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COMPARATIVE ASSESSEMENT OF HYGIENE QUALITY OF POTABLE WATER USED IN FOOD INDUSTRY

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Abstract

Samples of potable water were assessed using their chemical parameters as indices. The chemical properties such as concentration of nitrates, nitrites and residual chlorine were determined with standardized methods. The chemical parameters values obtained in the water samples from monitored food units were all within the normative recommendations. The public health importance of using potable water in food industry and the implications of the sanitary condition of the food units on the water quality are discussed in the text.

Keywords: hygiene, water, food industry

INTRODUCTION

The public health importance of using potable water in food industry and the implications of the sanitary condition of the food units on the water quality are the major issues. Potable water is widely used in the food industry for many purposes. Its quality should be assured in the same way as any other raw material or ingredient.

A quality assurance programe for water should cover its source, its treatment and its distribution and storage within the factory, and include regular checks for compliance with internal or legislative standards (Diersing and Nancy, 2009).

The food industry requires a huge amount of water. The water is used as an ingredient, a cleaning agent, for boiling and cooling purposes, for transportation and conditioning of raw materials.

Nitrate is used mainly in inorganic fertilizers. It is also used as an oxidizing agent and sodium nitrite is used as a food preservative, especially in cured meats. Nitrate is sometimes also added to food to serve as a reservoir for nitrite. Nitrate can reach both surface water and groundwater as a consequence of agricultural activity (including excess application of inorganic nitrogenous fertilizers and manures), from wastewater treatment and from oxidation of nitrogenous waste products in human and animal excreta, including septic tanks.

Nitrite can also be formed chemically in distribution pipes by *Nitrosomonas* bacteria during stagnation of nitrate-containing and oxygen-poor drinking-water in galvanized steel pipes or if chloramination is used to provide a residual disinfectant and the process is not sufficiently well controlled. In most countries, nitrate levels in drinking-water derived from surface water do not exceed 10 mg/l. In some areas, however, concentrations are higher as a result of runoff and the discharge of sewage effluent and certain industrial wastes. In 15 European countries, the percentage of the population exposed to nitrate levels in drinking-water above 50 mg/l ranges from 0.5% to 10% (WHO, 1985b; ECETOC, 1988), this corresponds to nearly 10 million people.

Chloramination may give rise to the formation of nitrite within the distribution system, and the concentration of nitrite may increase as the water moves towards the extremities of the system. Nitrification in distribution systems can increase nitrite levels, usually by 0.2–1.5 mg of nitrite per litre, but potentially by more than 3 mg of nitrite per litre (Awwarf, 1995).

When nitrate levels in drinking-water exceed 50 mg/l, drinking-water will be the major source of total nitrate intake, especially for bottle-fed infants. The contribution of drinking-water to nitrate intake is usually less than 14%. For bottle-fed infants, daily intake from formula made with water containing 50 mg of nitrate per litre would average about 8.3–8.5 mg of nitrate per kilogram of body weight per day.

The toxicity of nitrate to humans is mainly attributable to its reduction to nitrite. The major biological effect of nitrite in humans is its involvement in the oxidation of normal Hb to metHb, which is unable to transport oxygen to the tissues.

The reduced oxygen transport becomes clinically manifest when metHb concentrations reach 10% of normal Hb concentrations and above; the condition, called methaemoglobinaemia, causes cyanosis and, at higher concentrations, asphyxia.

The normal metHb level in humans is less than 2%; in infants under 3 months of age, it is less than 3%. The Hb of young infants is more susceptible to metHb formation than that of older children and adults.

This higher susceptibility is believed to be the result of the large proportion of fetal Hb still present in the blood of these infants. This fetal Hb is more easily oxidized to metHb.

In addition, there is a deficiency in the metHb reductase responsible for the reduction of metHb back to Hb. The net result is that a dose of nitrite causes a higher metHb formation in these infants than in adults.

Congenital malformations have been related to high nitrate levels in drinking-water in Australia; however, these observations were not confirmed.

Other studies also failed to demonstrate a relationship between congenital malformations and nitrate intake (Who, 1985b; Ecetoc, 1988). Studies relating cardiovascular effects to nitrate levels in drinking-water gave enconsistent results (Who, 1985b).

Possible relationships between nitrate intake and effects on the thyroid have also been studied, as it is known that nitrate competitively inhibits iodine uptake.

In addition to effects of nitrate on the thyroid observed in animal studies and in livestock, epidemiological studies revealed indications for an antithyroid effect of nitrate in humans.

Large amounts of chlorine are used to disinfect drinking-water and and to control bacteria and odours in the food industry. Chlorine is present in most disinfected drinking-water at concentrations of 0.2–1 mg/litre.

