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The influence of temperature on food emulsions stability

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Abstract Emulsions are heterogeneous systems consisting of at least one liquid dispersed in another immiscible liquid phase under variable sized drops. The aim of the present study is to determine some characteristics (aspect, odor, color, solubility, emulsion type, pH, water and volatile substances content, total fatty matter, acidity, iodine index) of three types of yogurts and three types of creams from the local market. The stability of emulsions has been studied at different temperatures: 4^0C, 30^0C and 60^0C. It has been noticed that for yogurt samples the temperature increasing determined the disperse of coagulant and the acidity increasing, while for creams the pH and fat content gradients are positive with temperature.

Keywords: food emulsions, temperature, stability

1. Introduction

From components number point of view, emulsions are systems consisting of two or more liquid immiscible phases and can be classified into two broad groups: simple emulsions and multiple emulsions.

Simple emulsions could be of two types: (a) water-in-oil (W/O) emulsions, and (b) oil in-water (O/W) emulsions. The water-in-oil emulsions consist of water droplets dispersed in a continuum of oil phase whereas the oil-in-water emulsions have a reverse arrangement.

Multiple emulsions are often classified into three groups depending on the number of internal droplets present in the multiple emulsion globules: (1) type A multiple emulsion, where the multiple emulsion globule consists of only one large internal droplet, that is, the multiple emulsion globule is of "core–shell" type; (2) type B multiple emulsion, where the multiple emulsion globule consists of several small internal droplets; and (3) type C multiple emulsion, where the multiple emulsion globule consists of a large number of internal droplets. Multiple emulsions can be further classified as either oil-in-water-in-oil (O/W/O) multiple emulsion or water-in-oil-in-water (W/O/W) multiple emulsion [1].

Yogurt is very popular fermented milk produced and widely consumed all over the world, while creams are dispersions of two immiscible liquids, oil and water. To preserve quality during storage and, in particular, physicochemical and sensory characteristics, packaging is essential [2, 3].

The term "emulsion stability" refers to the ability of an emulsion to resist changes in its properties over time. Emulsions have been studied by numerous techniques. Diffusing wave spectroscopy (DWS), laser scanning confocal microscopy (LSCM), nuclear magnetic resonance (NMR), and Turbiscan are among the more powerful, nonperturbing techniques used to characterize emulsions [4-8].

The aim of the present study is to determine some characteristics (aspect, odor, color, solubility, emulsion type, pH, water and volatile substances content, total fatty matter, acidity, iodine index) of three types of yogurts and three types of creams from local market. We have studied the stability of products analyzed at higher temperature than the temperature that yogurt and cream should be stored.

2. Experimental

Three types of yogurt (simple yogurt, with vanilla flavor and with fruits) have been used. Studied creams were from three different companies. Certain properties of these emulsions have been determined, such as: aspect, odor, color, solubility, emulsion type, pH, water and volatile substances content, total fatty matter, acidity, iodine index at different temperatures: 4^oC, 30^oC and 60^oC.

2.1. The *pH* value has been determined using a CONSORT C535 multimeter.

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2.2.Water and volatile subtances content

1 g of sample was weighed in a weighing vial. The vial was previously brought to constant mass by heating in an oven at 105 ± 5°C. The vial containing the sample has been placed in an oven at 105±5°C and dried until the mass remained constant. The percentage water and volatile substances content were calculated using the formula (1):

Water and volatile substances content, %

$$= \frac{m_2 - m_1}{m} \cdot 100 \qquad (1)$$

where: m_2 represents the mass of the vial containing the sample before drying, g; m_1 - the mass of the vial containing the sample after drying, g; m – the mass of the sample, g.

2.3. Total fatty matter (TFM)

5 grams of sample have been weighted and transferred into a 250 mL beaker. 100 mL of hot distilled water and 40 mL of 0.5N HNO_3 have been added until the content became slightly acidic. The mixture has been heated in a water bath until fatty acids begun floating as a layer above the solution. Afterwards, the mixture has been suddenly cooled down using an ice water bath in order to solidify and separate the fatty acids. 50 mL of chloroform has been added to the remaining solution that was transferred into a separating funnel. After shaking, the solution separated itself into two layers. The bottom layer has been drained. 50 mL of chloroform has been added to the remaining solution in the separating funnel. The fatty acids have been separated and the chloroform has been dissolved and transferred to the collected fatty matter, weighed in a porcelain dish.

