Journal homepage: www.fia.usv.ro/fiajournal
Journal of Faculty of Food Engineering,
Ştefan cel Mare University of Suceava, Romania
Volume XIII, Issue 2 – 2014, pag. 127 - 133

INFLUENCE OF DIFFERENT CHEMICAL AGENTS ON THE ADULTERED MILK PHYSICAL PROPERTIES CORRECTION

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Received April 7th 2014, accepted May 7th 2014

Abstract: *In the milk industry, one of the most common frauds is the mixing of milk with water with the goal of improving the quantity. After the water adding to the milk, the counterfitert adds different substances to bring the physical properties in the right range. The aim of this study is to evaluate the influence of adulteration agents on the milk physical properties. For this purpose, the milk was adultered with different percentages of water (0, 5, 10 and 20 % respectively). The milk adultered with 20 % water was mixed with four substantces in order to bring the density and crioscopic temperature in the right range. The substantces used for the density and crioscopic temperature corrections were: NaCl, NH_4Cl, NH_4NO_3 and CH_4ON_2. The NaCl, NH_4Cl, NH_4NO_3 and CH_4ON_2 were mixed with the milk substituted with 20% eater in three different levels (0.25, 0.5 and 1% respectively in the case of NaCl, and 0.05, 0.10 and 0.20% respectively in the case of the other adulterants). All the four chemical substances brought the density and crioscopic temperature in the normal range but in different percentages.*

Keywords: *milk, adulteration, density, crioscopic temperature*

1. Introduction

One of the most consumed food products in the world is the bovine's milk. The bovine's milk contains 3-4% fat [1], and its fat contains 98% triacylglycerols and 2% of other lipids such as diacylglycerols, phospholipids and cholesterol [2]. The milk industry challenges a growing number of frauds, because of the high nutritional value of milk, that have an effect on the process of these products [3]. The principal adulteratios in the case of milk are: the milk dilution with water, fat partial or total removal, skimmed milk powder addition, milk from other species addition, chemical substances addition for neutralisation and conservation, fertilizers addition and dyes addition, respectively [4, 5].

Another fraudulent practise in the milk industry happened in 2007 and 2008 when it was found melamine into the milk. These incidents happened in China [6, 7].

The milk density is the ratio of its mass and volume, and is expressed into g/cm^3. The milk density is influenced by the temperature, species, diet, the milk

chemical composition, adulteration and cow's diseases. The cow milk density is ranging between 1.029 – 1.033 g/cm^3. In the case of water adding into the milk, the density is decreasing, while in the case of fat removal the density is increasing [4].

Another important physical parameter of milk is crioscopic temperature. The crioscopic temperature is defined as the temperature where the milk is freezing. The value of crioscopic temperature is influenced by: the solubile substances concentration (lactose, mineral salts, nitrogen substances which form the neproteic nitrogen), substances added for the acidity reduction (carbonates), substances added for the dry matter increasing, water adding to the milk. The crioscopic temperature ranges between -0.512 and -0.560 °C. The crioscopic temperature should be corrected in function of milk acidity [4].

In the case of milk substition with water are added different substances (NaCl, NH_4Cl, NH_4NO_3 and CH_4ON_2) in order to correct their physical parameters [8].

The aim of this study is to evaluate the influence of adulteration agents on the physical properties of milk.

2. Materials and methods

2.1 Materials

Milk (3.5 % fat), distilled water, NaCl, NH_4Cl, NH_4NO_3 and CH_4ON_2.

2.2. Methods

Density determination

The milk density was measured using the picnometer method.

Crioscopic temperature determination

The crioscopic temperature was measured using the CryoStar I device. 2 ml of sample was placed into the device till the crioscopic temperature is achieved and displayed on the device display.

2.3. Milk adulteration

The milk was adultered with distilled water in different percentages (0, 5, 10 and 20% respectively). The sample with 20% water was mixed with different concentractions of NaCl, NH_4Cl, NH_4NO_3 and CH_4ON_2.

3. Results and discussions

3.1. The water influence on the milk physical properties

It is well known that if water is added to the milk, its density is decreasing with the increasing of the water percentage added. In our case the adding of water, in different percentages (ranging from 0 to 20%) decreased the magnitude of the density. In the table 1 is presented the milk density of the milk and of the adulterated samples.

Table 1.
Milk density evolution with different percentages od water

Sample	Density (g/cm^3)
Blanck	1.030
Milk with 5% water	1.027
Milk with 10% water	1.025
Milk with 20% water	1.021

The substition of milk with water is making that the density to not be in the normal range. If the milk is substituted with 20 % water, the density is decreasing with 0.87 %.

