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The Public Health Significance of Controlling Contaminants in Samples of Milk and Dairy Products in the Republic of Srpska in the Period 2010-2012

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ABSTRACT

Introduction: Controlling the presence of contaminants or harmful substances in milk and dairy products provides early detection of risks since their presence, even in legally permitted concentration, increases the risk of damaging human health, especially children's health, such as allergic manifestations, and they can have potentially toxic, carcinogenic and genotoxic effects.

Aim of the Study: The aim is to determine the frequency of the presence of contaminants in samples of milk and dairy products in the Republic of Srpska from 2010 to 2012 (metals, radionuclides, aflatoxins and residues of antibiotics and pesticides), and especially to point out their public health significance because of possible health risks. The aim of the paper is to emphasize the need for monitoring all the other contaminants in milk and dairy products specified in regulations.

Material and Methods: The frequency of the presence of contaminants in the samples of milk and dairy products (n= 407) was determined on the basis of legally prescribed methodology of sampling, chemical analyses and preparation of expert opinion on food safety in accordance with current food regulations. Descriptive statistical indicators were used (a number of the samples, minimum and maximum concentrations). Chi square test (χ^2) of contingency was used for testing the significance of differences in presence of contaminants and residues analyzed and recommended by regulations in samples of milk and dairy products.

Results: The results of public health research of contaminants in samples of milk and dairy products indicate that no health defective food samples were determined at tested parameters – metals, radionuclides, aflatoxins, and residues of antibiotics and pesticides. A statistically significant number of samples examined on heavy metal content (83.29% or 339 samples) was determined comparing to the number of samples examined on the other contaminants and residues recommended by regulations in milk and dairy products ($\chi^2=1000.776$, $p<0.001$)

Conclusion: The data obtained can serve as a basis for further analysis in the context of milk and dairy product sample monitoring. Although samples of milk and dairy products are safe, a long-term exposure to residues of harmful substances results in cumulative effect and damage health, meaning that each early detection of food risk found through continuous controls has a public health significance for preservation and promotion of population health in the Republic of Srpska.

Key words: public health significance, contaminants in milk and dairy products, health risk

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Introduction

According to the current Ordinance on maximum permitted levels for certain contaminants in foodstuffs, the contaminant is a chemical, radiological, biological or physical substance harmful for human health, not intentionally added to food but its presence in food is a result of crop production, animal breeding and veterinary medicines administration during food processing, preparation, transport or storage, or the contaminant is a consequence of environmental pollution.¹ According to the Law on Food of the Republic of Srpska, food is considered harmful to human health if it contains contaminants, residues of pesticides, antibiotics, veterinary medicines and the other medical products exceeding values permitted.²

The human body consists of a large number of essential metals but certain metals represent a continuous danger to human health. Arsenic and lead have acute toxic and chronic cumulative effects to organ system. According to the International Agency for Research on Cancer, arsenic is classified in a Group-1 human carcinogens due to sufficient evidence of carcinogenic effects to humans, and lead is classified in a Group-2 possibly carcinogenic to humans due to sufficient evidence of lead carcinogenicity in experimental animals, whereby numerous evidences imply that mechanism of carcinogenesis is the same at animals and man.³⁻⁵

Due to the contaminated food,^{6,7} the entire population is exposed to chronic pesticide poisoning. Public health problems of radioactive contamination of environment as well as food comprehend the incidents in nuclear power plants indicating the absence of barriers for chemical pollutions.^{3,4,8}

Aflatoxins B₁, G₁ and M₁ are of public health significance because of health risks, hepatotoxic, nephrotoxic, neurotoxic, carcinogenic and mutagenic activity. Aflatoxin B₁ is one of the most powerful human mutagens and teratogens. Aflatoxin B₁ is classified in group 1 or mycotoxins with proven carcinogenic effect.⁸ The uncontrolled use of antibiotics as biostimulants for animal feeding is important for public health since they can be found indirectly in milk and dairy products causing an increased frequency of antibiotic resistance in the human population.^{9,10}

Aim of the Study

1. To determine frequency of presence of contaminants in samples of milk and dairy products (metals, radionuclides, aflatoxins and residues of antibiotics and pesticides) in the Republic of Srpska from 2010 to 2012;
2. To point out public health significance of the presence of contaminants in samples of milk and dairy products because of possible health risks;

3. To emphasize the need for monitoring all the other contaminants or hormones, dioxins and polychlorinated biphenyls (PBC) in milk and dairy products specified in regulations.