The content has been evaporated and the residue has been weighed.

From the difference in weight, the percentage of fatty matter in the analyzed samples was calculated using the relation (2):

$$\% \text{ of fatty mater} = (B - A) \cdot 100 \cdot m \qquad (2)$$

where: A – weight of the porcelain, g; B – weight of the porcelain dish + sample after drying, g; m – the mass of the sample, g.

2.4. Acidity index

10 mL of sample with 20 mL of distilled water and 3-4 drops of phenolphthalein were mixed and then titrated with NaOH solution 0.1N, until the appearance of pink color, which must be maintained for 1minute. Acidity has been calculated according to the formula (3):

$$\text{Acidity } °T = 10 \times V \qquad (3)$$

V - volume of solution NaOH 0.1 N (mL).

2.5. Iodine index

1 g of sample has been weighed and dissolved in 4 mL chloroform into a bottle with glass stopper. 5 mL of 0.1 N alcoholic solution of iodine has been added. The bottle has been held in darkness for 30 minutes, stirring occasionally. 3 mL of KI and 2 mL of water have been added. The solution has been titrated with 0.1 N sodium thiosulfate until it reached a light yellow color. 0.4 mL of starch have been added and titration continued, shaking vigorously until discoloration. A parallel blank determination has been performed. The iodine index value has been calculated using the formula (4):

$$I = \frac{(V_1 - V_2) \cdot 0.01269}{m} \cdot 100 \qquad (4)$$

where: I – iodine index; V_1 – volume of 0.1 N sodium thiosulphate used in the titration of the blank sample, mL; V_2 - volume of 0.1 N sodium thiosulphate used in the titration of the sample, mL; m - mass of the sample, g; 0.01269 - grams of iodine corresponding to 1 mL 0.1 N sodium thiosulphate.

3. Results and Discussions

The characteristics of yogurt at 4^0C, 30^0C and 60^0C are presented in **table 1, 2** and **3**:

Table 1. The characteristics of yogurt at 4^0C

Emulsion type/ Characteristic		Simple yogurt	Yogurt with vanilla flavor	Fruits yogurt
Aspect		Normal		
Odor		Specific		
Color		white	yellow	pink
Emulsion type		O/W	O/W	O/W
Solubility	C_6H_6	Insoluble		
	C_2H_5OH	Soluble		
	H_2O	Soluble		
Water and volatile substances %		5.92	6.11	6.53
Total fatty matter %		2.55	2.14	3.91
Iodine index gI/100g		0.48	0.44	0.54

Table 2. The characteristics of yogurt at 30^0C

Emulsion type/ Characteristic		Simple yogurt	Yogurt with vanilla flavor	Fruits yogurt
Aspect		Normal		
Odor		Specific		
Color		white	yellow	pink
Emulsion type		O/W	O/W	O/W
Solubility	C_6H_6	Insoluble		
	C_2H_5OH	Soluble		
	H_2O	Soluble		
Water and volatile substances %		5.58	5.87	6.21
Total fatty matter %		3.73	3.23	4.02
Iodine index gI/100g		0.35	0.21	0.29

Table 3. The characteristics of yogurt at 60^0C

Emulsion type/ Characteristic		Simple yogurt	Yogurt with vanilla flavor	Fruits yogurt
Aspect		Dispersed		
Odor		Specific		
Color		white	yellow	pink
Emulsion type		O/W	O/W	O/W
Solubility	C_6H_6	Insoluble		
	C_2H_5OH	Soluble		
	H_2O	Soluble		
Water and volatile substances %		5.42	5.48	5.98
Total fatty matter %		3.85	3.33	4.12
Iodine index gI/100g		0.35	0.20	0.26

The characteristics of creams at 4^0C, 30^0C and 60^0C are presented in **tables 4,5** and **6**.