The crioscopic temperature of the adulterated milk increased with the

increasing of the water percentage. The increasing of the crioscopic temperature is caused by the dilution of the chemical parameters concentrations. In the table 2 is presented the milk crioscopic temperature of the milk and of the adulterated samples.

Table 2.
Milk crioscopic temperature evolution with different percentages od water

Sample	Crioscopic temperature (°C)
Blanck	-0.5398
Milk with 5% water	-0.5220
Milk with 10% water	-0.4837
Milk with 20% water	-0.4296

From the data presented in the table 2 we can see that the sample adultered with 5% water has the crioscopic temperature in the normal range, while in the case of the samples with 10 and 20 % water, the crioscopic temperature is not the right range. The addition of 20% water is increasing the crioscopic temperature of milk with 25.65%.

3.2. The influence of NaCl on the physical properties of milk adulterated with 20 % water

The NaCl is added into the milk for masking the water adding into the milk and for the correction of the density.

In this paper, it was added NaCl to the milk adultered with 20% water in different concentrations: 0.25, 0.5 and 1 % respectively in order to achieve the optimum quantity for the density and crioscopic temperature correction.

In the figure 1 is presented the density of the sample adultered with 20% water in which was added different concentrations of NaCl.

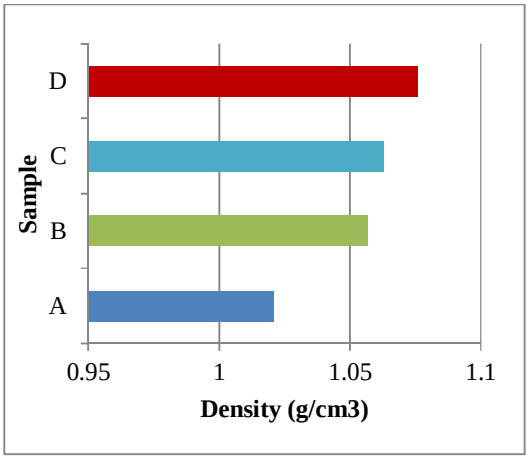

Fig. 1. The density of milk adultered with 20% mixed with different concentrations of NaCl, A: Milk with 20% water, B: Milk with 20% water with 0.25% NaCl, C: Milk with 20% water with 0.50% NaCl, D: Milk with 20% water with 1.00% NaCl

The addition of NaCl into the adultered milk increased the density, but the quantity of NaCl needed for achieving the right density is lower than the quantity studied in the present paper. The quantity should be around 0.1% NaCl. The addition of 1% NaCl increased the density with 5.38%.

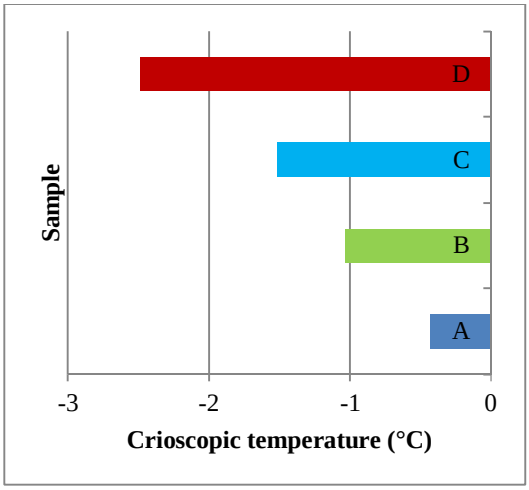

Fig. 2. The crioscopic temperature of milk adultered with 20% mixed with different concentrations of NaCl: A: Milk with 20% water, B: Milk with 20% water with 0.25% NaCl, C: Milk with 20% water with 0.50% NaCl, D: Milk with 20% water with 1.00% NaCl

In the figure 2 is presented the crioscopic temperature of the sample adultered with 20% water in which was added different concentrations of NaCl.

The addition of NaCl into the adultered milk decreased the crioscopic temperature, but the quantity of NaCl needed for achieving the right crioscopic temperature is lower than the quantity studied in the present paper. The quantity should be around 0.1% NaCl, like in the case of the density. The addition of 1% NaCl decreased the crioscopic temperature with 477.4 %.

3.3. The influence of NH_4Cl on the physical properties of milk adulterated with 20 % water

The NH_4Cl is added, like NaCl too, into the milk for masking the water adding into the milk and for the correction of the density.

