio

Whey leakage was determined with method published in [35]. First a 40 mm diameter semi-sphere was cut into surface of curd then after one hour the weight of accumulated whey was measured. Less amount of whey (higher water binding capacity) means better texture.

Sensory evaluation

Sensory evaluation was performed by ten persons using Hungarian Standard 12253-84. A part of sensory evaluation was the comparison of experimental samples to the control samples - contained 20% fat content - made in a dairy firm.

RESULTS

Whey leakage

The measured whey leakage values (Table 1) were high, considering the classification method in [35] (<0.5ml, 0.5–1.0ml, >2.0ml). It can be explained with the experimental condition of sour cream samples making, e.g. the low pasteurizing temperature and the slow heating rate.

But the explored differences demonstrate that whey proteins can play an important role in the water bonding capacity of lactic acid gels as sour cream. Interestingly, the higher whey retentate ratio decreased the whey leakage first, more than 5% ratio resulted worse result. It is explained by the higher dilution ratio of cream with UF whey retentate, maybe because of its lower crude protein content compared to cream (1.94-2.01%). Higher ratio of UF whey retentate resulted lower protein content in the cream - UF retentate mixture than the dilution in lower ratio. The 5% UFWR ratio was the optimal in our experiments.

Table 1. Whey leakage of sour cream samples (g; n=45)

Whey ratio (%)	Repetitions			Average
	First	Second	Third	
2	5.35	5.62	5.47	5.48
5	2.09	2.83	2.38	2.38
10	4.08	4.12	4.08	4.09

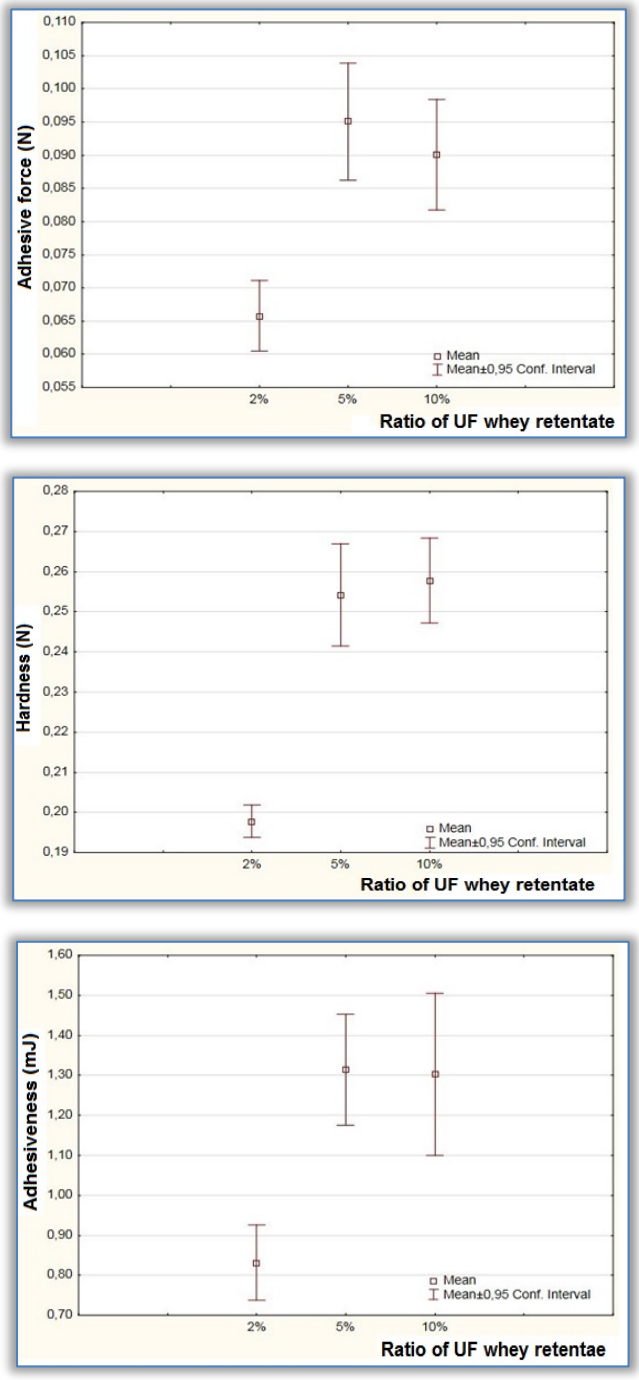

Figure 3. Texture properties of different samples made with UF whey retentate (n=45)

Texture analysis

Significant difference ($p \leq 0.05$; using Statistica 12 for MS Windows software) was explored between the samples made with 2% and 5% UF whey retentate added, and also between the samples 2% and 10% UF retentate added samples (Figure 3).
But the difference was not significant between the samples made with 5% and 10% UFWR addition. The higher values of investigated texture properties are explained by the higher amount of denatured whey proteins built into the casein protein matrix during the lactic acid clotting. The lack of the further improving in this properties can be explained by the lower relative ratio of casein in the mixture contains higher ratio of UF whey retentate. As the aggregation between denatured whey proteins and casein micelles can improve texture properties, as the lower casein content in the mixture can compensate this beneficial consequence.

