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# STUDIES ON THE DEGREE OF RADIOACTIVE CONTAMINATION OF POULTRY EGGS

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***Abstract***

*The natural sources of radiation represent the cause of the minimal contamination of the environment, including air, water, soil and generate the level of radioactivity detected in vegetal or animal food, under normal conditions. Of artificial radio nuclides which pollute the environment and food, the object of this study is 134 Caesium and 137 Caesium (134 Cs and 137 Cs), both because of their particularity to own a chemical structure similar to potassium ($K^+$), the prevalence in food of animal origin and total and rapid solubility in the body, and because of the usual measurements made in our country in order to detect the levels of radioactive contamination of food, aiming mainly the two mentioned isotopes of Caesium (134 Caesium and 137 Caesium). Given the fact that the eggs and egg products are not included in Romania in a strategic plan for monitoring the level of radioactive pollution, this study in dynamics, aims at recording the level of the two isotopes of Caesium, in the mentioned food products and at verifying if the detected values, are according to the rules laid down by the national and international norms. Thus, the comparative evaluation of the radioactive pollution in a year was aimed, at eggs collected from hens grown in particular, extensive, traditional system, compared to the eggs collected in the same period of time, in trade, from authorised units, from hens exploited in intensive system.*

***Key words*:** *Caesium, food safety, radioactive pollution, spectrometry*

## INTRODUCTION

The food safety is also known as hygienic quality. The exposure to high doses of radiation causes radioactive pollution by passing the heavy metals in the composition of food, which are dangerous both for the human body and also for the environment.
The sources of radioactive pollution can come from the industrial emissions of radioactive nuclear waste, nuclear weapons testing, and medical and scientific research with radioactive substances such as 137 Cs, that come through precipitation in the landscape and it is strongly absorbed by soil particles, limiting its movement through chemical and biological processes occurring in soil [11]. The most common radioactive form of Caesium is represented by 137 Caesium. Another radioisotope quite common is 134 Caesium, but 137 Caesium, is much more aggressive for the environment than 134 Caesium [9].
The concentrations of 137 Caesium of about 22 Bq $kg^{-1}$, were detected in species of plants, in different locations, following the accident of Chernobyl in April 1986 [2], [1].
Caesium is taken up by plants through the leaves, which can reach the food of the poultry which produce eggs [14], [12].
Considering the half-life of Caesium of approximately 30 years, It is long enough that the objects and regions contaminated with 137 Caesium, remain dangerous for humans for a generation or more, where relatively small amounts of 137 Caesium release dangerous doses of radiation (specific radioactivity is of $3.2 \times 1012$ Bq $g^{-1}$ [8], [6].
That is why, the control of the radioactive content of food in natural radio nuclides represent today a curret [4]. Radiations represent a potential danger for humans even if there are many beneficial uses (in medicine for diagnoses or therapeutic purposes, in

industry for producing some consume products, in producing electrical power using nuclear reactors etc.) [13], [10].

Foods of animal origin likely to be contaminated are eggs and milk [3]. Regular monitoring of food hygiene and strict implementation of the national health standards are the main methods of food control regarding the content of radioactive substances and compliance within the admitted range. In order to obtain safe food for human consumption, that will not affect the consumer's health, it is needed to assess the pollutant load (including 134 Caesium and 137 Caesium) of feed that the poultry consume to produce eggs.

## MATERIALS AND METHODS

The study was conducted on eggs, for 1 year and the samples needed for the present research were obtained from hens grown in the traditional, extensive system, from private households located in Bucharest region and from hens exploited in intensive system, eggs were collected in this case from trade.

Groups of 10 samples were formed, of eggs from private households and those from trade, by sampling within ten intervals, within a calendar year. These intervals were established on the basis of the average production of eggs, from hens exploited in extensive, traditional system, in an area with a temperate climate.

Variations in egg production by certain factors, as well the hybrid type used by different breeders, the influence of environment factors specific to geographic regions chosen, and the amount of administered fodder, were eliminated by establishing indicatively an average production of 180 eggs/hen, during a calendar year.

Considering by approximation, based on the same factors of variation of egg production, the period between March and November, as the annual period for obtaining eggs from this category of hens, the respective months were considered in the study, as the first 9 periods for sampling (March - sample 1 April - sample 2, May - sample 3 etc.). Months January, February and December were the 10 - the sampling period, given that, depending on the feed quality and type of hybrid, a certain percentage of hens exploited in traditional system, continues egg lying at a minimum level, including this season. Thus, we identified situations in which, in some households, in December and January, breeders obtained, from a group of 20 hens, three eggs/week.

Under these conditions, the eggs collected in each of the ten periods, represented one sample numbered from 1 to 10, so that the tests were carried out on groups of ten samples, for each of the two established categories, as regards the hens derived from private households and from units with extensive operating system.