Material and Methods

Research on the frequency of presence of contaminants was conducted on a total number of 407 samples of milk and dairy products submitted from the foreign and domestic trade in the Republic of Srpska from June 2010 to March 2012. Research included samples of milk and dairy products grouped in subgroups (pasteurized and sterilized milk, raw milk, cheese, yogurt, sour cream and the other dairy products such as chocolate milk, dairy dessert and beverage, ice cream, milk powder and the other dairy products). The content of metals was determined using Atomic Absorption Spectrophotometry (AAS) on the device 'UNICAM' England, a flame technique for the analysis of lead and cadmium, a hydride technique for arsenic analysis, a cold vapor technique for mercury analysis. The content of radionuclides ¹³⁴Cs ¹³⁷Cs was determined by gamma spectrometric method of high resolution; ISO 18589-1, ISO 10703 on the device 'Gamma spectrometar-Canberra Packard 7500 SL'.

The sum of aflatoxins (B₁, B₂, G₁, G₂) was analysed using HPLC method (High Performance Liquid Chromatography). The content of aflatoxin M₁ was determined by liquid chromatography after immunoaffinity chromatography purification. The content of pesticide residues (alpha HCH, beta HCH, lindane, delta HCH, aldrin, heptachlor epoxide, endosulfan, endosulfan sulfate, DDE, DDD, Endrin, the sum of PCB) was determined by Gas Chromatography/Mass Spectrometry (GC/MS), and the content of residues of Diazinon, Metalaxyl and Vinclozolin by Gas Chromatography/Mass Spectrometry (GC/MS).

Determination of sample safety was conducted in accordance with the applicable regulations on food safety.^{1,2} SPSS 16.0 was used for statistical analysis. Chi-square test (χ^2) of contingency¹¹ was used for comparing differences in a number of food group of 'milk and dairy products' for presence of contaminants and residues analyzed and recommended by regulations as well as for comparing differences in a number of different foodstuffs analyzed for presence of a particular contaminant.

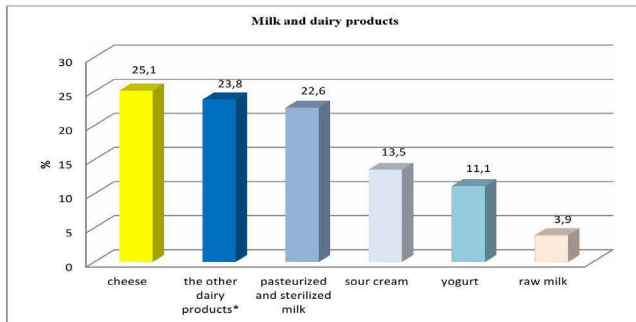
Results

Results on the presence of contaminants in samples of milk and dairy products are based on the laboratory analysis of 407 samples in the territory of the Republic of Srpska from 2010 to 2012.

Figure 1. shows percentage of foodstuffs within the

analyzed group of 'milk and dairy products'.

Figure 1. Percentage of foodstuffs within the analyzed group of 'milk and dairy products' from 2010 to 2012



*chocolate milk, dairy dessert, milk cream, milk pudding, dairy beverage, frozen desserts, ice cream, milk powder, condensed milk and the other dairy products

Figure 2. shows percentage of contaminants and residues of antibiotics and pesticides analyzed within the group of 'milk and dairy products' in the Republic of Srpska from 2010 to 2012.

