The vegetables contamination in the process of agricultural production on farms and private allotments

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Abstract. The results of comparative study of the chemicals content in vegetables, produced on farms and private allotments on the Saratov Region are present in this article. The content of organochloride, organophosphorus compounds, pesticides and herbicides in vegetables were analyzed by the thin-layer chromatography method. Nitrates levels in vegetables were determined by the potentiometric method. The organochloride pesticides content in the examples of foodstuffs which were produced on farms and private allotments didn’t have differences in terms of their contamination with these pesticides (р>0.05). The content of organophosphorus insecticides (chlorpyrifos) was not more than permissible level (0.01±0.002 mg/kg), but in agricultural products produced on private allotments the concentration of chlorpyrifos was not more than 50% of the permissible level (0.0045±0.001 mg/kg, р<0.05). The level of melation in vegetable products was from 0.02±0.004 to 0.05±0.001 mg/kg of the permissible level (0.5 mg/kg) and depended on the agricultural cultivation areas. The high content of glyphosate was found in agricultural products of the dry Zavolgskij Region (0.3±0.001 mg/kg). On the right side of the Volga River and in regions with the wide melioration system the herbicides concentration was from 30 to 50% from maximum permissible level (0.1±0.002 mg/kg). In all vegetable products produced on fields of farms the concentrations of nitrates were higher (р<0.05) than in the products produced on private allotments. All chemicals which were studied and found in vegetables products from farms and private allotments contained pollutants in normal concentration. The results of this study will allow us to develop recommendations to reduce the risks to public health.

1. Introduction.
One of the main conditions in the field of healthy nutrition of the population of the Russian Federation is to ensure the hygienic safety of food raw materials and food products [1,2]. The great territory of the Saratov Region, located in the lower part of the Volga River, is traditionally used as agricultural land for agricultural production. This makes it possible to provide the majority of the region’s population with local food. However, the modern and successful functioning of the region agricultural complex is practically impossible without the widespread use of different agrochemicals [3]. As a result, the biggest part of the region’s territory has a great negative influence by chemicals on environment and food raw materials [4].
2. Problem definition

The regular hygienic monitoring of the assessment of the quality of environmental factors by Regional Consumer Protection and Human Well-Being Service in 38 Saratov Region districts made it possible to identify 9 administrative territories that are most unpleasant in terms of sanitary-chemical indicators of pollution of atmospheric air, soil and water. In such districts as: Balakovsky, Dergachevsky, Ershovskiy, Markovsky, Engelsky, Perelubsky, Romanovsky, Saratovsky, Fedorovsky the concentration of chemicals contaminants exceed on 13.5% of the permissible level in drinking water, on 4.23% of the permissible level in the air. Also, more than 24 million tons of industrial wastes were found in soil at the last 5 years [5].

As a result, in the soil of the agricultural territories of the region we determined exceed concentrations of the petroleum products (from 1.1 to 3.0 times of the permissible level); heavy metals (from 1.1 to 2.3 times of the permissible level); pesticides (from 1.2 to 5.2 times of the permissible level); nitrites and nitrates (from 1.1 to 5.6 times of the permissible level) [6]. The same results were received by employees of the Saratov State Medical University and the Saratov Research Institution of Rural Hygiene in early studies in the same ecologically disadvantaged districts in the Saratov Region, in such environmental objects as soil, water and atmospheric air [7].

But regular control of chemical contamination by the veterinary service and the Regional Consumer Protection and Human Well-Being Service does not identify excess chemicals concentrations in certain products, produced in the ecologically disadvantaged districts on farms and private allotments and realized in local shops [8].

In view of the above, the aim of the research is a comparative assessment of the contamination by chemicals contaminants of vegetable products grown on farms and private allotments of ecologically disadvantaged districts and used as local nutrition.

3. Materials and methods

The researches were conducted in ecologically disadvantages districts of the Saratov region (Balakovsky, Dergachevsky, Ershovskiy, Markovsky, Engelsky, Perelubsky, Romanovsky, Saratovsky, Fedorovsky) in the summer-autumn period of 2017-2019 years. The samples, from the local vegetables products, such as potato, carrot, beet-root, zucchini and cucumber, were taken from 300 to 500 g. The samples were packed in the plastic bags. Vegetable products were transported in laboratory in the thermobags with cold temperature in first 36 hours after the picking.

