UDC 504.054:614.48:637.11

ECOLOGICAL RISKS OF USING CHEMICAL SANITIZING AGENTS FOR MILKING MACHINES AND MILK CONTAINERS

O. M. Zhukorskyi [1], Ye. M. Kryvokhyzha [2]

[1] *National Academy of Agrarian Sciences of Ukraine*
9, Suvorova Str, Kyiv, Ukraine 01010
[2] *Institute of Agroecology and Environmental Economics, NAAS of Ukraine*
12, Metrologichna Str., Kyiv, Ukraine, 03143

e-mail: o_zhukorskiy@ukr.net; kruvochuga@yandex.ru

Received on October 3, 2016

Aim. To analyze the level of the intake of active substances from chemical sanitizing agents into the environment after sanitizing milking equipment at farms of different ownership forms. **Methods**. The calculation method was used. **Results.** It was determined that after sanitizing of milking equipment and milk containers with such agents as GALA for dishes, FAIRY juicy lemon, as well as alkaline agents (Chlorantoin, Loiran, Eco chlor, San alkalin, Sulfochlorantin, Catril D, Basix, Hyproclor ED, CircoSuper AF) and acid agents (San acid, Acid XD, Eco cid, Hypracid, CircoSuper SFM) at a milking farm with 1,000 cows and at 800 private farms, within a year the environment would have the intake of chlorine compounds in the amount of 1,529.8 t, anion surface active substances (SAS) – 767.0 t, phosphates – 584.4 t, silicates – 365.0 t, cation SAS – 182.6 t, non-ionogenic SAS – 0.33 t and about 7,026.3 t acids. This may condition the impairment of natural biogeocenoses. **Conclusions**. The application of such agents as Loiran, Catril D and TDS to sanitize milking equipment and milk containers at milking farms and at private farms decreases the probability of impairing natural biogeocenoses.

Keywords: detergent, sanitizing, milking equipment, environment, biogeocenosis.

DOI: 10.15407/agrisp3.03.012

INTRODUCTION

Milk and dairy products have a relevant place in the market of food products. In recent years the main milk producers in Ukraine are farms. According to the data of the official statistics, posted at the website www.ukrstat.gov.ua, from January to August 2016, the share of private farms produced 74.1 % of the total volume of milk, produced by all the categories of farms. A significant prerequisite of obtaining milk with high microbiological quality indices is efficient sanitizing of milking equipment [1].

Cleaning and sanitizing of milking equipment and milk containers at milk farms and at private farms of the population are conducted immediately after milking of cows has been completed. The coolers are sanitized after the disposal of milk from them [2]. The sanitizing treatment of milking equipment and milk containers is aimed at maximal elimination of milk residues and microorganisms from the working surfaces of the equipment. For this purpose, washing, disinfecting, and cleaning-disinfecting agents and acids are used [3]. At the same time the majority of the mentioned agents contain compounds of active chlorine (derivatives of chloroisocyanuric acid, chloramines, chlor-hydantoins, hypochlorite) which have strong unpleasant smell and an irritating action, as well as anion surface active substances (SAS), capable of remaining in environment and polluting natural water bodies, including the ones of economic and household relevance. In addition, a great amount of cleaning and cleaning-disinfecting agents contain high concentrations of condensed polyphosphates (sodium trypolyphosphate, sodium hexametaphosphate) which are used to soften water and enhance the cleansing action. The intake of these substances into water bodies promotes intensive growth of algae and conditions the impairment of natu-

ral biocenoses. Therefore the analysis of the intake of chemically active substances from cleaning and disinfecting agents into environment from farms of different ownership forms is urgent and relevant.

The aim of the study was to determine the level of the intake of active substances from chemical sanitizing agents into the environment after sanitizing milking equipment at farms of different ownership forms.

