RESEARCH ON WATER QUALITY USED IN THE MILK INDUSTRY IN SIBIU COUNTY (TRANSYLVANIA, ROMANIA)

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ABSTRACT

Dairy wastewater consists of transport water and raw materials washing, technology water, condensation water or cooling water from the washing and disinfecting rooms, manufacturing and packaging equipment cleaning and water from plumbing. These wastewaters are characterized by a high turnover of physico-chemical and microbiological properties due to their composition and origin variety. Because of the composition of protein, fat, and lactose, wastewater cannot be discharged to the sewerage system before their purification, because the mere disposal would pollute the environment. The main purpose of this research is to monitorize the quality of water in the milk processors industry, in order to ensure food security by framing it within the limits permitted by current rules.

ZUSAMMENFASSUNG: Untersuchungen zur Qualität des in der Milchindustrie verwendeten Wassers im Kreis Sibiu/Hermannstadt (Transilvanien, Rumänien).

Die Abwässer aus der Milchindustrie entstehen beim Transport, durch Waschen der verwendeten Rohstoffe, als Ergebnis technologischer Prozesse, als Kondens- und Kühlwasser, beim Spülen und der Desinfektion der Produktionsräume, beim Reinigen der Geräte und der Verpackungen sowie aus Rohrleitungen. Diese Abwässer zeichnen sich bedingt durch ihre Zusammensetzung und Herkunft durch eine hohe Fluktuation der physikalisch-chemischen und der mikrobiologischen Eigenschaften aus. Bedingt durch die Zusammensetzung der Proteine, der Fettstoffe und der Laktose können die Abwässer nicht vor einem Reinigungsprozess in die Abwasserrohre geleitet werden, da sie eine Belastung der Umwelt hervorrufen würden. Das Hauptziel der durchgeführten Untersuchungen war ein Monitoring der Wasserqualität in der Milchverarbeitungsindustrie zur Qualitätssicherung im Rahmen der durch die derzeitigen Vorschriften gegebenen Grenzen.

REZUMAT: Cercetări privind calitatea apei folosite în industria laptelui în județul Sibiu (Transilvania, România).

Apele reziduale din industria laptelui constau în ape de transport și spălare a materiei prime, ape tehnologice, ape de condens sau de răcire, ape de la spălarea și dezinfectia sălilor de fabricație, a utilajelor și ambalajelor, ape de la instalațiile sanitare. Aceste ape reziduale se caracterizează printr-o mare fluctuație a proprietăților fizico-chimice și microbiologice, datorită varietății provenienței și compoziției acestora. Datorită compoziției în proteine, lipide, lactoză, apele reziduale nu pot fi deversate la rețeaua de canalizare înainte să se realizeze epurarea lor, deoarece simpla deversare ar contribui la poluarea mediului înconjurător. Scopul principal al cercetărilor este monitorizarea calității apei din industria laptelui, în vederea asigurării securității alimentare a acesteia prin încadrarea în limitele conforme normelor.

INTRODUCTION

Food wastewater has the characteristics of large high concentration amounts of organic pollutants (Xie and Sun, 2002). One of the main issues is the amount of wastewater continuously produced in the food plants worldwide. Compared to other sectors, the food industry uses a much greater amount of water for each ton of product (Chmiel et al., 1996).

In the future, food and beverage industries will be influenced by the need to comply with EU legislation governing the discharge of industrial effluents (Corporation, 2011). Food industry standards and eco-sanitation concept specify and encourage that processed water intended for reuse - even for cleaning purposes - must be of drinking quality (Mavrov and Bélières, 2000; Elkin et al., 2008; Media, 2012; Curtean-Bănăduc and Bănăduc, 2012; Aquamedia, 2013; Corporation, 2011; Klemeš et al., 2008). Regulations for other applications, such as boiler make-up water or warm cleaning water, are even much more stringent (Media, 2012; Klemeš et al., 2008).

In a background of natural water resource availability and cost increase, wastewater treatment for water reuse can lower the overall water consumption and the global effluent volume of industrial plants (Vourch et al., 2008).

Many older factories were traditionally built near rivers and other natural sources of water, such as springs. Thus, the factory had a supply of water to assist its processing, and also to use as an outlet for the wastewater from the site (Walker, 2008).

Water is used as an ingredient, an initial and intermediate cleaning source, an efficient transportation conveyor of raw materials, and the principal agent used in sanitising plant machinery and areas (Media, 2012). Dairy wastewater is distinguished by the high BOD₅ and COD contents, high levels of dissolved or suspended solids including fats, oils and grease, nutrients such as ammonia or minerals and phosphates and therefore requires proper attention before disposal (Sarkar et al., 2006). Milk industry wastewater contains high concentrations of COD, BOD₅ and TKN of up to 11,000, 5,900 and 720 mg/l, respectively (Viraraghavan et al., 1994; Sirianuntapiboon et al., 2005). Dairy companies have been using condensate from the evaporation of milk for feeding boilers and for lower grade use after simple treatment with chlorine dioxide (Elkin et al., 2008; Klemeš et al., 2008).

