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RHEOLOGICAL AND TEXTURAL PROPERTIES OF COCOA SPREAD CREAM WITH SUNFLOWER LECITHIN

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Abstract: Sunflower lecithin, together with commonly used soy lecithin, is a by-product of degumming of crude oil during refining process and can be defined as a mixture of phospholipids, residual oil and minor components. This paper investigated the influence of sunflower lecithin on rheological and textural characteristics of cocoa spread cream. Cocoa spread cream samples were made with the addition of 0.3, 0.5 and 0.7% of sunflower lecithin, with a milling time of 40 and 50 minutes in a laboratory ball mill. The results are compared with the results obtained for rheological and textural analyses of standard cocoa spread cream with soy lecithin added. Cocoa cream spread samples with the addition of all applied concentration of soy lecithin in milling time range of 40 to 50 minutes show lower values of thixotropic curve area, mean viscosity and Casson viscosity, but higher values of Casson yield stress, compared with cocoa cream samples with sunflower lecithin. Optimal concentration of soy lecithin is 0.5% with retention time of 40 minutes in laboratory ball mill, while addition of 0.7% of soy lecithin increases complexity of cocoa spread cream, but reduces Casson viscosity. On the other hand, the addition of 0.7% of sunflower lecithin and milling time of 50 minutes show the lowest values of rheological parameters. Cocoa cream samples with sunflower lecithin have lower values of textural parameters comparing with samples with standard soy lecithin.
Keywords: cocoa spread cream, sunflower lecithin, rheology, texture

1. INTRODUCTION

Vegetable lecithins are commercially derived from oil-bearing seeds such as soybeans, sunflower kernels and rapeseed and primarily contain the following phospholipids: phosphatidylcholine (PC), phosphatidylethanolamine (PE), and phosphatidylinositol (PI). These lecithins with surface-active properties are used as emulsifiers in a vast range of foods, feed, pharmaceutical and technical applications (Nieuwenhuyzen & Tomas, 2008).

The majority of commercial lecithins are derived from soybean oil, typically containing between 0.5 and 3% phosphatides (Doig & Diks, 2003). On the other hand, the percentage of phospholipids in sunflower oil ranges from 0.02% to 1.5%, with an average of around 0.75%. Sunflower lecithin has a mild taste and similar emulsifying properties as soybean lecithin. The composition of the phospholipids is similar to soybean lecithin, with a tendency to higher PC and lower PE ratios, which might be caused by crop varieties and processing conditions (Szuhaj, 2005).

In the food industry, lecithin represents a multifunctional additive in the manufacture of chocolate, bakery and instant products, margarines, and mayonnaise, due to the characteristics of its phospholipids (Cabezas et al., 2009). Lecithin helps to smooth the texture and serves as an emulsifying agent in margarine, chocolate, caramels, coatings (to control viscosity, crystallization, and sticking) (Ramadan, 2008).

Cocoa cream spread is confectionery product based on powdered sugar, vegetable fat, cocoa powder, milk powder and other ingredients. The basic characteristics of this type of product are: good spread ability in a wide temperature range (from ambient to fridge temperature), rich creamy taste, smooth homogeneous structure with no fat phase separation, and good oxidative stability (Petković et al., 2013). Since cocoa spread cream contains over 30% of fat phase its physical and sensory properties are strongly influenced by the behavior of fat phase. Therefore, the fat selection for cream spreads requires a good knowledge of characteristics of fat and complex processes that may occur during manufacture and later in storage (Pajin et al., 2007).

The lecithin obtained from sunflower should be examined in different confectionery products with continuous fat phase and if appropriate emulsifying properties are achieved, it could be used in the confectionery production as well (Loncarevic et al., 2013).

This research examined rheological and textural characteristics of cocoa spread cream with the addition of lecithins from different sources – soybean and sunflower.

2. MATERIALS AND METHODS

Materials

- ✓ Cocoa-cream mass that passed through 3 roll mill in industrial conditions (mixture of powdered sugar, cocoa powder, milk powder, vegetable fat)
- ✓ Vegetable non trans fat NTFCP – produced in Oil Factory "Dijamant", Serbia
- ✓ Sunflower oil "Iskon" – produced in Oil Factory "Victoriaoil", Serbia
- ✓ Native fluid soybean lecithin – produced in Oil Factory "Victoriaoil", Serbia
- ✓ Native fluid sunflower lecithin – produced in "Cargill", Italy
- ✓ Hazelnut and vanilla flavor

Methods

Raw materials were added into a laboratory ball mill with a capacity of 5 kg. The temperature in the ball mill was 40°C, with a speed of 50 rpm.

