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MEAT INDUSTRY WASTEWATER MANAGEMENT IN VOJVODINA REGION (SERBIA) ~ CURRENT SITUATION

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Abstract: Meat industry wastewater represents a serious problem regarding environmental degradation and human health protection. Even though this type of wastewater is biodegradable and therefore relatively easily purified, in Serbia, it is often discharged into the sewer and surface receiving water, without the prior treatment. The aim of the study was to create the Inventory of the meat industry and abattoir facilities in the territory of Vojvodina region, Serbia, in order to get an insight into number of entities that discharge polluted water into environment. Most of the discharged wastewater ends up in septic tanks, public sewerage system, or is removed as solid waste and stored on the landfills and open dumps. To ensure environmental sustainability, the polluted effluent should be managed in a way that minimizes its adverse effects on the environment. The first step towards achieving this goal is to determine the number of facilities, as the potential polluters. During the study 59 subjects were registered, and 52 of them took a part in the survey. The results indicate poor quality or complete absence of wastewater treatment and quality control.

Keywords: wastewater, meat industry, abattoir, water treatment, environment

INTRODUCTION

The meat industry is the type of food industry, which causes degradation of the environment to a large extent. This industry sector has a significant role in increasing water use, but only a small amount of the used water is a constituent of the final product, the remaining part is discharged as a wastewater with high biological and chemical oxygen demand, high fat content and high concentrations of dry residue, sedimentary and total suspended matter as well as nitrogen and chlorides (Urbaniak and Sakson, 1999; Arvanitoyannis and Ladas, 2008; Bohdziewicz and Sroka, 2005; Sroka et al., 2004). Wastewater will be generated whenever food is handled in any form, processed, packaged and stored (Iacovidou et al., 2012; Yushina and Hasegawa, 1994).

In meat processing industry, water is used primarily for carcass washing after hide processing from cattle, calves, and sheep or hair removal from hogs and again after evisceration, for cleaning, and sanitizing of equipment and facilities, and for cooling of mechanical equipment such as compressors and pumps. A large quantity of water is used for scalding of hogs for hair removal before evisceration (Ur Rahman et al., 2014; FAO, 2006; 2008).

During slaughtering and processing, usage of water and wastewater generation are relatively constant and low compared to the cleanup period that follows. Meat processing wastewater flow rates can be highly variable, especially on an hourly basis (FAO, 2006). Variability of the wastewater quality and quantity represents a serious problem in the situations when drawing of certain conclusions is needed. Especially when there is no permanent monitoring of wastewater quality provided.

Wastewater from meat processing can contain mineral elements and water supply systems and mechanical equipment may be significant source of metals, including copper, chromium, molybdenum, nickel, titanium, and vanadium (González-González et al., 2014; Wong and Cheung, 1995).

The main constituents of meat processing wastewater are biodegradable organic compounds, primarily fats and proteins, present in both particulate and dissolved forms. Pesticide residues may be present from treatment of animals or their feed. Therefore, the major problem of wastewater treatments for meat industries are the usual pollutants of these waters, such as organic macromolecules: proteins, polysaccharides, amino sugars, nucleic acids, humic and fulvic acids, and cell components in addition to wastewater

microbial contamination found in these waters (Mostafa and Darwish, 2014).

Significant amount of total coliform, fecal coliform, and fecal streptococcus groups of bacteria is present due to the presence of manure in meat processing wastewater. Although members of these groups of microorganisms generally are not pathogenic, they do indicate the possible presence of pathogens such as *Salmonella* spp. and *Campylobacter jejuni* (Barkocy-Gallagher et al., 2003; Sandvig and van Deurs, 2000). They also indicate the possible presence of gastrointestinal parasites and enteric viruses (EPA, 2004).

All of the mentioned possible pollutants from the meat industry processes are contaminants that cause concern in wastewater treatment (G. Coskuner and N.S. Ozdemir, 2006).