MATERIALS AND METHODS

The analysis of the intake level of chemically active substances from the solutions of cleaning and disinfecting agents after sanitizing milking equipment, milk containers and milk coolers into environment at farms of different forms of ownership was conducted using calculations. Taking into consideration the content of the active substance and concentration of working solutions of applied cleaning and disinfecting agents as well as the number of treatments, we calculated the intake of applied agents into environment for specified time periods (for one treatment, a day and a year).

RESULTS AND DISCUSSION

Usually the private farms of the population use the following cleaning and cleaning-disinfecting agents: GALA, FAIRY, Progress, Desmol, Loiran, Chlorantoin, Neochlor, and others. The intake level of the exhausted solutions of some of these agents into the environment after sanitizing milk containers (milk buckets and glass jars) was calculated by us for 800 farms of the population (Table 1).

In case of using such agents as Chlorantoin, GALA for dishes, FAIRY juicy lemon, and Loiran, within a year the highest intake to the environment is that of anion SAS – 474.6 kg, phosphates – 383.3 kg, chlorine compounds – 438.0 kg, and non-ionogenic SAS – 328.5 kg. There is a smaller intake of cation SAS into the environment – 109.5 kg.

Domestic milking farms use alkaline agents (Eco chlor, San alkalin, Sulfochlorantin, Catril D, Basix, Hyproclor ED, CircoSuper AF, *etc*.) and acid agents (San acid, Acid XD, Eco cid, Hypracid, CircoSuper SFM, *etc*.) for cleaning and disinfecting of inner surfaces of milk pipes and milk coolers.

One sanitizing treatment of milking equipment and milk pipes at a milking farm of 1,000 cows requires the application of Sulfochlorantin and Eco chlor in the amount of 1,500 g and 2,500 ml. respectively, which is 4.5 kg and 7.5 l per day respectively. Such alkaline agents as Neomoscan RD and Catril D are used in the amount of 5 l for one treatment and 15 l for one day. The daily sanitizing of coolers requires: Sulfochlorantin − 1,500 g, Eco chlor – 2,500 ml, Neomoscan RD and Catril D – 5 l.

The intake level of the agents, used to sanitize milking equipment, milk pipes, and milk coolers, in inner sewage facilities of the farm was also determined (Table 2).

In case of using Sulfochlorantin, within a year the highest intake into inner sewage facilities of a farm

Table 1. The intake of active substances of cleaning and cleaning-disinfecting agents into environment after sanitizing milk containers at private farms of the population

Name of the agent	Active substance	Quantitative content of components, %	Intake of exhausted solutions of cleaning and disinfecting agents into the environment (as per 1,000 cows), kg		
			One treatment	Day	Year
Chlorantoin	Active chlorine	14.1	0.4	1.2	438.0
	Sodium trypolyphosphate	9.0–12.5	0.3–0.4	0.9–1.2	328.5–438.0
	Anion SAS	3.2–5.0	0.1–0.2	0.3–0.6	109.5–219.0
GALA for dishes	Anion SAS	5.0–15.0	0.05–0.2	0.2–0.6	73.0–219.0
	Non-ionogenic SAS	5.0	0.05–0.2	0.2–0.6	73.0–219.0
FAIRY juicy lemon	Anion SAS	15.0–30.0	0.1–0.2	0.3–0.6	109.5–219.0
	Non-ionogenic SAS	5.0–15.0	0.03–0.1	0.1–0.3	36.5–109.5
Loiran	Non-ionogenic SAS	5.0	0.1	0.3	109.5
	Cation SAS	5.0	0.1	0.3	109.5

of 1,000 cows will be for chlorine compounds – 799350.0 kg, anion SAS – 766500.0 kg, and a little less for phosphates – 219000.0 kg. The application of such agents as Eco chlor or Neomoscan RD decreases the level of chlorine compounds intake by 54.3 %. However, the application of Neomoscan RD will result in the equal intake of phosphates and silicates into the environment – 365000.0 kg/year.

In case of using Catril D, there is annual accumulation of 182500.0 kg of cation SAS in the environment. At the same time all the components of the mentioned agent are biologically decomposed fats – more than by 60 % at the exposition for 28 days (according to OECD test), which corresponds to the requirements of EU No. 648/2004 [4].

