INTERNATIONAL CONFERENCE ON RADIATION APPLICATIONS

DETERMINATION OF NATURAL AND ARTIFICIAL RADIONUCLIDES (^{40}K, ^{137}CS) ACTIVITIES IN FREEZE-DRIED FOODS OF PLANT ORIGIN

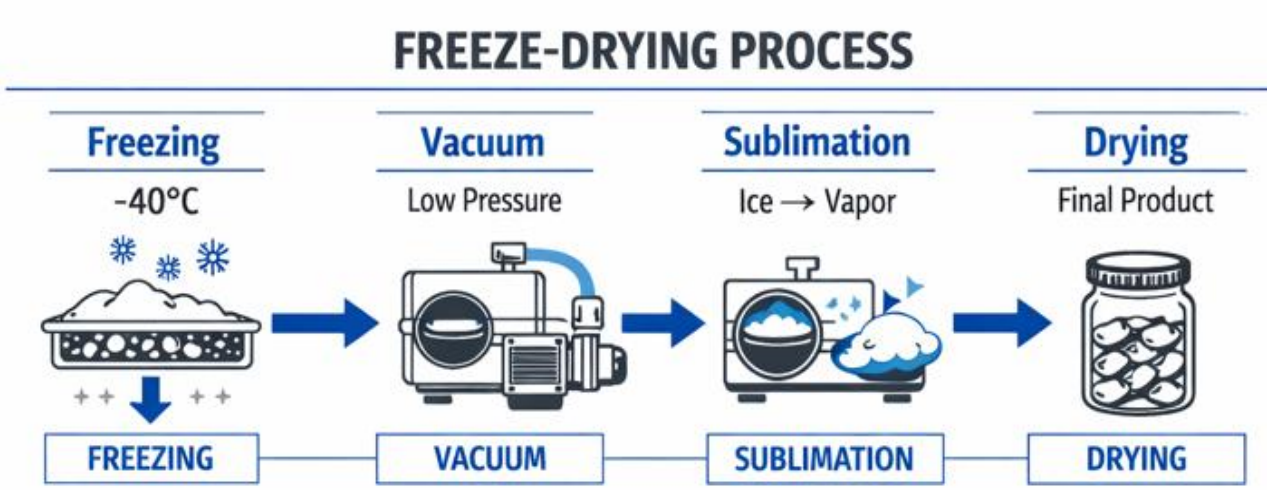
Ingrida Pliopaitė Bataitienė[1], Gražina Stasiulionienė[2], Vida Šeikienė[3]

[1, 2, 3] Higher Education Institution Utenos kolegija, Lithuania
Correspondence email.: ingrida.pl@gmail.com

Why is it important?

- For thousands of years, humanity has confronted the persistent challenge of hunger. Even as food availability has increased, the issue of how to preserve it so that it remains safe for consumption over extended periods of time has continued to pose significant difficulties. Humanity has long sought methods to ensure that food not only endures but also retains characteristics as close as possible to its original state.

- Lyophilization (freeze-drying), also known as sublimation drying, is a dehydration process used to preserve perishable materials or make them more convenient for transport and storage. It involves freezing the product and then reducing the surrounding pressure to allow the frozen water in the material to sublimate directly from the solid phase to the gas phase.



Why is it important?

•The products become porous and retain their biological, nutritional, and sensory properties.

•***When water is removed, the dry matter becomes concentrated, and therefore the radionuclides also become concentrated.***

•The main source of Lithuanian soil pollution with the artificial radionuclide (^{137}Cs) is the nuclear testing and nuclear power plant accidents (Chernobyl, Fukushima NPP). The soil contamination by these radionuclides is characterized by discoloration.

•^{40}K is a radioactive isotope of potassium, accounting for about 0.0117% of all potassium in nature. Since potassium is an essential biogenic element, ^{40}K is naturally present in every plant and food product."