Cocoa spread samples with the addition of different concentrations of soybean and sunflower lecithin depending on the milling time, were prepared according to the following scheme, presented in Table 1.

Rheological properties of cocoa spread cream samples were determined by rotational rheometer Rheo Stress 600, Haake, according to O.I.C.C. method. The tests were carried out at 35°C using a concentric cylinder system (sensor Z20 DIN). The shear rate was increased from 0 s^{-1} to 100 s^{-1} , and then was kept constant at max. speed of 100 s^{-1} and after that was reduced from 100 s^{-1} to 0 s^{-1}, each time within 240 s (OICCC 2000).

Table 1.

Cream spread with soy lecithin - Cs						
c (%)	0.3		0.5		0.7	
T (min)	40	50	40	50	40	50
Sample	Cs/0.3 /40	Cs/0.3 /50	Cs/0.5 /40	Cs/0.5 /50	Cs/0.7 /40	Cs/0.7 /50
Cream Spread With Sunflower Lecithin - Csu						
c (%)	0,3		0,5		0,7	
T (min)	40	50	40	50	40	50
Sample	Csu/0. 3 /40	Csu /0.3/50	Csu /0.5/40	Csu /0.5/50	Csu /0.7/40	Csu /0.7/5 0

*Concentration of lecithin (%); **Milling time (min)

Textural properties of fat samples were analysed using a Texture Analyser TA.XT Plus. The hardness and work of shearing were determined by penetration at temperature 20°C, according to method Chocolate Spread – SPRD2_SR_PRJ (using software Exponent by Stable Micro Systems). The accessories included TTC Spreadability Rig (HDP/SR) using 5 kg load cell and Heavy Duty Platform (HDP/90). Each sample was placed into the cone sample holder and pressed down in order to eliminate air pockets. Any excess of sample was scraped off with a knife. Then the filled cone sample holder was put in base holder and 45 degree cone probe was used to penetrate the samples. The distance between cone sample and cone probe was 23 mm with test speed of 3 mm/s. Results were expressed as mean of triplicate analyses.

3. RESULTS AND DISCUSSION

Rheological properties of cocoa spread cream samples

Fig. 1 shows flow curves of cocoa spread cream samples with addition of different concentrations of soybean and sunflower lecithin, with milling time of 40 and 50 minutes in laboratory ball mill.

All samples show very similar thixotropic flow. The rheological parameters of the samples are given in Table 2.

Samples with the addition of 0.3% of both soybean and sunflower lecithin have the highest values of thixotropy curve area, indicating the lowest homogeneity and spreadability of the system.

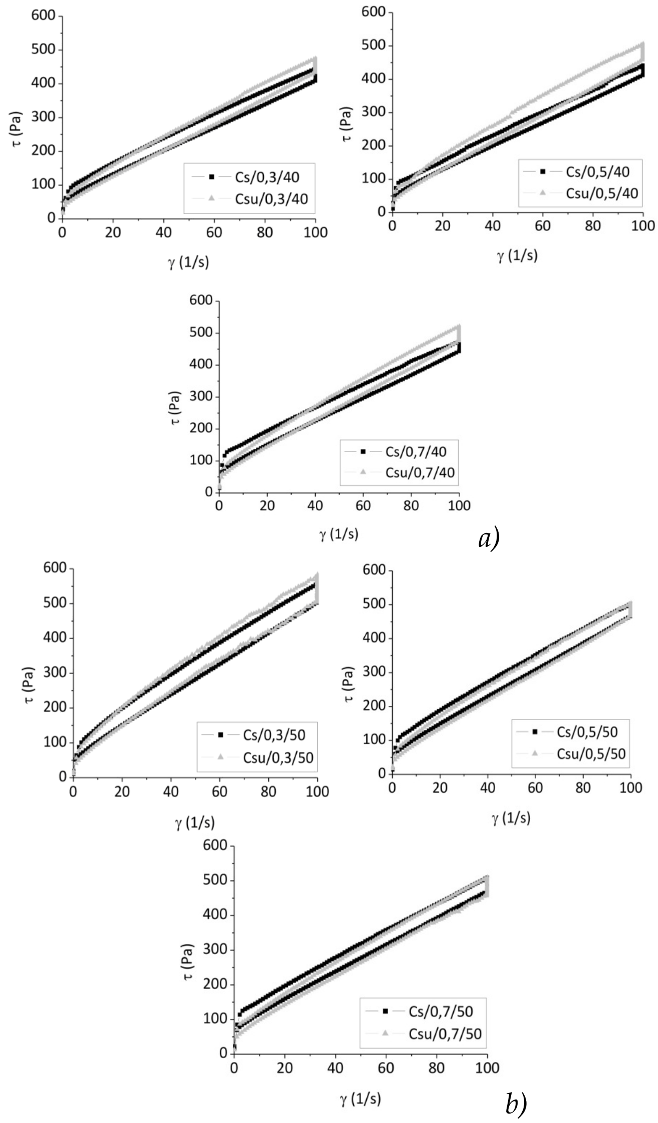

Figure 1. Flow curves of cocoa spread cream samples depending on different concentration of soybean and sunflower lecithin: a) 40 minutes, and b) 50 minutes in laboratory ball mill