The following stage of work was the determination of the intake level of exhausted solutions of acid cleaning and disinfecting agents after sanitizing milking equipment into local sewage facilities of farms. One treatment of milking equipment at a farm of 1,000 cows requires 2,500 ml of acid agents Acid XD, Eco cid, Hypracid, CircoSuper SFM, Niroklar Sauer flüssig and TDS – 7.5 l of each agent per day. These acid agents are used each other day to sanitize the coolers, in the amount of 2,500 ml (Table 3).

The highest amount of nitric acid will get into inner sewage facilities of a farm while using Niroklar Sauer flüssig − on average 1197656.3 kg/year. The application of such agents as Acid XD and CircoSuper SFM will decrease the intake level of nitric acid for a year by 33.3 %, and TDS – by 60 %. However, the application of CircoSuper SFM will result in the intake of orthophosphoric acid along with nitric acid into the inner sewage facilities of farms – 798437.5 kg/year. The same amount of the orthophosphoric acid will be released when using Hypracid agent. At the same time the application of Eco cid agent will decrease the release of the mentioned acid by 60 %. However it will entail the additional release of the sulphuric acid – 319375.0 kg/year.

The application of agents, containing orthophosphoric and nitric acids in the technologies of sanitizing milking equipment will result in the formation of salts of phosphoric and nitric acids, i.e. phosphates and nitrates, in sewage waters of farms which will have negative impact on the environment [5].

After sanitizing the milking equipment and coolers at farms, the exhausted solutions are disposed into local sewage facilities, from which they get into urine collectors and, to a somewhat smaller degree, – into sewage facilities of settlements. When urine collectors at animal farms are filled with urine and exhausted solutions of detergents, they may have negative impact on soil ecosystems due to splitting of their content along with sewage and melt water, which is especially facilitated by soil erosion. Also, when urine collectors are filled, their content is pumped out into autotanks and taken away with further disposal into the environment. The exhausted solutions of detergents from sewage facilities of settlements also get into the environment [6].

When chlorine-containing substances get into the environment and active chlorine is released, insoluble di-

Table 2. The intake of active substances of alkaline cleaning and cleaning-disinfecting agents into environment after sanitizing milking equipment and milk pipes

Name of the agent	Active substance	Quantitative content of components, %	The intake of the residues of cleaning and disinfecting agents into the environment after they have been applied (1,000 cows), kg		
			One treatment	Day	Year
Sulfochlorantin	Chlororganic compounds	36.5	1095.0	3832.5	799350.0
	Sodium trypolyphosphate	10.0	300.0	600.0	219000.0
	Anion SAS	35.0	525.0	2100.0	766500.0
Eco chlor	Sodium hypochlorite	10.0	500.0	1000.0	365000.0
Neomoscan RD	Sodium hypochlorite	5.0	500.0	1000.0	365000.0
	Sodium metasilicate	5.0	500.0	1000.0	365000.0
	Phosphates	5.0	500.0	1000.0	365000.0
Catril D	Cation SAS	2.5	250.0	500.0	182500.0

Table 3. The intake of active substances of acid cleaning and disinfecting agents into environment after sanitizing milking equipment and milk pipes

Name of the agent	Active substance	Quantitative content of components, %	The intake of the residues of cleaning and disinfecting agents into the environment after they have been applied (1,000 cows), kg		
			One treatment	Day	Year
Acid XD	Nitric acid	25.0	937.5	2187.5	798437.5
Eco cid	Sulphuric acid	10.0	375.0	875.0	319375.0
	Orthophosphoric acid	10.0	375.0	875.0	319375.0
Hypracid	Orthophosphoric acid	25.0	937.5	2187.5	798437.5
CircoSuper SFM	Nitric acid	25.0	937.5	2187.5	798437.5
	Orthophosphoric acid	25.0	937.5	2187.5	798437.5
Niroklar Sauer flüssig	Nitric acid	25.0–50.0	937.5–1875.0	2187.5–4375.0	798437.5–1596875.0
TDS	Nitric acid	15.0	562.5	1312.5	479062.5
	Citric acid	10.0	375.0	875.0	319375.0

