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REVIEW

from the foreign scientific supervisor Marko Štrok

For the thesis of Nurgul Nursapina

"Entering of natural radionuclides in soil and root crops with fertilizers and their distribution in "soil-plant" system" submitted for the degree of Doctor of Philosophy (PhD)

Natural radionuclides are omnipresent in the soil, where elevated activity concentrations can be found in many places around the world. Crops can take up these radionuclides, which subsequently enters into the food chain and can pose increased exposure of humans to radioactivity. Therefore, it is important to know to which extent and what mechanisms are governing radionuclides uptake into the crops. Many studies have been performed in this field in the past years and main conclusion is that radionuclide uptake is highly site specific and depends to the large extent on the soil type, crop type and agricultural practice. Therefore, it is advisable to perform site specific studies to characterize radionuclides uptake and provide recommendations for crops cultivation based on specific scientific findings rather than using literature data as a proxy. In addition, different fertilizers are nowadays used to increase crops yields. Although they improve growth conditions for crops, they can alter soil characteristics and local geochemical environment in which plants are grown. This can either foster increased uptake or decrease radionuclide uptake, depending on whether addition of fertilizers increase or decrease radionuclides bioavailability. Systematic studies on these effects have not yet been performed in the past and they would greatly enhance our understanding on how modern agriculture is affecting radionuclides uptake.

Nurgul thesis addresses these issues by studying uptake of natural radionuclides by crops from three different soils from Kazakhstan for which no data is existing so-far. In addition, she systematically analyzes influence of different fertilizers available on the market in Kazakhstan on the bioavailability and uptake of natural radionuclides into the crops. The methodology used to tackle these issues is appropriate. It involves cultivation of plants in pot experiment, which enables environment with enough control to key parameters and at the same time close analogue to the

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real agricultural practice. Bioavailability and distribution of radionuclides among different fractions in soil was assessed with the help of sequential extraction protocol, whereas natural radionuclides in soil and plant samples were determined with alpha spectrometry, following suitable sample preparation, digestion and radionuclide separation protocols.

The results included in the thesis enabled to quantify transfer factors of natural radionuclides in radish and carrots from soil from two different regions in Kazakhstan and to assess influence of different fertilizers on the uptake of U, Th and Ra. The results are very interesting and are emphasizing the need for site specific studies as radionuclide distributions among different fractions in two soils were completely different, which also had an influence on the radionuclides uptake into carrots. The results of the work formed the basis of 10 publications (two publications in journals included in Web of Science database, three publications in scientific journals recommended by the Committee for Quality Assurance in the Field of Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan and five abstracts at international conferences), which indicates the scientific importance and relevance of the work. In addition, many results are still in process of publication, with prospect of increasing peer-reviewed scientific articles output in the near future based on the results presented in the dissertation.

Nurgul is a young scientist with great promise. During the work on the thesis, she showed such qualities as high-level knowledge, responsibility, punctuality and independence. Therefore, I believe that the thesis work of Nurgul meets all the requirements for a PhD thesis and it can be recommended for the defense.

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