Figure 2. Percentage of contaminants and residues of antibiotics and pesticides analyzed within the group of 'milk and dairy products' from 2010 to 2012

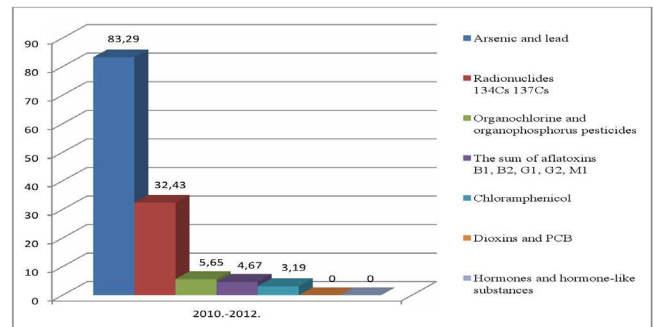


Table 1. shows the data of analyzed samples, and minimum and maximum concentrations of contaminants in samples of milk and dairy products from 2010 to 2012 including the analysis of the following contaminants - arsenic, lead, radionuclides ^{134}Cs ^{137}Cs , the sum of aflatoxins B₁, B₂, G₁, G₂, M₁ and residues of chloramphenicols and pesticides (alpha HCH, beta HCH, lindane, delta HCH, aldrin, heptachlor epoxide, endosulfan, endosulfan sulfate, DDE, DDD, Endrin, the sum of PCB, Diazinon, Metalaxyl and Vinclozolin).

Table 1. A number of analyzed samples, and minimum and maximum concentrations of contaminants in samples of milk and dairy products from 2010 to 2012

Types of contaminants in milk and dairy products	N of analyzed samples	Unit of measurement	Minimum concentration	Maximum concentration
Arsenic	339	mg/kg	< 0.02	< 0.1
Lead	339	mg/kg	< 0.05	< 0.05
Radionuclides ^{134}Cs i ^{137}Cs	132	Bq/kg	< 0.2	< 0.2
Organochlorine and organophosphorus pesticides*	23	mg/kg	< 0.005	< 0.005
The sum of aflatoxins B ₁ , B ₂ , G ₁ , G ₂ , M ₁	19	µg/kg	< 0.5	< 0.5
Chloramphenicol	13	mg/kg	0.00	< 0.1

*alpha HCH, beta HCH, lindane, delta HCH, aldrin, heptachlor epoxide, endosulfan, endosulfan sulfate, DDE, DDD, Endrin, the sum of PCB, Diazinon, Metalaxyl and Vinclozolin

Table 2. shows testing of the significance of differences in presence of contaminants and residues analyzed and recommended by regulations in milk and dairy products from 2010 to 2012, and results are expectedly positive due to determination of a statistically significant number

of samples analyzed on the content of heavy metals (83.29% or 339 samples) in relation to the number of samples analyzed on the other contaminants and residues recommended by regulations in milk and dairy products ($\chi^2=1000.776$, $p<0.001$).

Table 2. Testing the significance of differences in presence of contaminants and residues analyzed and recommended by regulations in milk and dairy products from 2010 to 2012

Food group	Milk and dairy products		
REG/Sample	χ^2	<i>df</i>	<i>p</i>
	1000.776	4	<0.001

Discussion

90% of environmental pollutants reach humans through the food. In the entire food chain, food products can be 'enriched' with contaminants which can lead to adverse health consequences, especially important for children's health.¹²⁻¹⁵

Public health control of harmful substances in milk and dairy products is of crucial importance because of the frequency of milk consumption in all population groups, especially in infant, child and adolescent population groups. Health Survey of the adult population (>18 years of age) of the Republic of Srpska in 2010 showed that 41.3% of the population consumed at least one cup of aforementioned food group meaning that this research on the content of harmful substances is justified since it is the one of core groups of foodstuffs.¹⁶

In all samples of milk and dairy products, determined arsenic concentrations range from <0.02 to <0.1mg/kg, and determined lead concentrations <0.02mg/kg. Determined concentrations of aflatoxins B1, B2, G1, G2, M1 are < 0.5µg/kg, radionuclides ¹³⁴Cs and ¹³⁷Cs <0.2Bq/kg. Determined concentrations of residues of chloramphenicol are <0.1mg/kg, and organophosphorus and organochlorine pesticides <0.005mg/kg (table 1).