The effects of heavily chlorinated water on human populations exposed for varying periods were summarized in a report that was essentially anecdotal in character and did not describein detail the health effects observed.

In a study on the effects of progressively increasing chlorine doses (0, 0.001, 0.014, 0.071, 0.14, 0.26, or 0.34 mg/kg of body weight) on healthy male volunteers (10 per dose), there was an absence of adverse, physiologically significant toxicological effects in all of the study groups.

It has been reported that asthma can be triggered by exposure to chlorinated water. Episodes of dermatitis have also been associated with exposure to chlorine and hypochlorite.

MATERIALS AND METHODS

The research was conducted in 2009 and 2010, in 4 units of food industry: Food Unit A, Food Unit B which are milk factories and Food Unit C, Food Unit D (meat factories).

Food Units A, B and C are placed in Bihor County while Food Unit D is placed in Satu Mare County. To study the hygienic quality of potable water used in food industry, water samples were collected from certain control points such as: drilled well water, 200 meters depth (Food Unit A and D) and tap input unit (Food Unit B and C).

The chemical analysis of water was accomplished corresponding with the methodology approved by the Laboratory of Sanitary Chemistry within the framework of Public Health Department of Bihor County. Part of the analysis were made as well in the Hygiene Laboratory of Environmental Protection Faculty, University of Oradea.

RESULTS AND DISCUSSION

In the following will be presented the results of chemical analysis of potable water samples collected from the milk and meat factories. Numerical results of analysis are expressed in tables and graphics and are compared with the maximum limits set by into force legislation.

The results are interpreted with statistical Student test. Statistical interpretation of results suggest significance or non-significance of values obtained such as a results of chemical analysis of potable water samples collected from monitored milk and meat factories.

So, the values of quality indicators monitored in Milk factory A, Meat factory B and Meat factory D with own source of water supply were matched with indicators of potable water monitored in Milk factory B which has a central source of water supply (table 1,2,3; fig. 1,2,3).

Table 1

Significance of differences between the quality indicators values determined in potable water samples collected from Milk factory A and Milk factory B

Quality indicator of potable water	*Unit of measure*	*Water supply source*		*Values*		*Significance of differences*
		Milk factory A (a)	Milk factory B (b)	a	b	
NO_2	mg/l	own source of water supply (a) central source of water supply (b)		0,2	0,01	$p<0,02$**
				0,1	0,06	
				0,1	0,05	
				0,2	0,04	
				0,05	0,01	
NO_3	mg/l			20	1,38	$p>0,001$***
				18,5	1,50	
				19,1	2,15	
				19	2	
				18,9	2,9	
Residual chlorine	mg/l			0,23	0,023	$p>0,10$
				0,45	0,045	
				0,35	0,030	
				0,15	0,016	
				0,25	0,25	

Significance of differences: ** - significantly distinct; *** - very significant.

Table 2

Significance of differences between the quality indicators values determined in potable water samples collected from Meat factory C and Milk factory B

Quality indicator of potable water	*Unit of measure*	*Water supply source*		*Values*		*Significance of differences*
		Meat factory C (a)	Milk factory B (b)	a	b	
NO_2	mg/l	own source of water supply (a) central source of water supply (b)		0,04	0,01	p<0,02**
				0,06	0,06	
				0,01	0,05	
				0,03	0,04	
				0,04	0,01	
NO_3	mg/l			0,1	1,38	p>0,001***
				0,01	1,50	
				0,12	2,15	
				0,19	2	
				0,23	2,9	
Residual chlorine	mg/l			0,2	0,023	p<0,02**
				0,45	0,045	
				0,30	0,030	
				0,16	0,016	
				0,25	0,25	

Significance of differences: ** - significantly distinct; *** - very significant.

Table 3

Significance of differences between the quality indicators values determined in potable water samples collected from Meat factory D and Milk factory B

Quality indicator of potable water	*Unit of measure*	*Water supply source*		*Values*		*Significance of differences*
		Meat factory D (a)	Milk factory B (b)	a	b	
NO_2	mg/l	own source of water supply (a) central source of water supply (b)		0,4	0,01	p<0,01**
				0,3	0,06	
				0,4	0,05	
				0,4	0,04	
				0,1	0,01	
NO_3	mg/l			24,3	1,38	p>0,001***
				26,5	1,50	
				30,1	2,15	
				31	2	
				30,9	2,9	
Residual chlorine	mg/l			0,3	0,023	p<0,02**
				0,4	0,045	
				0,3	0,030	
				0,1	0,016	
				0,2	0,25	

Significance of differences: ** - significantly distinct; *** - very significant.

