QUALITY PARAMETERS OF DRINKING WATER AND WASTEWATERS FROM FOOD INDUSTRY ASSESSEMENT

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Abstract

This paper presents the dynamic and the quality of drinking water and wastewater from four units of food industry: 2 milk factories and 2 meat processing factories. Depending on the need and use of potable water, in this research the potable water consumption (m^3/day) of the monitored units is presented and the average quantities of wastewater discharged by the monitored units are evaluated. Also, samples of drinking water and wastewater were assessed using their physical and chemical parameters as indices. The quality of water extracted from artificial wells in the ground has been compared to the quality of water coming from the central source supply.

To assess wastewaters quality from dairies and meat factories, before treatment and pre-treatment, values of physical and chemical parameters of wastewater from dairies were compared with the values obtained in meat factories.

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.

Key words: potable water, wastewater, food industry.

INTRODUCTION

The main concern of the society in present and future is the avoidance or limitation of water pollution as a first action to maintain existing natural resources of mankind and the implementation principles for monitoring and control of hygienic quality of water. 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. Access to safe drinking-water is essential to health, a basic human right and a component of effective policy for health protection (World Health Organization).

Today, water the most precious resource is generally contaminated with many kinds of impurities such as organic, inorganic contaminants and microorganisms. Also, water is one of the most comprehensively regulated areas of EU environmental legislation. It is necessary not only to adapt the original reglementations to bring it in line with the current scientific and technical progress, but also to bring it into accordance with the principle of subsidiarity by reducing the number of parameters that member states were obliged to monitor and by focusing on compliance with essential quality and health parameters. The importance of water, sanitation and hygiene for health and development has been reflected in the outcomes of a series of international policy forums. In some regions, it has been shown that investments in water supply and santitation can yield a net economic benefit, since the reductions in adverse health effects and health care costs outweigh the costs of undertaking the interventions (World Health Organization).

Potable water is extensively used in the food industry for many purposes. Water is involved in many food processing methods and unit operations, e.g., soaking, washing, rinsing, fluming, blanching, scalding, heating, pasteurising, chilling, cooling, steam production, as an ingredient, and for general cleaning, sanitation and disinfection purposes.

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 drivers to improving water efficiency in industry can be roughly classified into three types: economic, environmental and technological (Terrell and Holmes, 1994), whereas the barriers also include elements dealing with safety, legislation, perception, collaboration and communication.

Depending on the quality of the water and the technical requirements for use, this water may be further adjusted to suit different needs (Griffiths, 1998) such as removal of colour, softening or the addition of chlorine to minimise the count of potential spoilage microorganisms or the use of UV radiation, e.g., to disinfect stored water directly before use as an ingredient (Dawson, 1998).

Wastewater generated from agricultural and food operations have distinctive characteristics that set it apart from common municipal wastewater managed by public or private sewage treatment plants throughout the world: it is biodegradable and nontoxic, but that has high concentrations of biochemical oxygen demand (BOD) and suspended solids (SS). The various types of contamination of wastewater require a variety of strategies to remove the contamination

Processing of food from raw materials requires large volumes of high grade water. Animal slaughter and processing produces very strong organic waste from body fluids, such as blood, and gut contents. This wastewater is frequently contaminated by significant levels of antibiotics and growth hormones from the animals and by a variety of pesticides used to control external parasites (Tchobanoglous, et.al, 2003).

Quality standards for drinking water are long. As science progressed, pollution has intensified and diversified and in this context increased requirement and complexity of standards, methods of analysis and control. It is said today that water is usually the best known and monitored environmental factor. In developed countries it has been shown that standards and regulations should be reconsidered and updated periodically to ensure health. Regarding the quality, world tends to a common basis, resulting from experience and needs of all. In this regard the World Health Organization issued and periodically reissuing "Guidelines for Drinking Water Quality" and international economic and political unions such as European Union also promotes common detailed rules or at least guidelines, such as Directive 98/83/EC on the quality of water intended for human consumption. In Romania, for drinking water quality standards in the 80s were STAS 1342/84, then STAS 1342/1991, and most recently STAS 458/2002 and 311/2004.

