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Assessment of Possible Radioactive Contamination of Fruits and Vegetables Consumed in Iraq.

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ABSTRACT

Both Solid State Nuclear Track Detector (SSNTD), CR-39, and Geiger-Muller detector were used to estimate possible nuclear radioactive contamination in plant food consumed in Baghdad and its surrounding cities . The results indicate the absence of such contamination, with the exception of two samples in the Districts of Abughraib (Spinach) and Zaafraniya (Potato). However, in both these cases the detected dose was lower than the tolerated dose limit as defined by the World Health Organization (WHO).

Introduction:

Radioactive materials are created normally due to nuclear fission reactions of radioactive matter. They may get conveyed from one location to the other in the form of mass particles of the size 1- 10 µgram. The most probable hosts for these particles are the plants, which may receive them and introduce them later into the human and feed stock nutrition chain. Different plants show different abilities to accept the radioactive materials, due to their different biological natures and surrounding environments [1,2]

Radioactive materials found in the soil might get dissolved in local solutions or undergo ionic exchange with organic compounds or get precipitated as oxides. It's presence in the upper layers of the soil represents a threat to the environment and human health due to it's facile inclusion into the nutrition chain [3,4]. The water soluble uranium compounds might diffuse to the ground water levels and subsequently to broad areas of ground to cause ultimately radioactive contamination [4,5].

The absorption of such compounds by the plants forms the most probable intake mechanism into the human and animal bodies [6,7]. This fact was heavily pointed out by WHO as a result of inspecting the contamination manningfold cases around the globe [8].

In the recent years, an inreasing number of reports appeared which indicated the rapid increase in the number of child cancer, genetically caused malbirths, repetitive abortions and adult cancer cases in Iraqi cities [9-11]. Thus, it was necessary to inspect the possible causes of these epidemic like diseases, among which food contamination with radioactive material is suspected. This type of contamination was found to be an effective cause of health hazards according to the studies carried out by different centers of nuclear research [12-14]. The safety limit for the radioactive contamination of food and drinking water was defined as 1.63 ppm calculated as uranium element, or 1*mSiv/year* calculated for the equivalent dose of radiation [15].

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Solid state nuclear track detectors (SSNTD) had been used to measure the nuclear radioactivity[16]. They may be made from inorganic or organic material, mostly of organic polymers or resins[17]. On being exposed to radiation, they undergo cleavage of chemical bonds, which appears as optical holes on the surface of the detector. The holes can be detected and counted applying a suitable magnifying microscope. The number of these holes is a function of the concentration of the radioactive material. CR-39 is a favorable detector among the SSNTD's, [15].

Another physical tool for the detection of nuclear radioactivity, is the Geiger-Muller counter. To be named are the modern counters that are controlled by microprocessors and supplied with sophisticated software which allows the identification of the radiation under study [19].

In the present study, the possible plant food contamination with radioactive material, was inspected applying both methods; the CR-39 detector as well as the Gama- Scout Geiger- Muller counter, Heidelberg, Germany.

Materials and method.

CR-39 SSNTD, from Landauer, England.

GS-__Geiger- Muller Counter, Mannheim, Germany.

The food samples were cut to small pieces and then dried for 3 days in the oven (Heraeus Oven, 0 – 250^{O}C, Germany) at 130^{o} C. The dried samples were ground in an agate mortar. 1gram (Sarotorious- BP 3015, balance, Germany) of the ground, dry powder was pressed then into 1cm diameter ring applying a manual press. The ring was set in contact with a CR-39 sheet and left for 30 days. The CR-39 sheet was then dipped in a 6.25 N NaOH solution at 60^{o}C for 5 hours, washed with distilled water and studied under the x400 magnifying microscope(Nicon Microscope, x400, Japan). The formed optical tracks were counted then and their number applied for determination of the radiation dose, counted as Uranium concentration, according to Figure 1.

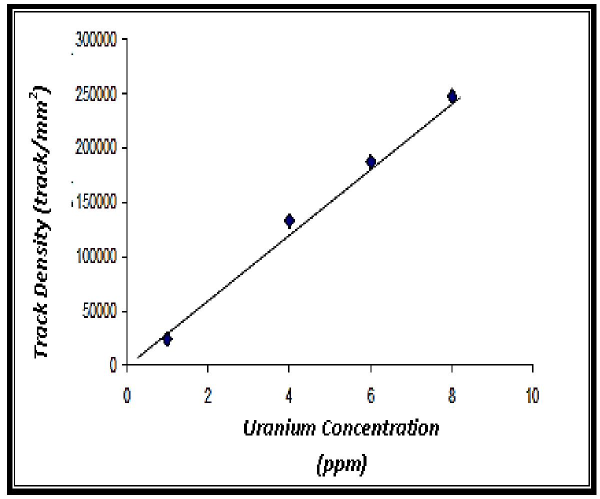

Figure 1; correlation curve of the measured track density in CR-39 as function of U concentration *.