Each sample consisted of 30 eggs, totalling 300 eggs for each category (trade and private households) and a total of 600 eggs, for this study. The results presented for each sample represents the average values obtained from processing of the 30 eggs that constitute a sample.

In order to determine the radioactivity, eggs are subject as the rest of the types of eggs, to some preliminary processing, with the following purposes:

- Bringing the sample in a form appropriate to make measurements;
- Increase of specific activity, so that the radio nuclides present can be measured accurately;
- Bringing the sample in the most convenient form for subsequent radio-chemical separation;
- Long-term preservation of sample.

The preliminary processing involved the following steps:

*Sample weighing*: after removing the shell, each egg is subject to weighting, because in the end, the results are expressed as Bq/fresh product.

*Sample Drying*: is carried out at a temperature of 125˚C in order to reduce the volume to be examined; it is carried out in an oven with adjustable temperature; the solid samples are crushed in advance.

*The destruction of organic matter (calcination)*, is performed at 150-250˚C for eggs and egg products, given the avoidance of

exceeding 425˚C temperature, for 134 Cs and 137 Cs; following the calcination of 1 kg of eggs, ≈ 10 g ash is obtained, while it is sufficient a quantity of 0.2 kg of powder egg, in order to obtain the same amount of ash.

*Weighing after calcination*

The products thus prepared were subject to measurements in order to detect the level of 134 Cs and 137 Cs, by the method of gamma spectrometry, which is based on the concomitant registration of the gamma radiation emitted by the mixture of nuclides range of the sample, followed by the identification of each component based on the energy of corresponding drip and the content of nuclide range in the sample is calculated. The measuring box with the sample is placed on the detector according to the geometry of measurement used and the sample spectrum is recorded in the analyzer.

The spectrum obtained is analyzed, determining the order numbers of the appropriate channels of drip maxim. It is identified, with the calibration curve in energy, the energy corresponding to each photo drip, then the isotope corresponding to the respective energy is determined and gamma nuclides activity is calculated, expressed in becquereli ($Bq = 1s^{-1}$).

Finally, the obtained results were compared with the maximum admitted limits, established both in our country and at international level.

## RESULTS AND DISCUSSIONS

After analyzing the samples of eggs from hens grown in the traditional system, in households in Bucharest region (Table 1), higher values of maximum admitted limit were not detected, established in our country by Regulation 2073, Annex 1 [5].

The values obtained were variable in insignificant limits for the sampling periods, being impossible to establish a correlation between certain levels of radioactive pollution and seasonal period.

The above mentioned situation was similar to the results obtained for the eggs collected from trade (Table 2), except that the values of the level of radioactivity, identified for this category of eggs were lower than those detected for the first group, which may be associated causally to the exposure of hens grown in the traditional system, to some higher amounts of natural radiation, compared with those exploited in intensive system [15].

Table 1. Level of radioactive pollution of the eggs collected from hens grown in traditional, extensive level.

| Sample | | 134 Cs + 137 Cs ($Bq\ kg^{-1}$) |
|---|---|---|
| Number | Month | |
| 1 | March | 11,3 |
| 2 | April | 14,5 |
| 3 | May | 13,4 |
| 4 | June | 12,7 |
| 5 | July | 13,8 |
| 6 | August | 10,8 |
| 7 | September | 15,3 |
| 8 | October | 8,5 |
| 9 | November | 14 |
| 10 | December, Ianuary, February | 15,8 |
| Maximum values for eggs, ($Bq\ kg^{-1}$) according to law | | 600 |
| AIEA* ($Bq\ kg^{-1}$) | | 1000 |

** International Standards of Basic Radioprotection [7].*

Table 2. Level of radioactive pollution of eggs collected from hens grown in intensive system (eggs bought from commerce)

| Sample | | 134 Cs + 137 Cs ($Bq\ kg^{-1}$) |
|---|---|---|
| Number | Month | |
| 1 | March | 8,4 |
| 2 | April | 11,2 |
| 3 | May | 9,3 |
| 4 | June | 13,2 |
| 5 | July | 10,4 |
| 6 | August | 15,1 |
| 7 | September | 12,4 |
| 8 | October | 7,6 |
| 9 | November | 9,5 |
| 10 | December, Ianuary, February | 10,1 |
| Maximum values for eggs, ($Bq\ kg^{-1}$) according to law | | 600 |
| AIEA* ($Bq\ kg^{-1}$) | | 1000 |

** International Standards of Basic Radioprotection [7].*

Regarding the values of contamination with Cs -134 and Cs -137 from the analyzed egg

powder, the situation is similar for the two groups of analyzed eggs (Table 3), noting that the values are closer to those detected for the eggs collected from commerce.

