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Natural radioactivity in oilseeds commercialized in the city of São Paulo, Brazil

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Introduction:
Natural radioactivity is present in all compartments of the terrestrial ecosystem (air, soil, water, food and in humans), in different chemical forms, originated from the natural radionuclides found in the earth's crust. The most abundant natural radionuclides in nature are those of the ^{238}U and ^{232}Th radioactive decay series, and ^{40}K. These natural radionuclides contribute with most of the natural radiation dose humans are exposed to. Hence, all ecosystems may contain traces of radionuclides in different concentrations and their distribution in the compartments is dependent on physical, chemical, and biological factors[1]. Natural radioactivity, due to its presence in all terrestrial ecosystems, reaches man by the food chain through plant and animal foods; therefore, all types of food have different concentrations of natural radionuclides. Oilseeds are widely used in human diets because they are an important source of protein and some essential micronutrients, mainly in vegetarian and vegan diets. It is known that some kinds of nuts (oilseeds), have significant concentrations of natural radionuclides, like Brazil nuts. The objective of the present work was to determine the concentrations of natural ^{40}K, ^{226}Ra, ^{228}Ra and ^{228}Th radionuclides in oilseed samples, commercialized in the city of São Paulo.

Methodology:
Samples of coconut, raw Brazilian pine, horse chestnut, Portuguese chestnut, pistachio, pine nut, baru chestnut, peanuts in shell, Brazil nuts, almond, hazelnut, cooked Brazilian pine, cashew nut, shelled peanut, licuri, chestnut, Brazilian pecan, pecan and macadamia were acquired in the Municipal Market of São Paulo. The samples were dried in an oven with air circulation at 60°C and, after dried, were macerated in porcelain mortar and pistil, homogenized, and packed in a high-density polyethylene (HDPE) bottle with 100 mL capacity. Natural radionuclides, ^{40}K, ^{226}Ra, ^{228}Ra and ^{228}Th, were determined by gamma spectrometry using a hyper pure germanium detector (HPGe) with beryllium window model GX 2520, CAMBERRA, associated to an electronic system and measurement time of 250,000 s [2] to each sample.

Results:
Table 1 presents the results obtained for the natural radionuclides analyzed in the oilseeds samples. The natural radionuclide ^{40}K was determined in all oilseed samples analyzed, above the detection limit (Figure 1). The highest activity concentration was found in the coconut sample and the lowest in the macadamia sample. As to the Brazilian pine samples, it was demonstrated that the cooking process decreased the concentration of ^{40}K activity, probably due to the solubility of the radionuclide. Comparing the radionuclides ^{228}Th, ^{226}Ra ^{228}Ra activity concentration in all analyzed samples, it was verified that the Brazil nut sample presented values tens of times greater. If a value of 10 kg is considered for the annual consumption of Brazil nuts, the committed effective dose calculated by the ingestion[3] will be 0.23 mSv, which corresponds to approximately 80% of the global mean value of the committed effective dose (0.29 mSv y^{-1})[4], for consumption of food and water.

Table 1. Activity concentration of ^{40}K, ^{226}Ra, ^{228}Ra and ^{228}Th, Bq kg^{-1}, in oilseeds samples.

Samples	K-40	Th-228	Ra-226	Ra-228
Coconut	580 ± 27	< 1.50	1.66 ± 0.36	< 2.93
Raw Brazilian pine	426 ± 30	< 1.04	1.42 ± 0.40	< 2.38
Horse chestnut	332 ± 23	< 1.74	< 2.09	< 3.52
Portuguese chestnut	327 ± 23	< 1.57	< 1.74	3.73 ± 0.70
Pistachio	297 ± 20	< 1.46	< 1.70	< 2.92
Pine nut	281 ± 19	< 1.67	< 1.98	< 3.43
Baru chestnut	270 ± 18	< 1.03	< 1.16	< 2.42
Peanut in Shell	230 ± 16	< 1.57	< 1.87	< 2.99
Brazil nut	222 ± 16	43 ± 3	64 ± 4	47 ± 3
Almond	220 ± 15	< 1.42	< 1.58	< 2.80
Hazelnut	216 ± 15	< 1.66	< 1.98	< 3.35
Cooked Brazilian pine	199 ± 14	< 1.40	< 1.54	< 2.68
Cashew nut	194 ± 14	< 1.76	< 2.02	< 3.40
Shelled peanut	178 ± 9	< 0.97	2.49 ± 0.46	< 2,28
Licuri	157 ± 11	< 1.58	< 1.88	< 2.97
Chestnut	156 ± 11	< 1,54	< 1.77	< 2.92
Brazilian Pecan	125 ± 9	< 1.25	< 1.47	< 2.26
Pecan	125 ± 9	< 1.30	< 1.59	< 2.60
Macadamia	96 ± 7	< 1.59	< 1.88	< 3.05

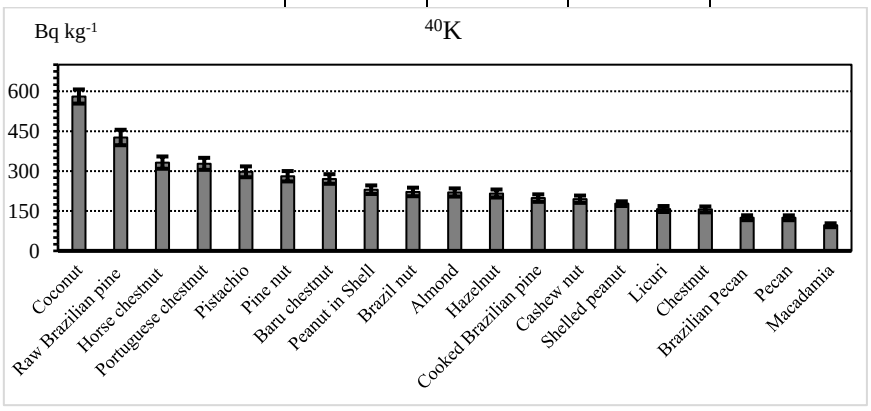

Figure 1. Activity concentration of ^{40}K in oilseeds samples, Bq kg^{-1}

Conclusions:

Natural radionuclides were determined in samples of oilseeds commercialized in the city of São Paulo using high resolution passive gamma spectrometry. The analytical technique used allowed the quantification of ^{40}K activity concentration in all samples, with the highest value found for the coconut sample. The high activity concentration values determined for all radionuclides analyzed in the Brazil nut sample indicate that this food has a significant contribution to the total value of effective dose compromised by food and water intake. Therefore, diets using oilseeds, especially Brazil nuts, such as vegetarian and vegan ones, may present a different value of commitment effective dose in this population.

References

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