In the Republic of Srpska, in the research of the harmful substances in the samples of milk and dairy products, no samples posing threat to human health were determined. Consistent results, as in the research shown, were confirmed by the Food Safety Agency of Bosnia and Herzegovina in food monitoring since there were no milk and dairy product samples posing threat to human health examined for presence of residues of organochlorine and organophosphorus pesticides in 2009, mycotoxins in 2010, metals in 2011 and antibiotics in 2014.¹⁷

Public health research on milk and dairy product samples in Iran from 2006 to 2007 identifies 4.4% of unsafe samples of raw and pasteurized milk because of aflatoxin M1 18 contamination.

During food monitoring in Bosnia and Herzegovina in 2009, 500 food samples were analyzed and unsatisfactory samples of milk and products were determined due to the increased concentration of lead and arsenic. In a risk assessment, during 2013, in Bosnia and Herzegovina,

aflatoxin M1 was determined at 3.3% samples of raw milk, pasteurized milk and milk intended for milk-based products.¹⁷

In the research of contaminants and residues in milk and dairy product samples, 83.29% of milk and dairy product samples were analyzed for the presence of arsenic and lead, and 32.43% for the presence of radionuclides ¹³⁴Cs and ¹³⁷Cs. The residues of organochlorine and organophosphorus pesticides were analyzed in 5.65% of milk and dairy product samples. Aflatoxins B1, B2, G1, G2, M1 and the chloramphenicol residues were analyzed in less than 5% of milk and dairy product samples (figure 2).

During the monitoring of food in Bosnia and Herzegovina in 2009, out of a total of 150 analyzed milk and dairy product samples, 48.67% was positive on the presence of the residues of antibiotics. The Food Safety Agency of Bosnia and Herzegovina carried out a risk assessment in 2010 on 2124 food samples examined for presence of the residues of chloramphenicol and sulfonamides indicating 0.09% of unsafe samples because one milk sample was positive for chloramphenicol residue. In Bosnia and Herzegovina, in 2011, there were 0.16% of unsafe samples out of 1882 food samples tested for chloramphenicol and sulfonamides, because three milk and dairy product samples were positive for sulfonamide residues. During the monitoring of food in 2015, the Food Safety Agency of Bosnia and Herzegovina reported 0.17% of unsatisfactory samples belonging to the group of milk and dairy products for the presence of the residues of antibiotics.¹⁷

Determination of the residues of antibiotics in food is of huge public health importance because of the possibility of reducing the health risks due to the increased frequency of antibiotic resistance in the human population¹⁹ and occurrence of antibacterial drug residues in food.^{9,10}

A statistically significant number of milk and dairy product samples tested for the content of heavy metals (83.29%) was determined comparing to the number of samples tested for the other contaminants and residues recommended by regulations. The other contaminants such as dioxins, polychlorinated biphenyls, hormones and hormone-like substances, being mandatory in food regulations, were not analyzed in any sample of milk and dairy product ($\chi^2=1000.776$, $p<0.001$) (figure 2, table 2).

The public health importance of the purposes of determining the presence of dioxins, polychlorinated biphenyls and hormones in the food monitoring including milk and dairy products is indicated by their potentially toxic and carcinogenic effects.²⁰

Conclusion

No milk and dairy product samples posing threat to human health were determined in the research of contaminants and residues of antibiotics and pesticides in the Republic of Srpska from 2010 to 2012. During that period, there was a statistically significant number of milk and dairy product samples tested for the content of heavy metals (83.29%) comparing to the number of samples tested for the other contaminants and residues recommended by regulations in milk and dairy products.