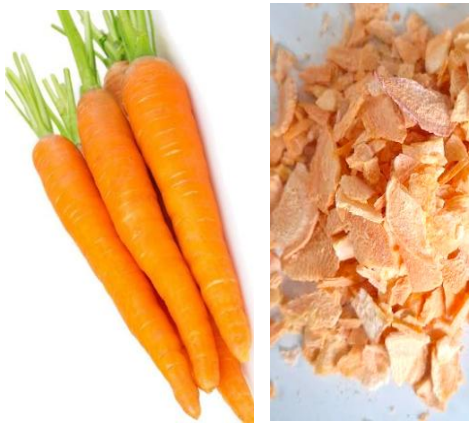
•The initial amount of radionuclides in plants depends on:– the radionuclide content in the soil of the growing site,– the chemical form of the radionuclides,– the plant species.

The aim of this study is to determine and compare the activity concentrations of the radionuclides ^{40}K and ^{137}Cs in distinct categories of freeze-dried plant-derived food products.

Investigation: the investigated raw and freeze-dried food products of plant origin

Forest mushrooms wrinkled ceps (*Rozites caperata*) (growing area - Varėna district, Puvočiai village)

Jerusalem artichokes (*Helianthus tuberosus*) (growing area - Ukmergė district, Jogvilai village)



Carrots (*Daucus carota)* (growing area - Molėtai district, Alanta village)

Beets (*Beta vulgaris* L.) (growing area - Molėtai district, Alanta village)

Methodology (1)

- **Freeze-drying**

Harvest Right PRO dryer

Freezing

Once the temperature reaches – 40 °C, the air is evacuated from the chamber until the pressure decreases to a level corresponding to high vacuum conditions.

Sublimation drying

Desorption (secondary drying)

Following primary drying, the process continues until the residual moisture content in the product is reduced to 1–4%.

Methodology (2)

- **Gamma spectrometry**

- The raw samples were washed and dried. The peeled skins of carrots, beetroots and Jerusalem artichokes were removed, and the edible portion of each sample was homogenized. A gamma-spectrometric analysis of ^{137}Cs and ^{40}K was performed.

- After the lyophilization of the food products, gamma-spectrometric analysis was performed.

- The samples (raw and freeze-dried) were measured in 0.5-L Marinelli container, using a gamma spectrometer equipped with a high-purity germanium (HPGe) detector.

Results

Sample	Radionuclide	Activity, Bq/kg
Raw forest mushrooms wrinkled ceps (*Rozites caperata*)	^{137}Cs	144±18
	^{40}K	87±17
Freeze-dried forest mushrooms wrinkled ceps (*Rozites caperata*)	^{137}Cs	1943±240
	^{40}K	778±307
Raw Jerusalem artichokes (*Helianthus tuberosus*)	^{137}Cs	<0,3
	^{40}K	165±15
Freeze-dried Jerusalem artichokes (*Helianthus tuberosus*)	^{137}Cs	<0,5
	^{40}K	792±67
Raw Carrots (*Daucus carota*)	^{137}Cs	<0,2
	^{40}K	149±13
Freeze-dried Carrots (*Daucus carota*)	^{137}Cs	<0,8
	^{40}K	963±82
Raw Beets (*Beta vulgaris* L.)	^{137}Cs	<0,2
	^{40}K	98±9
Freeze-dried Beets (*Beta vulgaris* L.)	^{137}Cs	<0,7
	^{40}K	691±59

The main conclusion

- Lyophilization significantly increases the specific activity of radionuclides due to the removal of water.
- ^{137}Cs was detected only in mushrooms from the Varėna district.
- ^{40}K was detected in all analyzed products.
- Radionuclide concentrations are influenced by the growing site, soil properties, water content, and the structural characteristics of the product.

Practical significance

- Lyophilized products may exhibit higher radionuclide concentrations per unit mass due to water removal. It is important to assess the environmental and site-specific risks when collecting forest products.
- The research are relevant for: food safety, radiological monitoring, food processing and technology.

Thank you for your attention

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Higher Education Institution Utenos kolegija, Lithuania
Correspondence email: ingrida.pl@gmail.com