oxin-like compounds are formed. Once getting into rivers, they precipitate on silt and soil, and get accumulated in the tissues of hydrobionts, where their concentration is tens and hundreds thousand higher compared to water. The specificity of dioxin-like compounds is their ability of bioaccumulation. They are chemically stable, as their half lifetime in nature is very long: from 29 to 139 years depending on the type of a compound. The transmission of dioxin-like compounds in food chains results in their concentration in the organism of fish, mammals, and humans, which is a threat to life [8].

CONCLUSIONS

When 800 private farms sanitize milk containers using such agents as Chlorantoin, GALA for dishes, FAIRY juicy lemon and Loiran, within a year the intake of anion SAS is 474.6 kg, phosphates – 383.3 kg, chlorine compounds – 438.0 kg, non-ionogenic SAS – 328.5 kg, and cation SAS – 109.5 kg into the environment.

When farms of 1,000 cows sanitize milk pipes and milk coolers, using alkaline agents (Eco chlor, San alkalin, Sulfochlorantin, Catril D, Basix, Hyproclor ED, CircoSuper AF) and acid agents (San acid, Acid XD, Eco cid, Hypracid, CircoSuper SFM), within a year the environment will be polluted with chlorine compounds (1,529.4 t), anion SAS (766.5 t), phosphates (584.0 t), silicates (365.0 t) and cation SAS (182.5 t), as well as about 7,026.3 t of acids, which may result in the impairment of natural biogeocenoses.

The sanitizing of milking equipment and milk containers at milking farms and private farms using ecologically safe agents Loiran, Catril D and TDS decreases the negative impact of chemically hazardous substances when they get into the environment and mitigates probable impairment of natural biogeocenoses.

Екологічні ризики застосування хімічних санітарних засобів для доїльного устаткування та молочного посуду

О. М. Жукорський [1], Є. М. Кривохижа [2]

e-mail: o_zhukorskiy@ukr.net; kruvochuga@yandex.ru

[1] Національна академія аграрних наук України
Вул. Суворова, 9, Київ, Україна, 01010

[2] Інститут агроекології і природокористування НААН
Вул. Метрологічна, 12, Київ, Україна, 03143

Мета. Проаналізувати рівень надходження у навколишнє природне середовище (НПС) діючих речовин хімічних санітарних засобів після проведення санітарної обробки доїльно-молочного устаткування у господарствах різних форм власності. **Методи.** Використано розрахунковий метод. **Результати.** Після застосування для санітарної обробки доїльного устаткування та молочного посуду засобів GALA посуд, FAIRY соковитий лимон, а також лужних засобів (Хлорантоїн, Лойран, Eco chlor, San alkalin, Сульфохлорантин, Катрил Д, Basix, Hyproclor ED, CircoSuper AF) і кислотних (San acid, Acid XD, Eco cid, Hypracid, CircoSuper SFM) на молочній фермі з поголів'ям 1000 корів та у 800 господарствах населення визначено, що в НПС впродовж року будуть потрапляти

сполуки хлору у кількості 1529,8 т, аніонні поверхнево активні речовини (ПАР) – 767,0 т, фосфати – 584,4 т, силікати – 365,0 т, катіонні ПАР – 182,6 т, неіоногенні ПАР – 0,33 т і приблизно 7026,3 т кислот. Це може зумовлювати порушення природних біогеоценозів. **Висновки.** Використання таких засобів, як Лойран, Катрил Д і ТДС, для санітарної обробки доїльного устаткування та молочного посуду на молочно-товарних фермах і в господарствах населення знижує ймовірність порушення природних біогеоценозів.

Ключові слова: мийно-дезінфікуючий засіб, санітарна обробка, доїльно-молочне обладнання, навколишнє природне середовище, біогеоценоз.