MATERIAL AND METHOD

During the years 2012-2013, was studied hygienic quality of drinking water and chemical characteristics of wastewaters in four food industry units (two dairies and two meat factories) from Bihor County, Romania.

Samples of drinking water and wastewater have been revealed before pre-treatment and sewage treatment plants and also after treatment from certain checkpoints and were analyzed in terms of toxicological and microbiological testing. Based on the results it was determined whether water samples characteristics are classified in accordance with hygienic quality of water specified in the rules laid down by the regulations in force.

Drinking water samples were taken from the valve located at the entrance into the monitored units or from the basin with water from the well drilled. To monitor the quality of untreated wastewaters the samples were collected from the discharge point of wastewaters to pre-treatment station (for the food units that do not have their own) and from the discharge point to own treatment plants.

Monitoring of the quality of effluent discharged from food units that do not have treatment plants was achieved by sampling pre-treated wastewaters from cesspools units to determine their classification quality standards for wastewater discharged into the sewage system. Monitoring of the quality of treated wastewater in case of the food units which have own treatment plants was performed by taking samples of wastewater from their final discharge point to surface water (receiver).

The physical, chemical and microbiological water analyses were performed according to standard methods and were achieved in the Hygiene Laboratory of the Faculty of Environmental Protection from Oradea. For determining the quality indicators of drinking water and wastewater the following methods were used: water samples taste and odor were determined by comparing this and/or their dilutions with a water reference; water color was measured using a color comparator; water turbidity was determined by comparison with a solution of water investigated using a known nephelometry comparator; nitrites were determined with absorption spectrometric molecular method; nitrates were determined with spectrometric method with 2.6-dimethylphenol; water hardness was determined by the complexometric titration of calcium and magnesium; residual chlorine was analyzed by iodometric method; pH of the water - with a pH meter; total number of germs, coliforms and faecal streptococci were counted with the membrane filter method.

Also were made following analysis of wastewater: biochemical oxygen was obtained by determining the dissolved oxygen content in water after harvest and after 5 days, and the difference was BOD_5; chemical oxygen demand was determined by potassium dichromate method; total suspensions were determined by their separation with filtration or centrifuging, depending on their size; pH of the wastewater - using a pH meter; chlorides were analyzed by titration with silver nitrate using chromate as indicator (Mohr method); total nitrogen was determined with Kjeldahl method; total phosphorus was determined using ammonium molybdate spectrometric method.

RESULTS AND DISCUSSION

Regarding the consumption of drinking water, making for an analysis of all four monitored food units was observed that the highest consumption have shown meat plants followed by dairies (fig. 1). Consumption of drinking water varied depending on production size, employees number, plant equipment and processes developed scale. The largest quantities of wastewaters were discharged by meat factories (table 1; fig. 2).

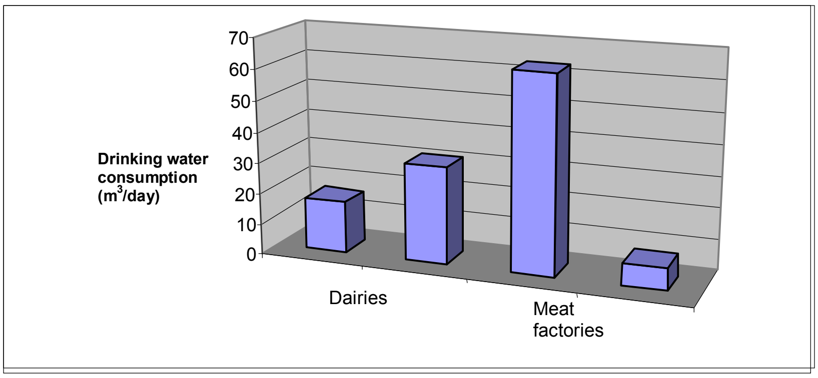

Fig. 1. Drinking water consumption (m^3/day) in monitored food units

Table 1

Average quantities of wastewater (m^3/day) discharged by the monitored food units