The chemical analysis of the samples included assessment of the content of organochlorides (dichlordiphenyl trichloethane – DDT, hexachloreocyclohexane – HCH), organophosphates pesticides (melation, chlorpyrifos) and herbicides which based on gliophos («Rundap», «Tornado»).

The pesticides concentrations in the foodstuffs were analyzed by the thin-layer chromatography method on the analytical plates PTSX-AF-A (Sorbfil) which were produced on aluminum foil with the micro fraction of silica gel sorbent working layer (90-120 mkm in thickness).

The nitrates levels in local vegetable products were analyzed by the potentiometric method on a «Micon-2» analyzer using the laboratory complex which based on an «Expert-001-3 (0.1)» photometer with the ion-selective electrodes.

The permissible content of agrochemicals in vegetable products was determined according to sanitary rules and norms (SanPiN 2.3.2.1078-01) «Hygienic requirements for safety and nutritional value of food products».

The mathematical processing of results was conducted using the components of the Microsoft Office 2003 computer program with the calculation of the average absolute value and it’s error, and also part of the maximum permissible level, which is made from medium level of relative value, expressed in %. The data obtained were considered reliable at p≤0.05 and a significance level of at least 95%.
4. Results and Discussion

The studies found that the concentrations of dichlordiphenyl, trichlorethane and hexachloreocyclohexane, their isomers and metabolites in foodstuffs grown and selected in most of the ecologically disadvantaged territories were the same for the farms and private allotments. At the same time, the concentration of DDT and HCH in vegetables (the amount of the medium concentrations of pesticides in potato, carrot and beet-root) did not exceed 0.05±0.001 mg/kg, which corresponded to maximum permissible level established for the food products in the Russian Federation.

Also, the preliminary questioning of farmers about use of the pesticides and herbicides made it possible to establish widespread use both on the fields of modern farms and on personal allotments of a number of organophosphorus pesticides. Among them, the most commonly used insecticides were chlorpyrifos, malathion (karbofos) and glyphos-based herbicides, mainly «Roundup» and «Tornado».

In the researches which were conducted on the territory of farms of the Volga region: Dergachevsky, Ershovsky, Perelubsky, Fedorovsky districts established the presence of chlorpyrifos in vegetable products in concentrations of 0.01 ± 0.002 mg/kg, which corresponded to maximum permissible level. In the vegetable products from the same districts which were grown on private allotments the chlorpyrifos concentration was 50% of the permissible level. In vegetable products from another ecologically disadvantage districts the chlorpyrifos did not found, regardless of farm form.

The widespread use of melation has found application on the private allotments to the insecticides protection. Its concentration in vegetable products was from 10 to 30% of the maximum permissible level (from 0.1 ± 0.05 to 0.3 ± 0.03 mg/kg) and depended on the type of agricultural territory. In drylands with a high level of insect pests, the insecticides concentration in vegetable products was maximum and equal to maximum permissible level (0.5 ± 0.001 mg/kg).

The level of hlyophosphate in vegetable products varied significantly in different studied ecologically disadvantage districts. The highest concentration of hlyophosphate (0.3 ± 0.001 mg/kg) which was equal to the maximum permissible level was found in vegetable products of the drylands of Zavolgsky region. On the right side of Volga River with a developed reclamation system, the herbicides concentration was about 30-50% of the maximum permissible level (0.15 ± 0.006). The hlyophosphate did not found in vegetable products grown on the private allotments.

According to the lows of the countries of the Eurasian Union (Russia is the member of the Union) in the study of food safety for pesticides, the objects of research are dichlordiphenyl trichlorethane and hexachloreocyclohexane. The latter is due to the fact that, despite the ban on their production and use in 2001 year (according to the Stockholm Convention) these persistent organic pollutants were widely used for decades, which led to the accumulation of the latter in one or another isomeric form in soil and water. But these polluted organic matters did not found, regardless of farm form.