Dioxins, polychlorinated biphenyls and hormones and hormone-like substances, being mandatory in food regulations, were not required by official inspection controls in any sample of milk and dairy products, and the results are expectedly positive and statistically significant ($\chi^2=1000.776$, $p<0.001$).

The data obtained can serve as a basis for further analysis in the context of milk and dairy product sample monitoring. Although samples of milk and dairy products are safe, a long-term exposure to residues of harmful substances results in cumulative effect and damage health, meaning that each early detection of food risk found through continuous controls has a public health significance for preservation and promotion of population health in the Republic of Srpska.

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Javnozdravstveni značaj kontrole kontaminanata u uzorcima mlijeka i proizvoda u Republici Srpskoj u periodu 2010-2012. godine

SAŽETAK

Uvod: Kontrola prisustva kontaminanata, odnosno štetnih materija u mlijeku i mliječnim proizvodima, omogućuje rano prepoznavanje rizika, jer njihovo prisustvo, i u zakonski dozvoljenim koncentracijama, povećava rizik za oštećenje zdravlja ljudi, posebno djece, kao što su alergijske manifestacije, a mogu imati potencijalno toksično, kancerogeno i genotoksično djelovanje.

Cilj rada: Utvrditi učestalost prisustva kontaminanata u uzorcima mlijeka i proizvoda u Republici Srpskoj u toku perioda 2010. do 2012. godine (metali, radionuklidi, aflatoksini i ostaci antibiotika i pesticida), a posebno ukazati na njihov javnozdravstveni značaj zbog mogućih zdravstvenih rizika. Cilj rada je ukazati na potrebu praćenja i svih drugih kontaminanata predviđenih propisima u mlijeku i mliječnim proizvodima.

Materijal i metode: Utvrđivanje učestalosti prisustva kontaminanata u uzorcima mlijeka i proizvoda (n= 407) sprovedeno je na osnovu zakonski propisane metodologije uzorkovanja, hemijskih analiza i izradom stručnog mišljenja o zdravstvenoj ispravnosti hrane u skladu sa važećim propisima o hrani. Korišteni su pokazatelji deskriptivne statistike (broj uzoraka, minimalne i maksimalne koncentracije). Za testiranje značajnosti razlike prisustva analiziranih kontaminanata i rezidua u uzorcima mlijeka i mliječnim proizvodima i preporučenih propisima korišten je χ^2 test kontigencije.

Rezultati: The Rezultati javnozdravstvenog istraživanja kontaminanata u uzorcima mlijeka i proizvoda ukazuju da nisu utvrđeni zdravstveno neispravni uzorci hrane za ispitivana obilježja - metali, radionuklidi, aflatoksini i ostaci antibiotika i pesticida. Utvrđen je statistički značajno veći broj uzoraka ispitanih na sadržaj teških metala (83,29% ili 339 uzoraka) u odnosu na broj uzoraka ispitanih na druge kontaminante i rezidue preporučene propisima u mlijeku i mliječnim proizvodima ($\chi^2=1000.776$, $p<0.001$).

Zaključak: Dobijeni podaci mogu poslužiti kao osnov za dodatne analize u okviru monitoringa uzoraka mlijeka i proizvoda. Iako su uzorci mlijeka i proizvoda zdravstveno ispravni, dugotrajna izloženost ostacima štetnih materija ima za posljedicu kumulativni efekat i oštećenje zdravlja, pa svako rano prepoznavanje rizika iz hrane kroz kontinuiranu kontrolu ima javnozdravstveni značaj za očuvanje i unaprijeđenje zdravlja stanovništva u Republici Srpskoj.

Ključne riječi: javnozdravstveni značaj, kontaminanti u mlijeku i proizvodima, zdravstveni rizici