Monitored food units	Total discharged wastewater (m^3/day)
Milk factory A	16.415
Milk factory B	28.93
Meat processing factory C	50.9
Meat processing factory D	5.64

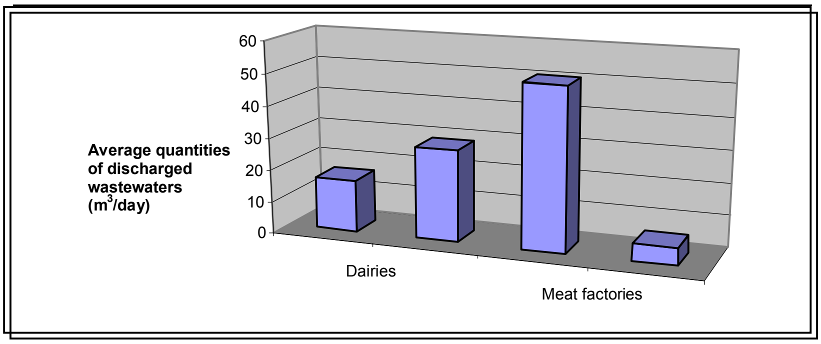

Fig. 2. Evalution of average quantities of discharged wastewaters (m^3/day)

The physical and chemical characteristics of drinking water samples taken from the food industry units monitored in terms of assessing the hygienic quality of the water used for technological purposes, showed that the samples presented no color change and no particular taste and odor characteristic of possible contamination with pollutants.

Drinking water from drilling showed significantly higher hardness values compared to the values for drinking water coming from the supply central source. Drinking water samples collected from monitored food units showed no degrees of turbidity values above the maximum allowed under the current rules (tables 1-4).

Although not exceed the maximum limits set by the standards, nitrates and nitrites concentrations had significantly higher values in food units supplied with water from its own source (water drilling) compared to units supplied with water from the central source (Fig. 3; Fig. 4) .

Table 2

Physical and chemical parameters of drinking water samples (drilled water) collected from a milk factory

Crt. nr.	Physico-chemical parameters	Unit of measure	Monitoring period / Results of analysis					Allowed Values
			I	II	III	I V	V	
1	Taste		0	0	0	0	0	no changes
2	Odor		0	0	0	0	0	no changes
3	Color	deg.	0	0	0	0	0	no changes
4	Turbidity	deg.	0	0	2	0	0	max. 5
5	Nitrite	mg/l	0.2	0.1	0.1	0.2	0.05	max. 0.5
6	Nitrate	mg/l	20.0	18.5	19.1	19.0	18.9	max. 50
7	Total hardness	germ.deg.	17.50	18.40	17.60	18.50	17.33	min. 5 – max. 20
8	pH	pH unit	7.44	7.56	7.62	7.64	7.55	6.5-9.5
9	Residual chlorine	mg/l	0.23	0.45	0.35	0.15	0.25	max. 0.5

Table 3

Physical and chemical parameters of drinking water samples (central source) collected from a meat factory

Crt. nr.	Physico- chemical parameters	Unit of measure	Monitoring period / Results of analysis					Allowed Values
			I	II	III	I V	V	
1	Taste		0	0	0	0	0	no changes
2	Odor		0	0	0	0	0	no changes
3	Color	degrees	0	0	0	0	0	no changes
4	Turbidity	degrees	1	0	2	0	0	max. 5
5	Nitrite	mg/l	0.01	0.06	0.05	0.04	0.01	max. 0.5
6	Nitrate	mg/l	1.38	1.50	2.15	2.0	2.9	max. 50
7	Total hardness	germ.deg.	4.48	4.56	5.04	6.05	7.39	min. 5 – max. 20
8	pH	pH unit	8.17	8.56	8.62	8.64	8.55	6.5-9.5
9	Residual chlorine	mg/l	0.023	0.045	0.030	0.016	0.25	max. 0.5