The presence of chlorpyrifos in vegetable products in maximal acceptable concentration on the farms territory of Dergachevsky, Ershovsky, Perelubsky, Fedorovsky districts was linked with the use of aviation chemical protection of plants from the crop pests, coming from the southern territory of Astrakhan and Volgograd Regions. The prediction of the emergence of herd locusts was early warm spring with low and short floods, dry summer [9]. Also the lower level of chlorpyrifos in the vegetable products grown on private allotments in the same districts was about 50% of the maximum
permissible level. This was explained by partly contamination of the pesticides after aerial-chemical treatment and the traditional use of melation and carbofos, as insecticides in agricultural producing on private allotments.

The hlyophosphate (N-phosphonometilglicin) is used as a herbiced for the control of the groundkeepers. The hlyophosphate has a low toxify and can be classified as a «medium risk» for human and widely used because it is coast effective. But last time there are a lot of European scientific researches which showed cancerogenic effects linked with the herbicides based on the hlyophosphate [10-13].

The established difference in glyphosate levels in vegetable products of various regions can be explained by the good solubility of the herbicide and its rapid uptake by weeds, including even before the start of growth of cultivated plants.

Also, the herbicides were more stable on the surface of the soil and then accumulated in plants in the drylands. The low efficiency of hlyophosphate use in drylands depended to retreatment of farms fields against groundkeepers. It leads to the huge herbicides accumulation in vegetable products.

The nitrates levels in vegetables from ecologically disadvantaged territories were different according to the content of the poisonous substances in the vegetable products, production conditions and cultivation area type. At the same time, the nitrate content in all analyzed vegetable products, regardless of the region of growth and growing conditions, did not exceed the maximum permissible levels regulated by state sanitary rules. The nitrates content in vegetable products was equal to the maximum permissible level: for zucchini – 37%, for carrot – 46%, for potato – 69%, for cucumber – 98% and determined by national sanitary standard. The highest nitrates concentration was found in vegetable products from the Balakovskiy, Marksovsky, Engelsky, Saratovsky districts. In the same districts the nitrates concentration in vegetable products grown on farms was a higher (p<0.05), than in vegetables grown on private allotments. With the Russian sanitary rules and norms (SanPiN 2.3.2.1078-01 «Hygienic requirements for safety and nutritional value of food products»), normal nitrates concentration in potato – 250 mg/kg, in carrot – 400 mg/kg, in beet-root – 1400 mg/kg, in zucchini – 400 mg/kg, in cucumber – 150 mg/kg.

The higher nitrates concentration in the soil of private allotments linked with the traditional usage the industrial ammonium solution in autumn and then in spring, which causes glut of field’s soil by nitrates. This process causes plants to accumulate unused nitrate nitrogen. The right transformation of the nitrates in plants proteins was possible in correct fertilizer consumption in soil in the planting and development periods. More often the scheme of fertilizer consumption used in private allotments. The «green fertilizer» consumption leads to decreased nitrates content. The «green fertilizer» received by the preliminary composting the special biomass from bean plants. But in economical context there is impossible to usage in large farms.

Low nitrates concentration in drylands was associated with the natural condition (lack of precipitation) and traditional irrigation cessation after the flowering period. As a result, water-soluble nitrates did not accumulate in vegetable products. So, in Ershovskiy and Dergachevskiy districts the nitrates content in potato was 72.0 ± 18.0 mg/kg and 70.0 ± 21 mg/kg respectively. This concentration was less than nitrates content in other districts (p<0.05). In other vegetable products the nitrates concentration were equal on farms and on private allotments, the same on drylands.

5. Conclusions

Despite the fact, that all the studied chemical contaminants, detected in vegetable products, grown on farms and on private allotments contained poisonous substances in maximal acceptable concentrations, their cumulative influence caused health risk to the population.

Given the fact that the great part of Saratov Region located in the ecologically disadvantaged territories, the raw materials, produced in these districts, makes up the significant part in the nutrition of the population. The result scientific research will allow one to develop practical recommendations to the reduce health risks of the population by the limiting the consumption of the chemically poisonous substances.
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