Global meat production was estimated at approximately 280 million tonnes in 2008. Experts predict that by 2050 nearly twice as much meat will be produced as today, for a projected total of more than 465 million tonnes (Kosseva, 2013). Consumption of meat and other animal products also continues to grow (Nordgren, 2012; Graca et al., 2014). From analysis of the Food and Agricultural Organisation of the United Nations (FAO) Food Balance Sheet data, it is clear that there has been a significant increase in global meat consumption over time. Aggregate meat consumption increased by almost 60% between 1990 and 2009, from 175,665 thousand tonnes to 278,863 thousand tonnes, driven in part by a growing world population (Henchion et al., 2014; Delgado, 2003). Most of this increase in production will come through industrialized animal production systems (Allievi, 2015). Although it is well known that meat industry sector is one of the main causes of insufficient effluent quality, data on meat production in Vojvodina region, Serbia, are poor due to lack of public awareness and non-compliance with national legislation. These trends will have major consequences on contamination of environment and human health as well as on the establishment of good wastewater management practice in Serbia.

Meat production makes huge amounts of waste (Cuadros et al., 2011; Virmond et al., 2011; Ur Rahman et al., 2014; Vujic et al., 2010). Processes, like rendering and hide processing operations, can be the significant sources of all kind of wastes mainly discharged on unsanitary landfills and opened dumps. Meat processing wastes consist of blood, viscera, soft tissue removed during trimming and cutting, bone tissue, urine and feces, soil from hides and hooves, and various cleaning and sanitizing compounds (Ur Rahman et al., 2014).

In Serbia, there is a lack of data regarding the total number of meat industry facilities that have wastewater treatment. Also the information about quantity and quality of wastewater generated in meat industry processes is unknown.

Vojvodina makes almost a quarter of the Serbian territory or 21,506 square kilometres. Although husbandry is in continuing decrease for years, meat production does show positive trends. Apart from smaller farmers, there are also large trading companies, who have their own food production, pig and cow production and sales.

Within the National project of the Ministry of Education, Science and Technological Development: Improvement and development of hygienic and technological procedures in production of animal originating foodstuffs with the aim of producing high-quality and safe products competitive on the global market, preparation of the meat industry inventory was the main activity in the first phase in order to develop, organize and archive the database. The inventory contains data on sources, types, amounts, method and place of discharge of polluting substances into water, as well as on amounts, type, content and the method for treatment and disposal of wastewater. Main focus was on meat industry facilities in the territory of Autonomous Province of Vojvodina (AP Vojvodina), and the research was conducted in the year 2011.

This kind of research was conducted for the first time in Serbia indicating the relevance of obtained results. In the future, knowledge gained from this Project phase could be used for strengthening the capacity of meat industry sector in the Republic of Serbia. Obtained data could be used for evaluation of potential risks for natural water resources, where untreated or partially treated wastewater is discharged.

METHODOLOGY

Researchers from the Department of Environmental Engineering, Faculty of Technical Sciences, University of Novi Sad conducted the preparation of the Inventory of the meat industry potential polluters from the territory of the AP Vojvodina. Researchers separately studied three regions within AP Vojvodina: Srem, Banat and Bačka. The first phase of the investigation consisted of identification of all legal entities from the meat industry sector in each region. These data were obtained from the Serbian Business Registers Agency (SBRA), and the overall number of potential water polluters within this sector totals up to 94 legal entities. The research group collected all the information through field observations and fulfilled the Questionnaires with meat industry employments. After this phase, it was concluded that there are

only 59 registered meat industries still operating in the territory of Vojvodina in the year 2011.

The Questionnaire was conducted in all the particular meat processing facilities and the most important data about the wastewater defined within the survey were:

- » Wastewater discharge location – Information about the wastewater recipient
- » Information about flow rate and methods for measuring – Estimation of flow rate or measured data
- » Wastewater treatment – Information about existing wastewater treatment method
- » Wastewater quality control before and after the treatment – Information about whether a treatment exists

The following phases included collection and processing of the data, requested within the Questionnaire, identification of GPS location of all potential polluters and field visits, which included identification of wastewater discharges at each polluter, if any.