Table 4

Physical and chemical parameters of drinking water samples (drilled water) collected from another milk factory

Crt. nr.	Parameters	Unit of measure	Monitoring period / Results of analysis					Allowed Values
			I	II	III	I V	V	
1	Taste		0	0	0	0	0	no changes
2	Odor		0	0	0	0	0	no changes
3	Color	degrees	0	0	0	0	0	no changes
4	Turbidity	degrees	0	0	2	1	1	max. 5
5	Nitrite	mg/l	0.04	0.06	0.01	0.03	0.04	max. 0.5
6	Nitrate	mg/l	0.1	0.01	0.12	0.19	0.23	max. 50
7	Total hardness	germ.deg	5.61	5.66	5.74	6.05	5.83	min. 5 – max. 20
8	pH	pH units	7.75	7.56	7.60	7.30	7.80	6.5-9.5
9	Residual chlorine	mg/l	0.2	0.45	0.30	0.16	0.25	max. 0.5

Table 5

Physical and chemical parameters of drinking water samples (central source) collected from another meat factory

Crt. nr.	Physico- chemical parameters	Unit of measure	Monitoring period / Results of analysis					Allowed Values
			I	II	III	I V	V	
1	Taste		0	0	0	0	0	no changes
2	Odor		0	0	0	0	0	no changes
3	Color	degrees	0	0	0	0	0	no changes
4	Turbidity	degrees	1	2	0	1	0	max. 5
5	Nitrite	mg/l	0.4	0.3	0.4	0.4	0.1	max. 0.5
6	Nitrate	mg/l	24.3	26.5	30.1	31.0	30.9	max. 50
7	Total hardness	g. deg.	9.48	10.55	12.44	11.50	13.37	min. 5 – max. 20
8	pH	pH units	8.27	8.55	8.62	7.93	8.04	6.5-9.5
9	Residual chlorine	mg/l	0.3	0.4	0.3	0.1	0.2	max. 0.5

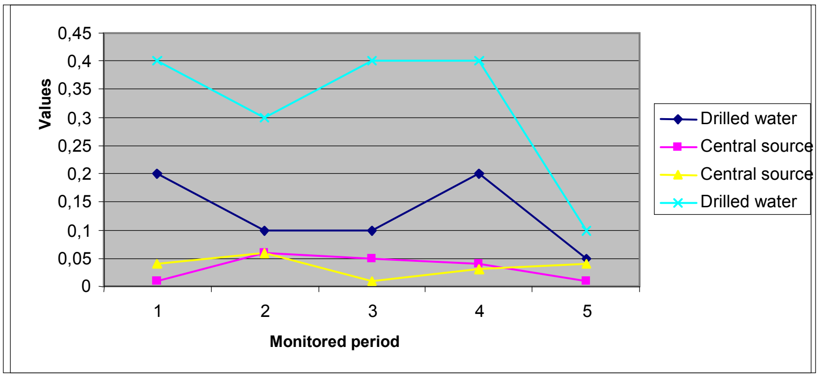

Fig.3. Monitoring of nitrite concentrations (mg/l) of drinking water samples collected from monitored food units

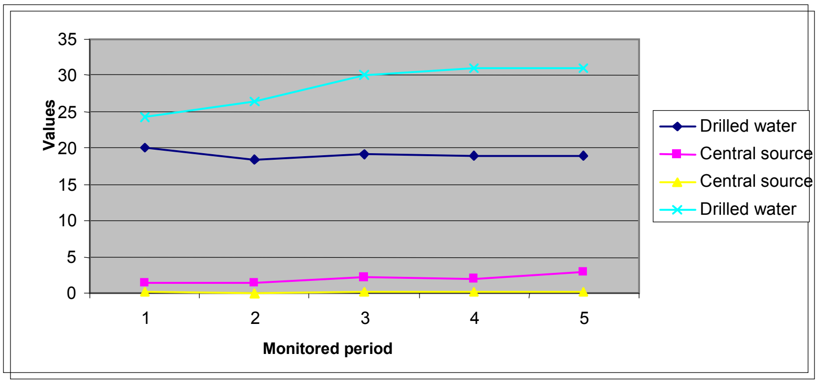

Fig.4. Monitoring of nitrate concentrations (mg/l) of drinking water samples collected from monitored food units

