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Hygienic Assessment of Alimentary Exposure to Stable Strontium in Russia: A Risk Analysis

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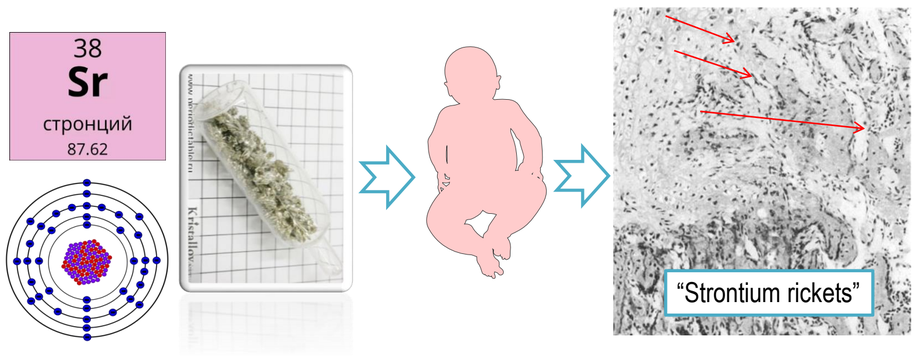
INTRODUCTION & AIM

Stable strontium (Sr) is a toxic trace element and a chemical analog of calcium. Its primary target is bone tissue, where it accumulates, disrupting mineralization and causing “strontium rickets”. Classified as a non-carcinogen with an oral reference dose (RfD) of 0.6 mg/kg bw/day. High variability of Sr levels in water and food across Russian regions necessitates a detailed risk assessment. This study evaluates alimentary Sr exposure by analyzing its content in drinking water and food products.



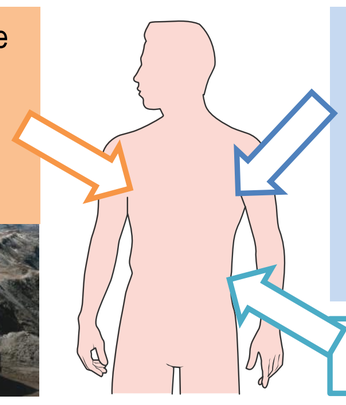
METHOD

The analysis is based on a review of peer-reviewed literature and official Russian monitoring data on stable Sr concentrations in water. Non-carcinogenic risk was assessed using the Hazard Quotient (HQ) by comparing estimated daily intake with the RfD.

RESULTS & DISCUSSION

❑ Inhalation: Sr aerosols in the air of the work area and populated areas
❑ Content from 0.004 to 10 mg/m3 (3 orders of magnitude)
❑ Relevant for professional exposure

Open-source mining of strontium minerals: $SrSO_4$ – Celestine and $SrCO_3$ – strontianite.



❑ With drinking water: MPC=7 mg/l
❑ The actual content in centralized water supply sources is from 0.01 to 20 mg/l
❑ Geochemical provinces with abnormally high Sr in drinking water have been identified in the USA, Turkey, India, and Russia (Moscow and Smolensk regions)

Intake of Sr from food products

The highest food levels were found in spices *Trachyspermum ammi* seeds (**490 mg/kg**) and fennel (**183 mg/kg**). According to published data, high concentrations are also known in nuts (almonds 15.7 mg/kg), dairy (hard cheese 12.0 mg/kg), mollusks (14.3 mg/kg), fish liver (3.54 mg/kg). Legumes (up to 3.34 mg/kg), chocolate (3.17 mg/kg), and spinach/cabbage (up to 2.65 mg/kg) also show significant levels.

The Sr content in animal products such as meat, milk, and chicken eggs is usually **very low** and not significant in the overall assessment of exposure.

Product groups	Typical Sr content, mg/kg, wet weight
Grains and cereals	1-2
Vegetables	6
Berries	0.26-2.2
Fruit	0.08-1.74
Grape	0.11-3.8
Potato	0.26-1.12
Nuts	7.6-15.7
Spices	50-490
Cheeses	3-12
Fish and seafood	1.27-2.17

Assessment of non-carcinogenic risk

The total consumption of Sr from all food products characterized by its content, thus, will be in an unfavorable scenario:

❖ AD (mg/day)= 0.6 (bread and cereals) + 1.5 (vegetables) + 0.1 (fish) + 0.2 (milk) + 0.2 (nuts, spices)+ 1 (other sources, including cheeses, coffee) ≈ **3.6 mg** per day.

❖ Combined effects from all sources (food and drinking water), the daily oral intake of Sr by adults in Russia is a maximum of 5.6 mg/day and does not exceed **6** mg/day.

For a person weighing 70 kg:

✓ HQ = AD/RfD = 3.3/42 = 0.08 (according to foreign sources).
✓ HQ = AD/RfD = 5.4/42 = 0.13 (our calculation is based on data on the Sr content in food and drinking water).

! Sr content in Russian artesian water varies greatly, reaching **15.45 mg/L** in the Smolensk region.

! This corresponds to an **acceptable/low** level of non-carcinogenic risk.

At average concentrations, total daily Sr intake yields an HQ **within acceptable range (<1.0)**. However, for some regions of Russia, high Sr in water together with consumption of products at maximum concentrations **approaches threshold levels**.

CONCLUSION

Alimentary exposure to Sr in Russia generally poses acceptable non-carcinogenic risk for average consumer. However, in certain biogeochemical provinces and among consumers on diets rich in Sr-accumulating foods, exposure may approach RfD. Such a scenario is also possible in other countries with similar hydrogeochemical conditions and dietary patterns. These findings highlight need for regional monitoring and targeted risk management.

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