In this paper, it was added NH_4Cl to the milk adultered with 20% water in different concentrations: 0.05, 0.10 and 0.20 % respectively in order to achieve the optimum quantity for the density and crioscopic temperature correction.

In the table 3 is presented the density of the sample adultered with 20% water in which was added different concentrations of NH_4Cl.

The addition of NH_4Cl into the adultered milk increased the density, it seems that the addition of 0.05% is bringing the milk density into the desired range. The others percentages studied were to big for bringing the density in the normal range. The addition of 0.20% NH_4Cl increased the density with 1.37%.

Table 3.
The density of milk adultered with 20% mixed with different concentrations of NH_4Cl

Sample	Density (g/cm^3)
Milk with 20% water	1.021
Milk with 20% water with 0.05% NH_4Cl	1.031
Milk with 20% water with 0.10% NH_4Cl	1.034
Milk with 20% water with 0.20% NH_4Cl	1.035

In the table 4 is presented the crioscopic temperature of the sample adultered with 20% water in which was added different concentrations of NH_4Cl.

Table 4.
The crioscopic temperature of milk adultered with 20% mixed with different concentrations of NH_4Cl

Sample	Crioscopic temperature (°C)
Milk with 20% water	-0.4296
Milk with 20% water with 0.05% NH_4Cl	-0.5869
Milk with 20% water with 0.10% NH_4Cl	-0.6687
Milk with 20% water with 0.20% NH_4Cl	-0.9050

The addition of NH_4Cl into the adultered milk decreased the crioscopic temperature, but the quantity of NH_4Cl needed for achieving the right crioscopic temperature is lower than the quantity studied in the present paper. The quantity should be around 0.03% NH_4Cl. The addition of 0.20 % NH_4Cl decreased the crioscopic temperature with 110.66 %.

3.4. The influence of NH_4NO_3 on the physical properties of milk adulterated with 20 % water

The NH_4NO_3 is added, like NaCl and NH_4Cl too, into the milk for masking the water adding into the milk and for the correction of the density.

In this paper, it was added NH_4NO_3 to the milk adultered with 20% water in different concentrations: 0.05, 0.10 and 0.20 % respectively in order to achieve the optimum quantity for the density and crioscopic temperature correction.

In the figure 3 is presented the density of the sample adultered with 20% water in which was added different concentrations of NH_4NO_3.

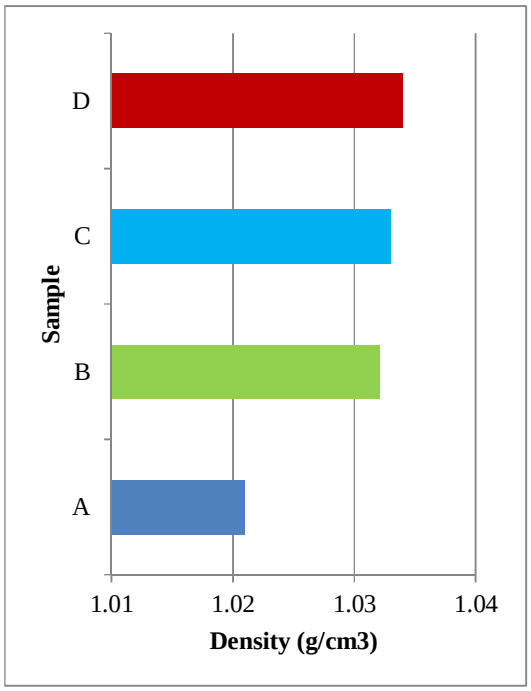

Fig. 3. The density of milk adultered with 20% mixed with different concentrations of NH_4NO_3, A: Milk with 20% water, B: Milk with 20% water with 0.05% NH_4NO_3, C: Milk with 20% water with 0.10% NH_4NO_3, D: Milk with 20% water with 0.20% NH_4NO_3

The addition of NH_4NO_3 into the adultered milk increased the density, it seems that the addition of 0.05 and 0.10% NH_4NO_3 is bringing the milk density into the desired range. In the case of 0.20% NH_4NO_3 the value of the density is appropriated to the normal value. The addition of 0.20% NH_4NO_3 increased the density with 1.27%.

In thefigure 4 is presented the crioscopic temperature of the sample adultered with 20% water in which was added different concentrations of NH_4NO_3.