Environmental considerations are receiving an increased priority upon political, social, and economic agendas, especially when related to agriculture (Capper et al., 2009). Disposal of improperly treated wastewater often poses risks to the environment (Wu et al., 2005). Using advanced technology to mitigate risk by refined wastewater treatment is a key issue in meeting legislative guidelines, e.g. EU Water Framework Directive (Wu et al., 2005).

Environmental management was regarded as having a function operationally linked and often health and safety at work, while environmental and safety activities include making necessary costs in the business, recognizing that firms implement an environmental management system, have strategic function and help define the entire business strategy, product design, financial and information systems design (Banu and Vizireanu, 1999).

The main purpose of this research is monitoring water quality in the milk processors industry, in order to ensure food security by framing it within the limits permitted by current rules. In order to fulfil this purpose there have been made physico-chemical analyses on wastewater from milk industry units, to ensure optimal quality for their reintegration into the natural circuit.

MATERIAL AND METHODS

Research location

In order to achieve the established goals and objectives, research was conducted at two dairy processing units. To monitor the quality of untreated wastewater samples were collected from the discharge point for wastewater pre-treatment station (for food units that do not have effluent treatment plants - C1) and from the discharge point of the own wastewater treatment stations of food units denoted.

In order to study water quality in the dairy industry, during the 2013-2014 period, wastewater samples were collected (before pre-treatment), from some work control points.

The physico-chemical analysis of water was to determine the organoleptic and physical properties and chemical composition. Water samples were collected in bottles provided with ground glass stoppers.

The main measurements that were made:

- Nitrites were determined by the molecular absorption spectrometric method STAS 12754-89;
- Nitrates were determined by the STAS 12999-91;
- Water hardness was determined by complex metric titration of calcium and magnesium by the method STAS 3026-76;
- pH of water by ISO 10523:2009;
- BOD₅ was obtained by determination of oxygen dissolved in water after harvest and after five days by method EN 25814:1999;
- CCO-Cr - Determination of chemical oxygen consumption by method ISO 6060:1996;
- Total suspension was determined by filtration on glass fiber filters by method EN 872:2005;
- Wastewater pH by method ISO 10523:2009;
- Chlorides were analyzed by titration with silver nitrate using chromate as indicator (Mohr method) by method ISO 9297:2001;
- Total nitrogen was determined by method EN 25663:2000;
- Total phosphorus - spectrometric method with Ammonium molybdate ISO 6878:2005.

RESULTS AND DISCUSSION

After withdrawing the samples from the checkpoints of the monitored units, physico-chemical analyses were conducted to determine whether values of water quality indicators are consistent with the maximum limits governed by the regulations in force. The results obtained after realizing all measurements are presented in table 1.

Knowing the value of biochemical oxygen demand in five days (CBO₅) is extremely important in assessing wastewater pollution, expressing the amount of biodegradable organic substances contained in that water.

Also determining the chemical oxygen demand (CCO_{Cr}) is extremely important in assessing wastewater pollution, expressing the amount of organic substances in the water subjected to this analysis.

The results obtained show that the pollution degree of the water used is insignificant and therefore this water can be used to collect milk without any influence on the characteristics.

All results obtained show that parameters are compliant to the current legislation in the field.

Table 1: Monitoring control from the discharge point for wastewater to the pre-treatment stations.

Sample point	Date	15 January		15 March		15 May		15 July		Normal values
	Year	C1	C2	C1	C2	C1	C2	C1	C2	
NO ³⁻ (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	25.00
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
NO ²⁻ (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	2.00
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
Cl ₂ (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	0.50
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
pH	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	6.5-8.5
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
CBO ₅ (mg O ₂ /l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	20
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
CCO _{Cr} (mg O ₂ /l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	500
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
Susp. solids (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	35
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
Total N (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	10
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
Total P (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	5
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	

CONCLUSIONS

Comparative analyses of potable water used in monitored processing units revealed that, although not exceeding the maximum values allowed by current standards, the highest concentrations of nitrites and nitrates as well as the higher water hardness values, are presented at the power units supplied with water from its own source, compared to power units supplied with water from the central source.

Results confirm that the water used to receive raw milk materials has no influence on the milk composition and all the parameters analysed are compliant to the standards imposed by existing legislation.

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