Table 4. The characteristics of cream at 4^0C

Emulsion type/ Characteristic		Cream 1	Cream 2	Cream 3
Aspect		homogeneous		
Odor		specific		
Color		white		
Emulsion type		O/W	O/W	O/W
Solubility	C_6H_6	insoluble		
	C_2H_5OH	soluble		
	H_2O	soluble		
Water and volatile substances %		6.55	7.61	5.16
Total fatty matter %		10.25	10.12	10.40
Iodine index gI/100g		0.74	0.44	0.33

Table 5. The characteristics of cream at 30^0C

Emulsion type/ Characteristic		Cream 1	Cream 2	Cream 3
Aspect		homogeneous		
Odor		specific		
Color		white		
Emulsion type		O/W	O/W	O/W
Solubility	C_6H_6	insoluble		
	C_2H_5OH	soluble		
	H_2O	soluble		
Water and volatile substances %		5.24	5.24	5.24
Total fatty matter %		10.32	10.32	10.32
Iodine index gI/100g		0.72	0.72	0.72

Table 6. The characteristics of cream at 60^0C

Emulsion type/ Characteristic		Cream 1	Cream 2	Cream 3
Aspect		heterogeneous		
Odor		specific		
Color		white		
Emulsion type		O/W	O/W	O/W
Solubility	C_6H_6	insoluble		
	C_2H_5OH	soluble		
	H_2O	soluble		
Water and volatile substances %		5.04	5.04	5.04
Total fatty matter %		10.45	10.45	10.45
Iodine index gI/100g		0.75	0.75	0.75

Figures 1 and **2** present the influence of temperature on the pH and acidity of the studied yogurts and creams:

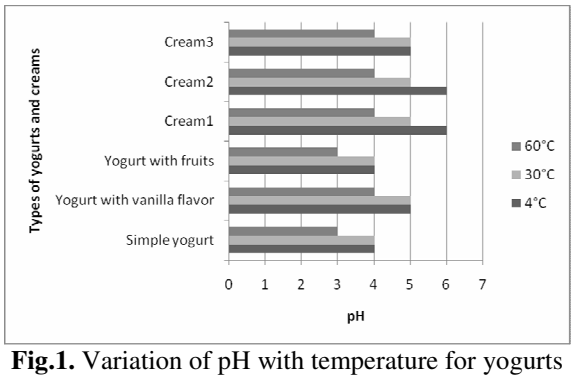

Fig.1. Variation of pH with temperature for yogurts and creams studied

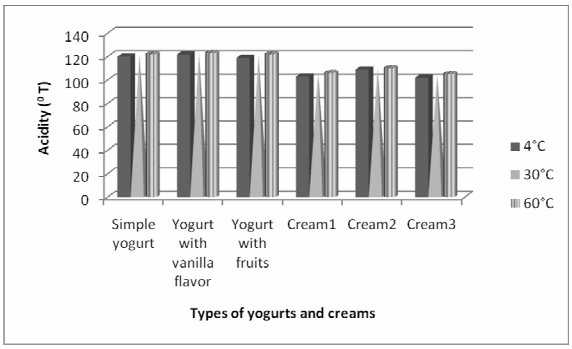

Fig.2. Variation of acidity with temperature for yogurts and creams studied

It has been noticed that for yogurt samples with increasing temperature coagulant was dispersed. The yogurts are more acidic than the creams, at the same temperature. The pH increasing with temperature is greater for creams than for yogurts. The odor, color, solubility and yogurt emulsion type were not influenced by temperature, remaining unchanged. Water and volatile matter content decreased with temperature increasing. Iodine index decreased and fat content increased with increasing temperature.

In accordance with ISO 13580-2009 [9], water and volatile substances content should be 8.5% and yogurt acidity should be **120^0T** according to ISO 11869-2000[10]. The values obtained for all three types of studied yogurts were closed to the values from ISO normative. Fat content values obtained for studied samples varied between 2.14 and 4.12% according to STAS 6352/1-88 [11], where fat values should be between 0.05 and 8%.

The odor, color, solubility and creams emulsion type were not influenced by temperature, remaining unchanged. The pH values, the fat content were increased with the increasing of temperature.

The cream acidity is according to ISO 11869-2000 [10] recommendations. Iodine index and fat content of creams were higher than for yogurts. The fat content of creams was under the limits (15% to 32%) recommended by SR EN ISO 2450-2009 [12].

4. Conclusions

The purpose of this work was to study the influence of temperature on the stability of some food emulsions (yogurts and creams). It has been noticed that for yogurt samples with increasing temperature, coagulant was dispersed, the pH tends to become more acidic and the acidity increased with temperature increasing while for cream samples the odor, color, solubility and creams emulsion type were not influenced by temperature, remaining unchanged, and the pH values, the fat content were increased with increasing temperature.

In conclusion, we can say that it's better to store the yogurt and the cream at low temperatures, to preserve their physical and chemical characteristics appropriate to human consumption.

5. References

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