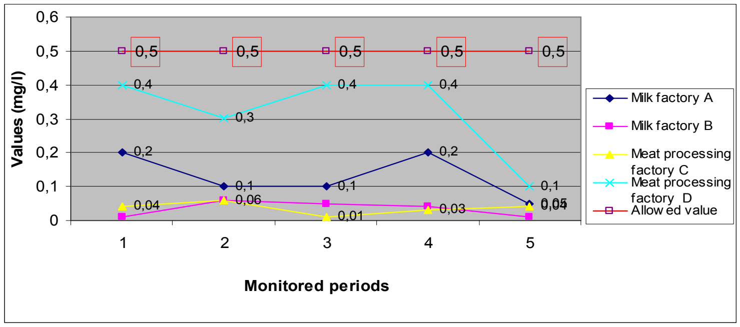

Fig. 1. Monitoring of nitrite NO_2 (mg/l) concentrations of potable water samples collected from monitored food units

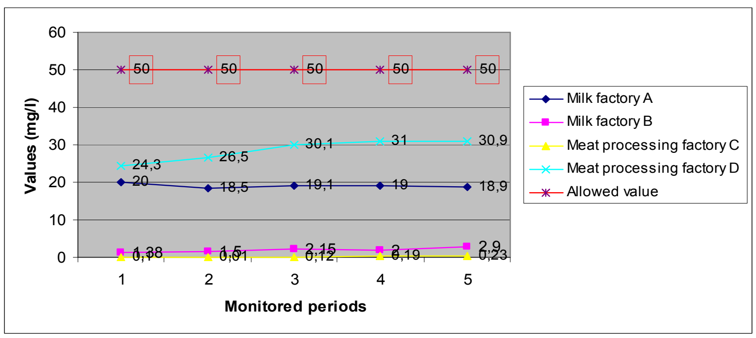

Fig. 2. Monitoring of nitrate NO_3 (mg/l) concentrations of potable water samples collected from monitored food units

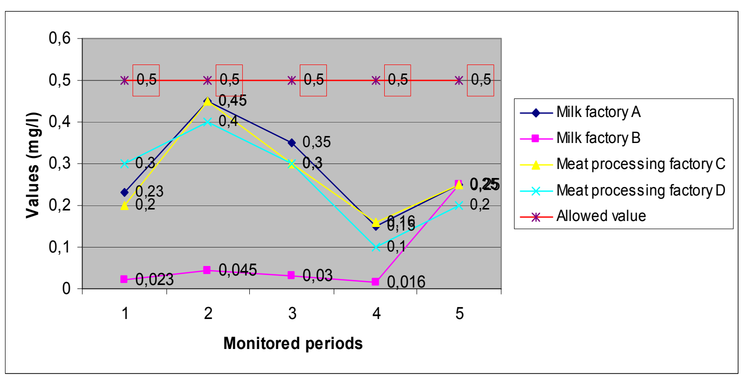

Fig. 3. Monitoring of residual chlorine (mg/l) concentrations of potable water samples collected from monitored food units

The chemical analysis of potable water samples collected from monitored food units reveals that analyzed water coresponded to water quality standards and analysed parameters such as nitrite, nitrate, and residual chlorine were included in the maximum permissible limits for potable water quality.

Making a comparative analysis of water quality used in monitored food units is found that the highest concentrations in nitrates and nitrites ($p<0,02$; $p<0,01$; $p>0,001$) were determined in water samples collected from „Meat processing factory D” who is a meat processing factory with own source of water supply and the highest concentrations of residual chlorine ($p<0,02$) were determined in potable water samples collected from „Milk factory A”.

The presence of nitrate in the surface water and groundwater is a consequence of agricultural activity, wastewater treatment and oxidation of nitrogenous waste products in human and animal excreta, including septic tanks.

The presence of residual chlorine in disinfected water has a sanitary importance and suggest the efficiency of disinfection process of potable water and an integrity of water distribution network.

CONCLUSIONS

The values of chemical parameters of the water samples collected from monitored food units were all within the normative recommendations.

Today, water the most precious resource is generally contaminated with many kinds of impurities such as organic, inorganic contaminants and micro organisms.

The provision of safe drinking water is one of the most important steps that can be taken to improve the health of a community by preventing the spread of water-borne disease.

The maintenance of a sufficient supply of wholesome drinking water is a complex undertaking in which individuals from many disciplines have a role.

Contamination is often intermittent and may not be revealed by the examination of a single sample.

Information gained over time through monitoring will provide a comprehensive picture of the range of quality of any particular source of water, any deterioration from which should at once arouse suspicion.

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