The chemical analysis of water samples collected from the studied food units showed no residual chlorine concentrations above permissible limits but drinking water from wells drilled presented concentrations of residual chlorine significantly higher than the values recorded in drinking water from the central source. This may highlight that water disinfection process was done efficiently and properly (tables 1-4; Fig. 5).

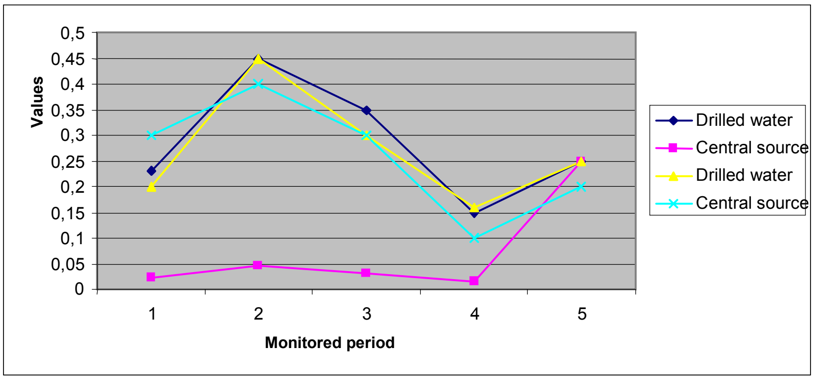

Fig.5. Monitoring of residual chlorine (mg/l) of drinking water samples collected from monitored food units

Microbiological analysis of water samples collected from the studied food units shows that there were no exceedances of the maximum limits on the presence of numerical mesophilic microorganisms but in certain monitoring period were exceedances of total number of coliform bacteria admitted as regulations. This means that the disinfection was done incorrectly, however, necessary steps were taken to remedy the situation, then absence of coliform bacteria was recorded in drinking water samples. Regarding the presence of enterococci, drinking water harvested from monitored food units was within the permissible limits set by law ascertaining the absence of germs.

In the following, to assess wastewaters quality from dairies and meat factories, before treatment and pre-treatment, values of monitored pollution indicators from dairies were compared with the values obtained in meat factories. The highest values of the COD and BOD_5 indicators were recorded in samples of wastewater from milk processing units, samples taken before pre-treatment and treatment from the monitored food unit's checkpoints (Fig. 6).

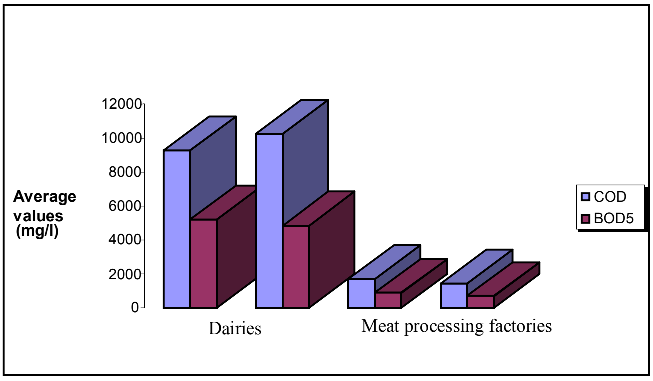

Fig.6. Comparative analysis of the average values of COD and BOD_5 (mg/l) pollution indicators determined in wastewater

The highest chloride concentrations and pH values were recorded in the wastewater samples taken from dairy plants compared to those registered in the samples of wastewater from meat factories. Chloride concentrations values in the wastewater from milk industry are much higher than those from the meat industry since the washing waters resulting from the processing of butter and cheese making are heavily loaded with inorganic salts (Fig. 7). Wastewaters from the meat processing industry had higher concentrations of N and P compared to concentrations determined in wastewater samples from dairy industry (Fig. 8; Fig. 9). Wastewaters discharged from monitored food units not comply with the regulations in force and recorded exceedances of indicators: COD, BOD_5, total suspended solids, total nitrogen, total phosphorus, chloride, pH. Following these deviations from the quality standards specified for the wastewaters from food industry the monitored units were sanctioned under the law in force. The situation was corrected and later the monitored parameters recorded corresponding values.

