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Soil and landscape geochemical factor of iodine distribution in the main environmental components and agricultural food chain within the central Russian plain

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The main goal of the study was to reveal landscape geochemical and soil conditions responsible for iodine deficit in the environment and natural food chains in the Russian plain forest zone and for natural conditions favoring iodine accumulation in food chains (1-6).

Distribution of iodine was studied in soils, soil microorganisms, water and dominating plant species collected in flood plain and watershed landscapes formed on different geochemical types of sedimentary rocks typical for the central Russian plain (fluvioglacial sands, moraine deposits, loess-like loams, eluvium of carbonate and Permian rocks). Soils and plants were sampled at test plots sized 10x10 m (grasslands) and 25x25 m (woodlands). Soil samples from master horizons were also analysed. Biomass of soil microorganisms for iodine determination was grown in nutrient medium prepared from original soils. Ground water was sampled directly from soil pits. Drinking water, cow milk and hair were collected in the selected local collective farms situated within the areas of different soil-forming rocks. Iodine was determined by kinetic rodanide-nitrite method known for its high sensitivity and a wide determination interval (4-200 μg/l). Determination error in water samples equaled 2-4% and did not exceed 15-20% for the other objects.

Mean iodine concentration in the parent rocks depended upon their origin, texture, the presence of carbonates and ranged from 0,19±0,04 mg/kg dw (fluvioglacial sands) to 5,0±1,87 mg/kg dw (carbonate eluvium of Permian rocks). In water samples iodine content varied from 0,2 μg/l to 21,0 μg/l increasing in water rich in organic substances or carbonates. Relatively high values were found in water of the humus-carbonate soils of the Vladimir opolje landscapes (14 μg/l) and the alluvial peaty soils of the northernmost site (Luza river basin, 21,0 μg/l). Iodine accumulation in the top organic horizon correlated with humus content ($r_{0,95}$=0,626, biogeochemical barrier) and increased in soil layers enriched in fine fraction (sorption barrier) and in carbonates (alkaline-carbonate barrier). The watershed areas with podzolized sandy soils developed on the young fluvioglacial and moraine deposits present the areas most impoverished in iodine (not exceeding 0,5 mg/kg). However the subordinated terrace and flood plain soils appeared to be 2 to 6 times richer in this element presenting local areas most favorable for better iodine supply for agricultural production. Soil microorganisms isolated from soils collected at 4 geochemically different sites (41 plots)showed high ability for iodine concentration (1,8 to 315 mg/kg dw that corresponded to 0.01- 3,24% of iodine inventory in the top 20-cm soil layer correspondingly). Direct correlation between iodine content in humus horizon and in microbial biomass was established for soddy podzolic sandy and loamy sand soils ($r_{0,90}$=0,842). Iodine concentration in plants depended upon their systematic and ecological type and iodine water mobilization. Its maximum concentration was found in lichens and mosses (1,08±0,19 mg/kg, n=14 and 0,743±0,10 mg/kg dw, n=46) as well as in grasses growing on wet organic soils (sedges, horsetail, *Oxalis acetosella*, approximately 0,2 mg/kg dw). In general hydrophyllous plants (both trees and grasses) were richer in iodine as compared to mesophytes. The lowest iodine content was typical for grasses growing in watershed fluvioglacial and young moraine landscapes with sandy soils. Iodine amount in cow hair followed its content in soils and rocks of the grazing areas and was 2-3 times lower in polesje and moraine landscapes as compared to those formed on eluvium of carbonate loess-like and Permian rocks (0,13-0,18 mg/kg and 0,24-0,54 mg/kg correspondingly). Iodine concentration in hair was definitely related to the one in forage (r=0,804, n=17). Iodine content in milk corresponded to its content in hair (r=0,698, n=15) and in forage (r=0,687, n=15). According to veterinary examination (Kondratiev, Timokhin, Shushlebin, unpublished report) clinical features of iodine deficiency in cattle were rare in landscapes developed on covering loams, while in farms on young moraine landscapes they varied from 10 to 24%. The study proved landscape geochemical approach to be a fast and effective method for evaluation of spatial iodine variation in the environmental objects and to reveal provinces with the low geochemical background incorporating local areas providing higher iodine supply for the direct natural agricultural food chain. Prophylaxis of iodine deficiency should account of its spatial variability in natural landscapes to be more effective and to use natural sources of iodine enrichment of the local food chains.

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