Table 3. Level of radioactive pollution of egg powder

| Sample | | 134 Cs + 137 Cs (Bq kg$^{-1}$) |
|---|---|---|
| Number | Month | |
| 1 | March - April | 10,2 |
| 2 | May - June | 11,4 |
| 3 | July - August | 8,9 |
| 4 | September - October | 12,7 |
| 5 | November - December | 11,8 |
| 6 | Ianuary - February | 11,1 |
| 7 | March- April | 12,5 |
| 8 | May - June | 12,4 |
| 9 | July - August | 10,3 |
| 10 | September - October | 12 |
| Eggs (Bq kg$^{-1}$) | | 600 |
| AIEA* (Bq kg$^{-1}$) | | 1000 |

** International Standards of Basic Radioprotection [7].*

## CONCLUSIONS

After analyzing the samples of eggs from hens grown in the traditional system, in households in Bucharest region, higher values of maximum admitted limit were not detected.

By analyzing the samples of eggs from hens grown in traditional system, higher values than the maximum admitted limit were not detected, the values obtained are varying in insignificant limits for the sampling periods, without a correlation between certain levels of radioactive pollution and seasonal period.

For the eggs collected from trade (from hens exploited in intensive system), the level of radioactivity values were lower than those detected for the first group, which may be causally associated with higher exposure to natural radiation.

At any of the categories of samples analyzed, values of 134 Cs and 137 Cs located above the admitted maximum limits, were not recorded.

## REFERENCES

[1]Avery, S.V., 1996, Fate of caesium in the environment: distribution between the abiotic and biotic components of aquatic and terrestrial ecosystems. Journal of Environmental Radioactivity, 30(2), p. 139-171.

[2]Brickmann, A., Volkmar, W., 1994, Microbial immobilization and recycling of 137Cs in the organic layers of forest ecosystems: relationship to environmental conditions, humification and invertebrate activity; Elsevier, The Science of the Total Environment 157, p. 249-256.

[3]Eremeev, V.N., Ivanov, L.M., Kirwan, A.D., Margolina, T.M., 1995, Analysis of caesium pollution in the Black Sea by regularization methods. Marine pollution bulletin, 30(7), p. 460-462.

[4]FAO/WHO, 2002, Global Forum of Food Safety Regulators, Marrakesh, Morocco. Improving Efficiency and Transparency in Food Safety Systems, Sharing Experiences. Proceedings of the forum FAO, in April 2002 in Rome, Italy.

[5]Food Standards Agency, 2005, General Guidance for Food Business Operators. EC Regulation, No. 2073/2005 on Microbiological Criteria for Foodstuffs, 24 p.

[6]Kagawa, A., Aoki, T., Okada, N., & Katayama, Y., 2002, Tree-ring strontium-90 and cesium-137 as potential indicators of radioactive pollution. Journal of environmental quality, 31(6), p. 2001-2007.

[7]IAEA Safety Standards for protecting people and the environment, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements, Part 3, International Atomic Energy Agency Vienna, ISBN 978–92 –0–135310–8, No. GSR Part 3, (Interim).

[8]Hervàs, S.M., 2014, Preprojecte de millora d'una estació de vigilància d'aerosols mitjançant la supressió del continu Compton per anticoincidència. Universitat Politècnica de Catalunya. Departament de Física i Enginyeria Nuclear. Available on the Internet: http://upcommons.upc.edu/pfc/handle/2099.1/23863,

[9]Omar, H.A., Abd El-Baset, A.L., 2013, Kinetic and Equilibrium Studies of Cesium-137 Adsorption on Olive Waste from Aqueous Solutions. Arab Journal of Nuclear Science and Applications 46 (2), p. 58-70.

[10]Papuc, C., Şerban, M., Pop, A., 2000, Biochimie analitică – principii fundamentale şi metodologice, Editura Printech, Bucureşti, ISBN 973-652-206-7. p. 49 – 68, (in Romanian).

[11]Ritchie, J.C., McHenry, J.R., 2009, Application of radioactive fallout cesium-137 for measuring soil erosion and sediment accumulations rates and patterns, *Journal of Environmental Quality - J ENVIRON QUAL* vol. 19, no. 2. p. 215-233.

[12]Robertson, A., Tirado, C., Lobstein, T., Jermini, M., Knai, C., Jensen, H. & James, W.P.T., 2004, Food and health in Europe: a new basis for action, WHO Regional Publications, European Series no.96. 388 p.

[13]Savu, C., 1999, Poluarea mediului şi prezenţa substanţelor toxice în alimente – controlul calităţii alimentelor, Editura Semne, Bucureşti, ISBN 973-9446-88-4. p. 24 – 58, (in Romanian).

[14]Sawidis, T., Drossos, E., Papastefanou, C. & Heinrick, G., 1990, Cesium-137 accumulation in higher plants before and after Chernobyl, Environment

International (USA); Journal Volume: 16:2.
[15]Voigt, G., Pröhl, G., Müller, H., Bauer, T., Lindner, J. P., Probstmeier, G. Röhrmoser, G., 1989, Determination of the transfer of cesium and iodine from feed into domestic animals. Science of the Total Environment 85, p. 329-338.