Экологические риски применения химических санитарных средств для доильного оборудования и молочной посуды

О. М. Жукорский [1], Е. М. Кривохижа [2]

e-mail: o_zhukorskiy@ukr.net; kruvochuga@yandex.ru

[1] Национальная академия аграрных наук Украины
Ул. Суворова, 9, Киев, Украина, 01010

[2] Институт агроэкологии и природопользования НААН
Ул. Метрологическая, 12, Киев, Украина, 03143

Цель. Проанализировать уровень поступления в окружающую среду действующих веществ химических санитарных средств после проведения санитарной обработки доильно-молочного оборудования в хозяйствах различных форм собственности. **Методы.** Использован расчетный метод. **Результаты.** После применения для санитарной обработки доильного оборудования и молочной посуды средств GALA посуда, FAIRY сочный лимон, а также щелочных средств (Хлорантоин, Лойран, Eco chlor, San alkalin, Сульфохлорантин, Катрил Д, Basix, Hyproclor ED, CircoSuper AF) и кислотных (San acid, Acid XD, Eco cid, Hypracid, CircoSuper SFM) на молочной ферме с поголовьем 1000 коров и в 800 хозяйствах населения определено, что в окружающую среду в течение года будут попадать соединения хлора в количестве 1529,8 т, анионные поверхностно активные вещества (ПАВ) – 767,0 т, фосфаты – 584,4 т, силикаты – 365,0 т, катионные ПАВ – 182,6 т, неионогенные ПАВ – 0,33 т и около 7026,3 т кислот. Это может обусловить нарушение естественных биогеоценозов. **Выводы.** Применение таких средств, как Лойран, Катрил Д и ТДС, для санитарной обработки доильного оборудования и молочной посуды на молочно-товарных фермах и в хозяйствах населения снижает вероятность нарушения природных биогеоценозов.

Ключевые слова: моюще-дезинфицирующее средство, санитарная обработка, доильно-молочное оборудование, естественная окружающая среда, биогеоценоз.

REFERENCES

1. *Hrynova DV*. Influence of quality of washing of technological line of production of milk on contamination of raw material. *Actual problems of modern science*. Kyiv. 2013; Pt. 2:54−7.
2. *Jones GM*. Cleaning and sanitizing milking equipment. *Virginia Cooperative Extension*. 2009; 400−404.
3. *Reinemann DJ, Wolters G, Billon P, Lind O, Rasmussen MD*. Review of practices for cleaning and sanitation of milking machines. *Bulletin-International Dairy Federation*, 2003;(381):4−19.
4. *Regulation* (EC) No 648/2004 of the European Parliament and of the Council of 31 March 2004 on detergents. *Official Journal of the European Union*. 2004; L 104/1−L 104/35.
5. *Resolution* of the Verkhovna Rada of Ukraine "On Elaboration of the National Program of Reducing and Gradual Suspending of the Application of Phosphate-Based Detergents in the Territory of Ukraine" Document 2335-VI. Adopted. 15.06.2010. *The Official Bulletin of the Verkhovna Rada of Ukraine*. 2010;(38):512.
6. *Zhukorskiy OM, Kryvokhyzha YM*. Regeneration and repeated application of the solution of alkaline detergents and disinfectants means for milking machines on livestock farms. *Ecological security and balanced nature management in agroindustrial production*: Materials of the international scientific-practical conf. (6−8 July, 2016, Kyiv). Kyiv; 41−4.
7. *Vishnevetsky VY, Vishnevetsky YM*. On the impact of water pollution with polychlorinated aromatic compounds in the Black Sea region on HEALTH. *Engineering Journal of Don*. 2015;(4):1−17.
8. *Bryukhovetska IV, Kropyvnytska LM*. Dioxins: basic sources of onset and ways of getting into the natural environment. *Chemical education in the context of chemical safety: state and prospects of research*: Coll. of theses and abstracts of the International scientific and practical conf. (25−26 February, 2011). Kyiv; 41−3.