*) Dr. N. F. Tawfiq, Al- Nahrain University.

As for the GS – GM measurement the equivalent dose for each sample was read in terms of µSi/hr (micro Sievert/hour). The units were recalculated then as mlSi/yr (milli Sievert/year), considering 365 days for the year. The measurement considered all 3 types of nuclear radiation, α, β and γ. The measured background dose was 0.102 µSi/hr. The net measurement result was then, (X-0.102) µSi/hr.

Calculated to the final unit; mlSi/yr = (X-0.102) µSi/hr x24x365x 10^{-3} .

Results and discussion.

Measurement of the radioactive dose was done applying the CR-39 detector. The results were compared

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with the tolerated value 1.63 ppm natural Uranium as accepted by the American Standard [20]. Table 1 includes the measurement results for a number of samples chosen from different areas in Baghdad city and some other areas in Iraq. The table shows too, the year of collecting the sample, the name of location where the sample was collected and the ratio of measurement result to the tolerated value 1.63 ppm (ratio). The value of f(r) column 6, should indicate the extent of radioactive contamination for each sample.

Table 1; CR-39 measured nuclear radioactive dose (ppm Uranium) of plant food consumed in different districts of Baghdad, and some Iraqi cities.

Sample	year	method	result (ppm)	ratio (f_r)	district
swiss chard[1)]	2012	CR-39	0.136	0.08	Karrada.
Petroselinum[2)]	2012	CR-39	0.247	0.15	Aadhamiya
Petroselinum	2012 `	CR-39	0.151	0.16	Waziriya
Spinach[3)]	2012	CR-39	1.539	0.95	Abughraib
bit.orange[4)]	2012-13	CR-39	0.228	0.14	Taji
bit. Orange	2012-13	CR-39`	0.527	0.32	Tarmiya
bit.orange	2012-13	CR-39``	0.273	0.17	Albenook
bit.orange	2012-13	CR-39	0.356	0.22	Mosul
swiss chard	2013	CR-39	0.152	0.09	Baghdad
lettuce[5)]	2013	CR-39	0.134	0.08	Yusufia
lettuce	2013	CR-39	0.439	0.27	Tikrit
lettuce	2013	CR-39	0.433	0.26	Hilla
Cabbage[6)]	2013	CR-39	0.128	0.08	Kerbala
Date[7)]	2013	CR-39	0.164	0.10	Haditha
date	2013	CR-39	0.145	0.09	Taji
date	2013	CR-39	0.121	0.07	Hilla
date	2013	CR-39	0.109	0.07	Najaf
date	2013	CR-39	0.205	0.10	Basra
date	2013	CR-39	0.158	0.10	Alsadir-
date	2013	CR-39	0.159	0.10	Fallujah
date	2013	CR-39 `	0.087	0.05	Kerbala
date	2013	CR-39	0.087	0.05	Imara
date	2013	CR-39	0.146	0.09	Diyala
date	2013	CR-39	0.125	0.09	Diyala
date	2013	CR-39	0.142	0.09	Diyala

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1) Beta vulgaris subsp.vulgaris Cicla; 2)Petroselinum sativum; 3) Spinacia oleracea; 4)Citrus × aurantium; 5) Lactuca sativ; 6) Brassica oleracea var. capitata; 7) Phoenix dactylephra.

Table 2; Nuclear radioactive equivalent dose results obtained with the G-S Geiger-Muller counter of plant food consumed in different districts of Baghdad, and some Iraqi cities. Accepted dose level is (1mlSi/ jr), according to the American Standards.