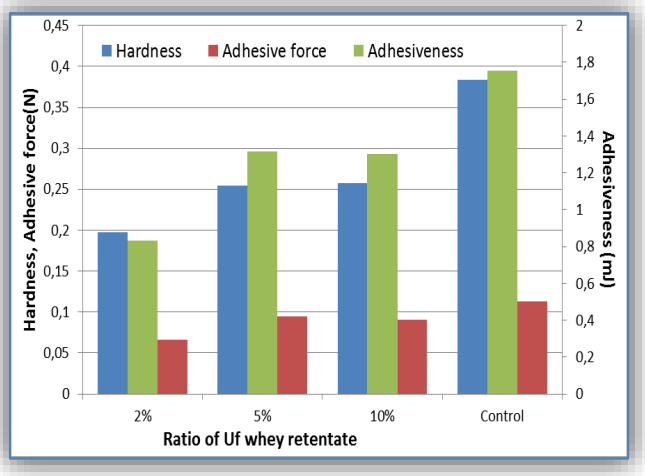

Figure 4. Comparison of texture properties of experimental and the control samples(n=10)

As the Figure 4 represents, the control sample gave slightly better results. It is explained by higher fat content (20%) and the industrial processing condition. But the results of samples made with the addition of 5% and 10% Uf whey retentate were close to the control ones.

Sensory evaluation

The sensory evaluation showed markedly different results compared to the results from texture analysis. Higher UFWR addition resulted worse judgement of experimental samples (Figure 5). Especially, samples made the highest UFWR addition had got unsavoury characteristics.
We can confirm that the special sensory property of whey, especially lactic acid whey ones limit the further direct utilization. Higher ratio of UFWR addition resulted worse scores in every repeats, except the smell. The sample made with 10% UFWR addition represented the worst score (12.5 points) so this experimental product cannot be marketed.

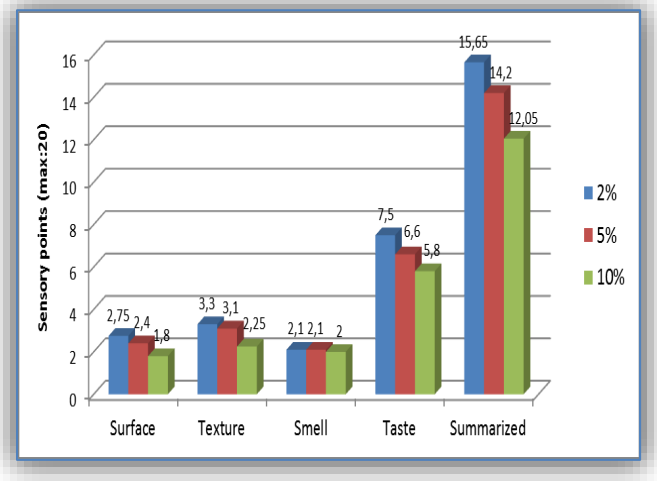

Figure 5. Sensory evaluation of samples with Uf whey retentate addition

CONCLUSIONS

The addition of UFWR into cream can be a form of the utilization of this dairy side product. We investigated the use of UFWR from a single batch ultrafiltration in order to limit the cost of the further processing costs. We did not achieve enough high protein content in retentate and as mild sensory properties of experimental samples, our mixtures did not result a real, satisfactory solution. Although, the texture properties of experimental samples were improved (5% UFWR addition resulted the best result) the sensory scores decreased with the increase of UFWR addition. Based on the sensory evaluation, the limit of the addition of Uf lactic acid whey retentate came from a single batch ultrafiltration is 5%. Further investigation is needed to find the optimal composition and sensory properties of whey UFWR using diafiltration. Furthermore, we have to perform technological investigation to reach higher concentration factor using pre-treatment of whey and to avoid the precipitation of whey proteins during the high temperature pasteurization of cream, cream mixed with UFWR or diafiltered whey retentates. We guess that the use of one stage diafiltration would already decrease the unfavourable sensory properties of lactic acid whey retentate.

Note

This paper is based on the paper presented at International Conference on Science and Technique based on Applied and Fundamental Research – ICoSTAF 2016, organized by University of Szeged, Faculty of Engineering, in Szeged, HUNGARY, 2 June 2016

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