For the collection of a geographic information system (GIS) data and mapping of all identified meat industry facilities the Trimble® GeoXT Handheld device from GeoExplorer series has been used. All recorded GPS locations were stored in the joint database together with the data collected through questionnaires. For this purpose ESRI's ArcInfo GIS software was applied. ArcGIS is a GIS for work with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analyzing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database. The system provides an infrastructure for making maps and geographic information available throughout an organization, across a community, and openly on the Web.



Figure 1. Locations of existing registered meat industry facilities in Vojvodina

Figure 1 presents the overview of locations of meat industry facilities in Vojvodina, prepared using ArcInfo. When observing the regions of Vojvodina separately, it can be concluded that the most extensive meat production is in the region of Srem. It is almost twice the number of meat industry facilities in Bačka, and almost six times higher than in Banat region. Most of them are located in the industrial centres of the region.

RESULTS AND DISCUSSION

During the campaign, 59 meat processing facilities have been identified. All the results used in this paper were obtained by processing the data given through a Questionnaire, which was answered by 52 subjects. Meat industry facilities are divided by the primary activity of these selected industries into: abattoirs, meat production facilities and facilities for the manufacture of meat products. Many of the selected plants combine these activities (Fig. 2). Concerning these 52 selected meat industry facilities, 3 of them are just abattoirs (5.8%), 3 of them are combined abattoirs and meat production industries (5.8%), 3 are combined abattoirs and facilities for manufacture of meat products (5.8%), 30 facilities have all three activities combined – abattoir, meat production and manufacture of meat products (57.7%), 8 are just manufacture of meat products (15.4%) and 5 facilities have combined production of meat and meat products (9.6%).

After observing all of the data from the selected meat industry facilities, it can be concluded that the number of facilities that have an abattoir is 39, from which 26 have wastewater treatment, and the other 13 have no treatment at all (Fig. 3). Concerning these 26 abattoirs that have wastewater treatment, 12 of them have quality control of wastewater before the treatment, as well as after the treatment, 1 abattoir facility have only before, and 6 only after wastewater treatment. Seven abattoirs with the wastewater treatment conduct wastewater quality control neither before nor after the treatment. It should be mentioned, that there are two abattoirs that have quality control of the wastewater, but do not have the wastewater treatment.

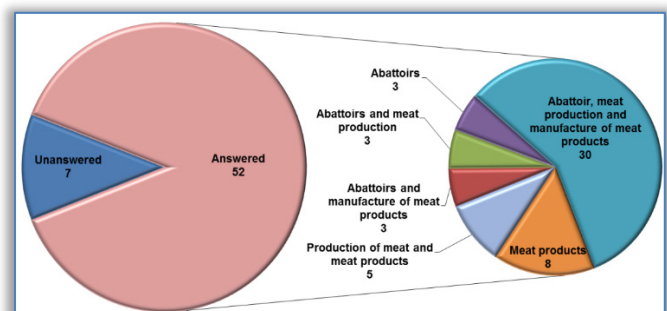


Figure 2. Division of meat industry facilities by primary activity

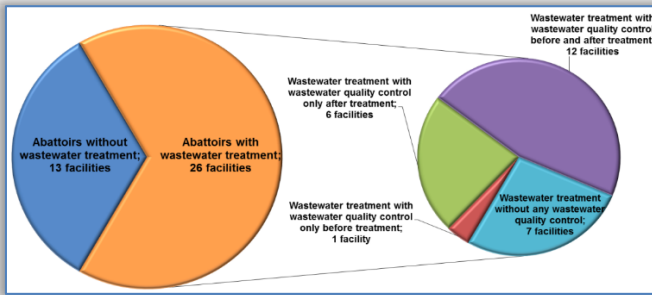


Figure 3. Wastewater treatment quality control in abattoirs

Within 52 observed meat industry facilities, 38 are dealing with the processes of the meat production from which 26 have the wastewater treatment. When observing the meat production industries that have wastewater treatment, 11 of them have quality control of wastewater before and after the treatment. One facility has a wastewater quality control only before, and 8 only after the treatment. Six meat production facilities with the wastewater treatment do not conduct wastewater quality control either before or after the treatment (Fig. 4). Also there are two meat production facilities that have quality control of the wastewater, but do not have the wastewater treatment.