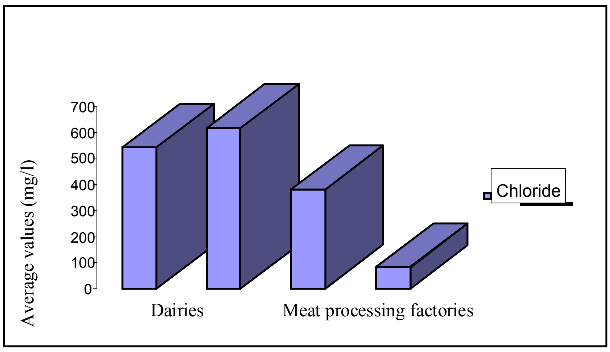

Fig. 7. Average values of chloride concentrations (mg/l) of wastewaters taken before pre-treatment and treatment from the checkpoints of the monitored food units

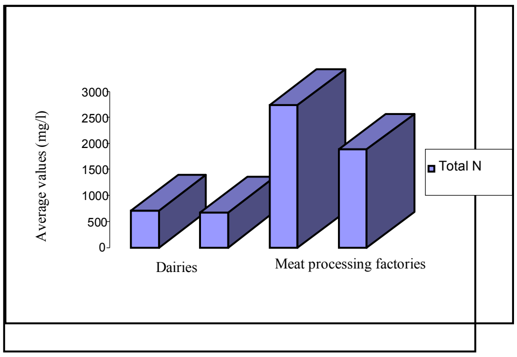

Fig. 8. Average values of total nitrogen concentrations (mg/l) of wastewater taken before pre-treatment and treatment from the checkpoints of the monitored food units

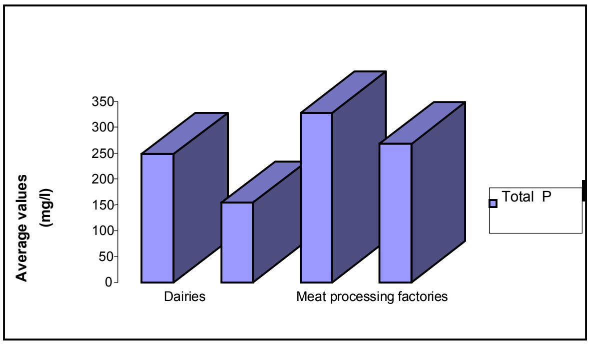

Fig.9. Average values of total phosphorus concentrations (mg/l) of wastewater taken before pre-treatment and treatment from the checkpoints of the monitored food units

CONCLUSIONS

The samples of drinking water from monitored units presented no color change and no particular taste and odor characteristic of possible contamination with pollutants. Samples of drinking water extracted from artificial wells in the ground presented significantly higher hardness values compared to the values obtained for drinking water coming from the central source supply. Also, drinking water samples collected from monitored food units showed no degrees of turbidity values above the maximum allowed under the current rules and presented concentrations of residual chlorine significantly higher than the values recorded in drinking water from the central source. Nitrates and nitrites concentrations had significantly higher values in food units supplied with water from own source (water extracted from wells) compared to units supplied with water from the central source

Wastewaters from the milk industry presented different characteristics from those generated by the meat industry. The highest values of the chloride concentrations, pH values and COD and BOD_5 indicators were recorded in samples of wastewater from milk processing units. Wastewaters from the meat processing industry had higher concentrations of N and P.

In order to produce food supplies, units from food industry must contribute with new technologies that can meet qualitative and quantitative consumer and compete to enter in the world economic circuit.

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