Table 2. Rheological parameters determined by static measurements

Sample	Thixotropic curve area (Pa/s)	Yield stress (Pa)	Viscosity at maximum shear rate (Pas)
Cs/0,3/40	4678±37	17.50±0.54	4.54±0.74
Cs/0,3/50	5852±20	19.72±0.39	5.23±0.56
Cs/0,5/40	3109±73	17.54±0.69	4.25±0.62
Cs/0,5/50	4378±49	29.61±0.89	4.83±0.71
Cs/0,7/40	4425±59	23.17±0.28	4.57±0.98
Cs/0,7/50	4266±30	29.95±0.81	4.84±0.91
Csu/0,3/40	6268±34	21.09±0.77	4.97±0.68
Csu/0,3/50	7292±85	24.77±0.71	5.34±0.77
Csu/0,5/40	5261±65	25.72±0.59	4.82±0.91
Csu/0,5/50	4553±54	16.69±0.70	4.79±0.85
Csu/0,7/40	4598±45	16.54±0.95	4.96±0.79
Csu/0,7/50	4457±39	15.27±1.09	4.73±0.97

Values represent the means; n=3

The sample of cocoa cream spread with 0.5% of soybean lecithin with retention time of 40 minutes in ball mill has the most homogenous structure, with the lowest value of thixotropy curve area (3109 Pa/s), comparing to all samples. This sample has lower values of viscosity at the maximum shear rate (4.25 Pas) compared to samples with the same concentration of soybean lecithin, with milling time of 50 minutes.

On the other hand, cocoa spread cream samples with 0,5 and 0.7% of sunflower lecithin have lower rheological values with increasing the milling time on 50 minutes. Sample Csu/0,7/50 has a slightly smaller value of thixotropic curve area and viscosity comparing to sample Csu/0,5/50, however, the difference is very small and there is no need for the addition of a maximal concentration of sunflower lecithin.

Comparising to samples with soybean lecithin, cocoa spread cream samples with sunflower lecithin have higher values of thixotropic curve area.

Textural characteristics

Figure 2 shows hardness and work of shearing of cocoa spread cream samples depending on different concentration of soybean and sunflower lecithin and milling time in laboratory ball mill.

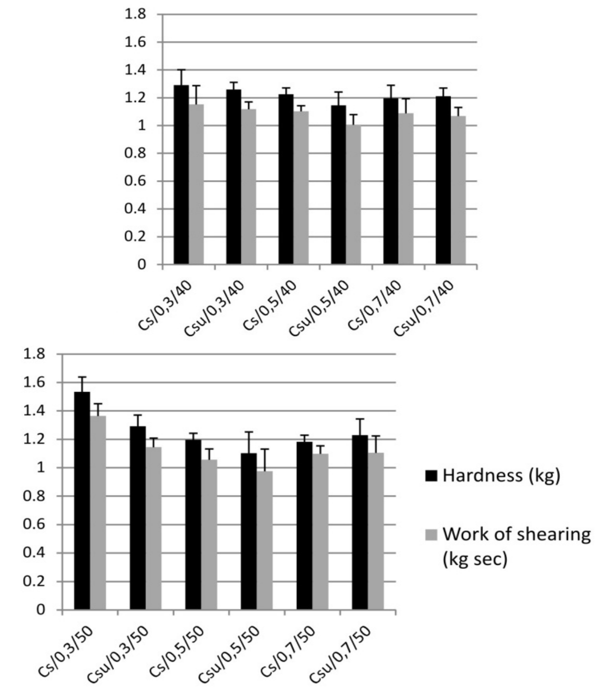

Figure 2. Hardness and work of shearing of cocoa spread cream samples depending on different concentration of soybean and sunflower lecithin: a) 40 minutes, and b) 50 minutes in laboratory ball mill

Samples with the addition of sunflower lecithin have lower textural values, comparing to samples with soybean lecithin added, at all concentrations and retention time in a ball mill (with the exception of a sample Csu/0.7/50).

Increasing the milling time from 40 to 50 minutes leads to increasing the values of hardness and work of shearing.

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