Sample	year	method	initial result (µSi/ hr)	year result (mlSi/ jr)	(f_r)	Source Location
Potato[8)]	2016	G-S GMT	-0.013[*)]	-.113	(0.0)	Alsadir
potato	2016	G-S GMT	-0.014	-0.123	(0.0)	Baghdad
potato	2016	G-S GMT	-0.006	-0.053	(0.0)	Husseiniya
potato	2016	G-S GMT	-0.001	-0.009	(0.0)	Abughraib
potato	2016	G-S GMT	0.093	0.815	0.82	Zaafraniya
Potato	2016	G-S GMT	0.002	0.175	0.18	Aadhamiya
potato	2016	G-S GMT	-0.016	-0.140	(0.0)	Diyala/brd.
Potato	2016	G-S GMT	-0.004	-0.035	(0.0)	Kadhimiya
Potato	2016	G-S GMT	-0.005	-0.044	(0.0)	Saydiya
Potat	2016	G-S GMT	-0.003	-0.026	(0.0)	Suwairah
Onion[9)]	2016	G-S GMT	0.006	0.053	0.05	Alsadir
Onion	2016	G-S GMT	-0.005	-0.044	(0.0)	Baghdad
Onion	2016	G-S GMT	-0.015	-0.131	(0.0)	Hussainiya
Onion	2016	G-S GMT	0.007-	-0.061	(0.0)	Abughraib
Onion	2016	G-S GMT	-0.017	-0.149	(0.0)	Zaafraniya
Onion	2016	G-S GMT	-0.004	-0.035	(0.0)	Aadhamiya
Onion	2016	G-S GMT	-0.015	-0.118	(0.0)	Diyala/brd.
Onion	2016	G-S GMT	-0.007	-0.061	(0.0)	Kadhimiya
Onion	2016	G-S GMT	-0.003	-0.026	(0.0)	Saydiya
Onion	2016	G-S GMT	-0.011	-0.096	(0.0)	Suwairah
Radish[10)]	2016	G-S GMT	0.015	0.132	0.13	Al-Sadir
Radish	2016	G-S GMT	0.016	0.140	0.14	Baghdad
Radish	2016	G-S GMT	0.013	0.096	0.10	Hussainiya
Radish	2016	G-S GMT	0.001	0.009	0.01	Abughraib
Radish	2016	G-S GMT	-.007	-0.000	(0.0)	Zaafraniyah
Radish	2016	G-S GMT	-0.005	-0.000	(0.0)	Aadhamiya

Radish	2016	G-S GMT	0.002	0.018	0.18	Diyalah/brd.
Radish	2016	G-S GMT	0.003	0.026	0.28	Kadhimya
Radish	2016	G-S GMT	0.005	0.044	0.44	Saydiyah
Radish	2016	G-S GMT	0.009	0.013	0.13	Suwairah
Radish	2016	G-S GMT	0.001-	0.000	(0.0)	Yusufia
Radish	2016	G-S GMT	0.010	0.088	0.09	Yusufia
Radish	2018	G-S GMT	-.002	(-)	(-)	Yusufia
Radish	2018	G-S GMT	0.010	0.088	0.09	Yusufia
Turnip[11)]	2018	G-S GMT	0.017	0.149	0.15	Yusufia
Beet[12)]	2018	G-S GMT	-0.010	(-)	(-)	Yusufia
Potato	2018	G-S GMT	0.010	0.091	0.09	Dawra
Radish	2018	G-S GMT	0.009	0.082	0.08	Dawra
Turnip	2018	G-S GMT	0.001	0.009	0.01	Dawra
Beet	2018	G-S GMT	0.004	0.035	0.04	Dawra
Potato	2018	G-S GMT	0.017	0.105	0.10	Shaab
Radish	2018	G-S GMT	0.002	0.017	0.02	Shaab
Turnip	2018	G-S GMT	0.001 -	(-)	(-)	Shaab
Beet	2018	G-S GMT	0.016	0.157	0.16	Shaab

8) Solanum tuberosum; 9) Allium cepa; 10) Raphanus sativus ;11) Brassica rapa var. rapa;12) Beta vulgaris.

*) the radiation equivalent dose is smaller than that of the enbackground (holder), such that the measurement sample acts as an (absorber) of the holder's radiation.

Considering the measurement results obtained with the two different methods, one finds good similarity in the values of f(r) values i.e. measured dose/ tolerated dose (WHO). As for the values of the CR-39 measurements, they range from 0.32 to 0.5 and for the GS- GM results they range from 0.0 to 0.44. This similarity in the f(r) small values confirms obviously that the inspected food samples are free from effective contamination with radioactive material. Exceptions are the two samples of spinach (Abughraib) and potato (Zaafraniya) which show non negligible f(r) values, that however are still lower than 1.

Conclusion.

Both CR-39 and GS-GM measurements indicate the absence of considerable radioactive contamination of plant food that is being consumed in the city of Baghdad and some other cities in Iraq. However, it should be mentioned that the samples were taken as they are marketed in different districts of the city or of Iraq. A better choice of the samples would be to collect them according to their planting location. This work is to be done in future studies.

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دراسة ميدانية لاحتمال التلوث الاشعاعي للمواد الغذائية النباتية المتداولة في السوق العراقية

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الخلاصة:

تم فحص عينات من المواد الغذائية النباتية المتداولة في اسواق بغداد و المدن المحيطة بها بشأن التلوث المحتمل بالمواد ذات الفعالية النووية وباستعمال كاشف الاثر النووي الصلب CR-39 و جهاز كايكر- موللر للكشف عن الاشعة الايونية . و كانت النتيجة خلو كل العينات من التلوث النووي حسب ما هو ممكن من حساسية الطريقتين في القياس. و شذ عن هذه النتيجة العامة نموذجان : نموذج في ابو غريب (نبات السبانخ) ونموذج في الزعفرانية (البطاطا)- الا ان هاتين العينتين ابديتا قيما للفعالية نووية اوطأ من القيم المسموحة حسب منظمة الصحة العالمية .(WHO)