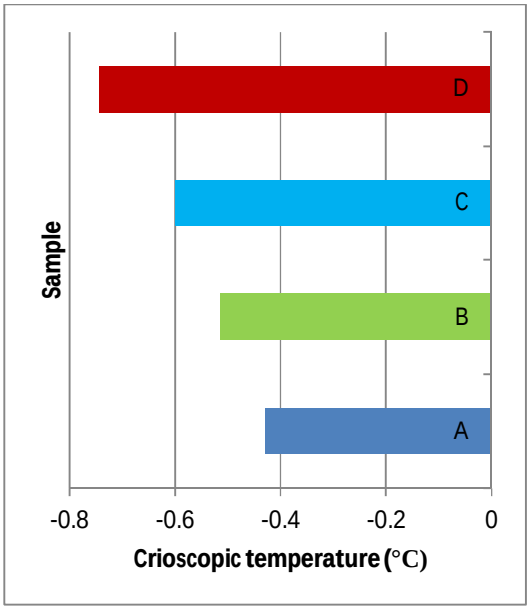

Fig. 4. The crioscopic temperature of milk adultered with 20% mixed with different concentrations of NH_4NO_3: A: Milk with 20% water, B: Milk with 20% water with 0.05% NH_4NO_3, C: Milk with 20% water with 0.10% NH_4NO_3, D: Milk with 20% water with 0.20% NH_4NO_3

The addition of NH_4NO_3 into the adultered milk decreased the crioscopic temperature, it seems that the addition of 0.05% of this adulterant brings the value in the normal range. The addition of 0.20 % NH_4NO_3 decreased the crioscopic temperature with 73.16 %.

3.5. The influence of CH_4ON_2 on the physical properties of milk adulterated with 20 % water

The CH_4ON_2 is added, like NaCl, NH_4NO and NH_4Cl too, into the milk for masking the water adding into the milk and for the correction of the density.

In this paper, it was added CH_4ON_2 to the milk adultered with 20% water in different concentrations: 0.05, 0.10 and 0.20 % respectively in order to achieve the optimum quantity for the density and crioscopic temperature correction.

In the table 5 is presented the density of the sample adultered with 20% water in which was added different concentrations of CH_4ON_2.

Table 5.
The density of milk adultered with 20% mixed with different concentrations of CH_4ON_2

Sample	Density (g/cm^3)
Milk with 20% water	1.021
Milk with 20% water with 0.05% CH_4ON_2	1.032
Milk with 20% water with 0.10% CH_4ON_2	1.034
Milk with 20% water with 0.20% CH_4ON_2	1.035

The addition of CH_4ON_2 into the adultered milk increased the density, it seems that the addition of 0.05 CH_4ON_2 is bringing the milk density into the desired range. In the case of 0.10% CH_4ON_2 the value of the density is appropriated to the normal value. The addition of 0.20% CH_4ON_2 increased the density with 1.35%.

In the table 6 is presented the crioscopic temperature of the sample adultered with 20% water in which was added different concentrations of CH_4ON_2.

Table 6.
The crioscopic temperature of milk adultered with 20% mixed with different concentrations of CH_4ON_2

Sample	Crioscopic temperature (°C)
Milk with 20% water	-0.4296
Milk with 20% water with 0.05% CH_4ON_2	-0.4916
Milk with 20% water with 0.10% CH_4ON_2	-0.5410
Milk with 20% water with 0.20% CH_4ON_2	-0.6794

The addition of CH_4ON_2 into the adultered milk decreased the crioscopic temperature, it seems that the addition of 0.10% of this adulterant brings the value in the normal range. The addition of 0.20 % CH_4ON_2 decreased the crioscopic temperature with 58.14 %.

4. Conclusions

The milk adulteration is one of the common adulterations of food products. The substitution of milk with water is leading to the modification of the physical parameters. In this paper we studied the influence of different adulterants on the physical properties of the milk substituted with 20% water. The substances used for the density and crioscopic temperature are useful for the correction of the two parameters. All the four adulterants (NaCl, NH_4Cl, NH_4NO_3 and CH_4ON_2) brought the density and the crioscopic temperature in the normal range. For the corrections of the density is needed 0.1% NaCl or 0.05% CH_4ON_2, 0.05% NH_4NO_3 or 0.05%

NH_4Cl. In the case of the crioscopic temperature is needed 0.1% NaCl or 0.10% CH_4ON_2 or 0.05% NH_4NO_3 or 0.05% NH_4Cl for the corrections. The addition of NaCl in the milk is not leading to a health issue, but the other three substances must not be presented in the milk.

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