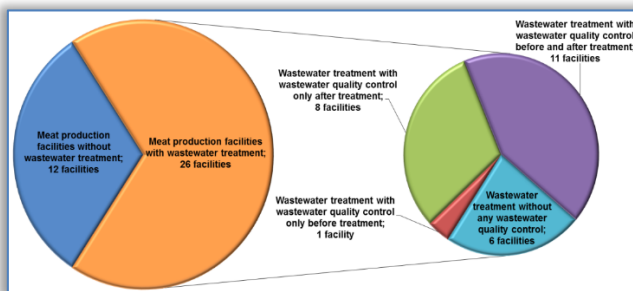


Figure 4. Wastewater treatment quality control in meat production facilities

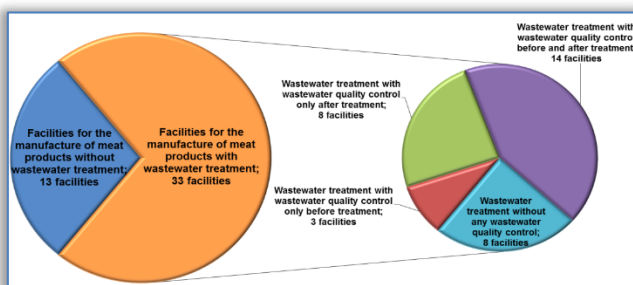


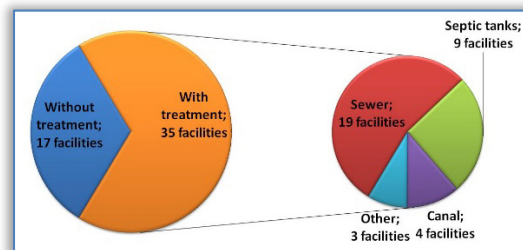
Figure 5. Wastewater treatment quality control in facilities for the manufacture of meat products

The number of facilities for the manufacture of meat products is 46, and 33 of them have wastewater treatment, while 13 do not have treatment at all. Two of those 13 meat product manufacture facilities have wastewater quality control, but they do not have solution for wastewater treatment. Thirty three meat product manufacture facilities, which do have the wastewater treatment, are divided into four groups:

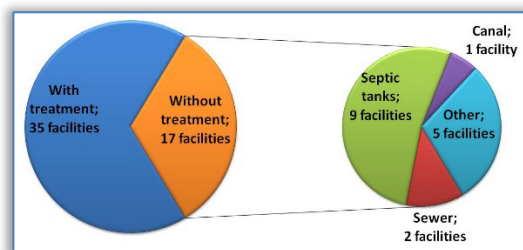
those that control the wastewater only before the treatment – 3 facilities, those that control the wastewater only after the treatment – 8 facilities, those that control the wastewater before and after the treatment – 14 facilities, and finally those that do not conduct wastewater quality control either before or after the treatment – 8 facilities (Fig. 5).

The data collected from all meat industry facilities showed that most of them discharge the wastewater into a public sewer (40.4%) or directly into a canal (9.6%). Also a large number of the meat industry facilities discharge the wastewater into their own septic tanks (34.6%). The main concern are the facilities that discharge the wastewater into sewers, which ends up in canals or rivers. It is important to perceive the number of facilities that have wastewater treatment before discharging it.

The research data indicate that a great number of all the meat industry facilities that discharge their wastewater into a public sewer have wastewater treatment, up to 90.5% of them (Fig. 6). Facilities that discharge their wastewater into septic tanks have wastewater treatment in only 50% of cases. The most important conclusion after collecting the data is that 80% of all facilities that discharge their wastewater directly into a canal have wastewater treatment. This means that 88.5% of wastewater from surveyed meat industry facilities that ends up in a canal or river is treated before discharge. It should be noted that this information is not sufficient without a detailed observation of the types of treatment these facilities have.



a)



b)

Figure 6. Recipients of meat industry facilities wastewater: a) with wastewater treatment and b) without wastewater treatment

The total number of meat industry facilities that have wastewater treatment is 35 (Fig. 6), which is 67.3% of the 52 industries that responded to the Questionnaire. Twenty seven meat industry facilities have the pre-treatment of the wastewater (77.14%), which is not the only form of wastewater

treatment they conduct (Fig. 7). Six meat industry facilities have only primary treatment, one has disinfection and one only secondary treatment. Fig. 7 also shows methods of wastewater treatments in these 35 surveyed meat industry facilities. As it was mentioned before, most of discharged wastewater ends up in septic tanks, public sewerage system, canals or rivers, or it is removed as solid waste and stored on the unsanitary landfills and open dumps. According to the "Regulation on emission limit values of pollutants in water and deadlines for achieving them" ("Official Gazette RS" no. 67/2011 and 48/2012), for discharging of industrial wastewater into the public sewerage system, pre-treatment of wastewater is required (Mostafa and Darwish, 2014). Given the fact that the Regulation entered into force after this research, it can be concluded that most of the studied subjects previously fulfilled this requirement of the Regulation.

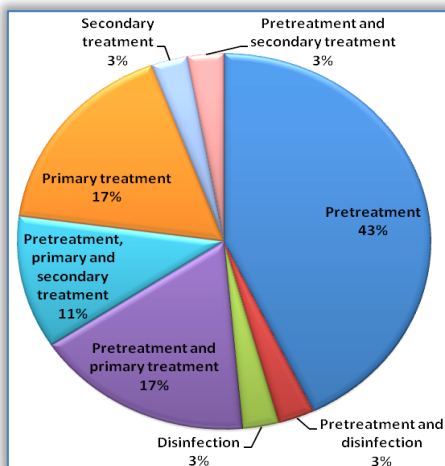


Figure 7. Methods of wastewater treatments for 35 surveyed meat industry facilities

Good water quality control practice is of great importance for wastewater management and preserving of natural water resources. During the field research and survey it was noted that most of the existing wastewater treatments are incomplete. One of the objectives in this phase of research was to get information about wastewater quality control before and after the treatment. The number of industries that have wastewater treatment (35 of them), but do not have quality control before is 16 (45.7%), and the number of those who do not control the quality of wastewater after the treatment is 11 (31.4%), which is unsatisfactory for the EU and the new regulations in the Republic of Serbia. Even though some of the industries do not have any treatment, there is a small percentage of them that monitor the quality of wastewater (11.8%). Still, there is a big lack of data regarding the quantity of discharged wastewater. Obtained results about the flow rate are mainly based on engineering

evaluation or they are gained through monitoring of water consumption.

CONCLUSIONS

This paper aimed at analysing the current practice in meat industry wastewater management in order to get the preliminary data on the real influence of this sector on environment and human health in Vojvodina region, Serbia. The lack of adequate infrastructure for wastewater treatment causes the bulk of poor quality meat industry wastewater to be discharged in water bodies, which damages health of living organisms and environment.

There were no official data about the number of abattoir and meat industry facilities from previous studies, and there were no information regarding meat industry wastewater management in Vojvodina region, which is why the results of the conducted survey are valuable and significant for future studies.

Results obtained in this study showed that almost 70% of surveyed subjects treat their wastewater, but only 11% of them include pre-treatment, primary and secondary treatment while 43% include just pre-treatment of wastewater. It can be concluded that most of the applied treatments are incomplete due to financial problems and unavailability of the satisfactory techniques.

Regarding quality control of wastewater, the situation is even worse, more than 60% of surveyed subjects do not conduct the monitoring of their effluents and discharge them into the sewer, canals or rivers, or into the collection tanks. Application of obsolete technologies and inadequate quality control practice, characterise meat industry sector of Vojvodina as dominant source of surface water pollution, which indicates its high impact to the environment and human health. This situation gives room for further work in meat industry sector in Vojvodina and creates opportunities for new developments in the field of wastewater treatment.

The results obtained during this study in combination with other sources of information suggests that there is a considerable degree of variation among facilities even within each segment of the industry in wastewater management practice and this initial version of the study can provide valuable data for further investigation in this area.

It is of great importance to continue with solving problems regarding wastewater treatment, but also to work on development and implementation of good monitoring practice in Vojvodina region, Serbia. The complexity of the problem requires approaches considering technical, organizational and governance aspects.

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