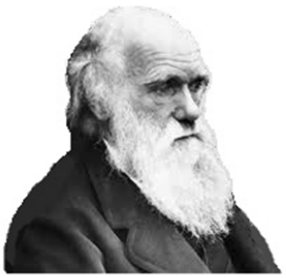
Available online at www.worldnewsnaturalsciences.com



World News of Natural Sciences

An International Scientific Journal

WNOFNS 26 (2019) 138-145 EISSN 2543-5426

Determination of Track Density of Animal Bones using CN-85 Detector

Yasser Ayad Kadhim[1], **Nada Farhan Kadhim**[1,*], **Laith Ahmed Najam**[2]

[1]Department of Physics, College of Science, Mustansiriyah University, Baghdad, Iraq

[2]Department of Physics, College of Science, Mosul University, Iraq

*E-mail address: dr.nada@uomustansiriyah.edu.iq

ABSTRACT

The aim of the study is to calculate the alpha emitters in bone samples of some animals by counting the tracks of alpha particles emitted from radioactive nuclei (Pb-210, Po-210, Ra-226) using the CN-85 detector. The detectors were kept with the samples in closed clear plastic cups at a 2 cm distance for 60 days. The track density in the detector, and, hence, the alpha emitters from the bones were counted with an optical microscope after etching the detectors with an etchant solution (NaOH). The results showed that the optimum etching time of CN-85, when using to detect alpha emitted from natural radionuclides, was 40 minutes and the highest track densities were found in chicken, beef, and sheep, respectively.

Keywords: CN-85 Detector, bones, alpha particles, alpha emitters

1. INTRODUCTION

Radioactivity is the number of disintegrations per second, its unit for measurement is Becquerel [1]. There are two main sources of radiation found in the environment: Natural Radioactivity Sources (which include terrestrial, cosmic rays, and cosmogenic) and Man-Made Radioactivity Sources (which include medical, fallout and nuclear power) [2].

Uranium is naturally present in soil, rock and water. The dominant isotope, Ranium-238, forms a long chain of decay products that include the key radionuclides such as Radium-226 and Radon-222 [3].

(Received 25 July 2019; Accepted 10 August 2019; Date of Publication 11 August 2019)

Alpha particles will travel only about (30 μm) in soft tissue and, therefore, are unable to penetrate paper, glass, or even dead superficial layer of skin. Radioactive elements emit alpha particles, which in direct physical contact, the insoluble parts of these particles enter the body of an exposed person, will stay there and consequently ionize the body organ and the tissue surrounding it and causing different types of cancer [4]. The biological effects of radiation are terms in their effect on the living cells. These effects depend on the type of cell, the amount and type of radiation [5].

Solid State Nuclear Track Detectors (SSNTD) have been used increasingly in a variety of fields, such as cosmic radiation [6], nuclear reactions [7], and space research and dosimetry applications [8]. Thus, the particle track identification in Solid State Nuclear Track Detectors is required. Tracks of charged particles can be developed by selection of the best etching condition with suitable chemical etching in a dielectric track detector [9].

Polymer-based solid-state nuclear track detectors (SSNTDs) are extensively used for the detection of several types of radiation [10]. (SSNTDs) have the properties for registering charged ionizing particles, such as protons, alpha particles or fission fragments [11, 12]. The widespread use of SSNTDs is due to their unique features, e.g. low cost, less weight, threshold nature [13, 14].

One of the most common polymer based SSNTDs is the Cellulose nitrate (CN-85, Kodak) ($C_6H_{18}O_5N_2$) is one of the polymeric nuclear track detectors used widely for investigating both low and high energy ion (several MeV) registration [15-17].

Bone marrow is a dynamic tissue compartment in the cavity of bones. In adults, hematopoietic cells are produced by the bone marrow cells in the large bones that account for 2– 5% of an adult's weight. Ra-226 and Ra-228 isotopes are considered as the most important natural radionuclides of the U-238 and Th-232 series, respectively. In the human body the radioisotopes behave chemically and physiologically like calcium and are inclined to concentrate in the bones.

Uranium may enter the body through the skin, lungs or gut. Once uranium enters the systemic circulation, it is distributed throughout the body. Ra-226 is a bone-seeking radionuclide that accumulates in calcareous tissues because of its chemical similarity to calcium. Alpha Particle emitting radionuclides such as Pb-210, Po-210 and Ra-226, accumulate in bone, which has proven to be a critical organ in the dosimetry of human and animal exposure to radionuclides [18].

The fraction of the absorbed radionuclides within the skeleton differs widely between individuals. And some 99% of Ra-226 body content is in human bones. It is expected that Ra-226 would be present in bones because it tends to be moderately transferable in the physical environment.

2. EXPERMINTAL METHODE

2. 1. Sample preparation

Fifteen bone samples of eaten animals were collected from Iraqi markets. The samples were prepared by isolating the bones from the meat, dried them using sun light then electric oven, powder, sieve to make homogenous. 20 g of each sample was weight and placed in a plastic cup. The CN-85 detector of 1 cm^2 is hanged at 2 cm from the sample. The cup was tightly closed and left for 60 days to reach the radioactive balance as shown in **Figure 1**.

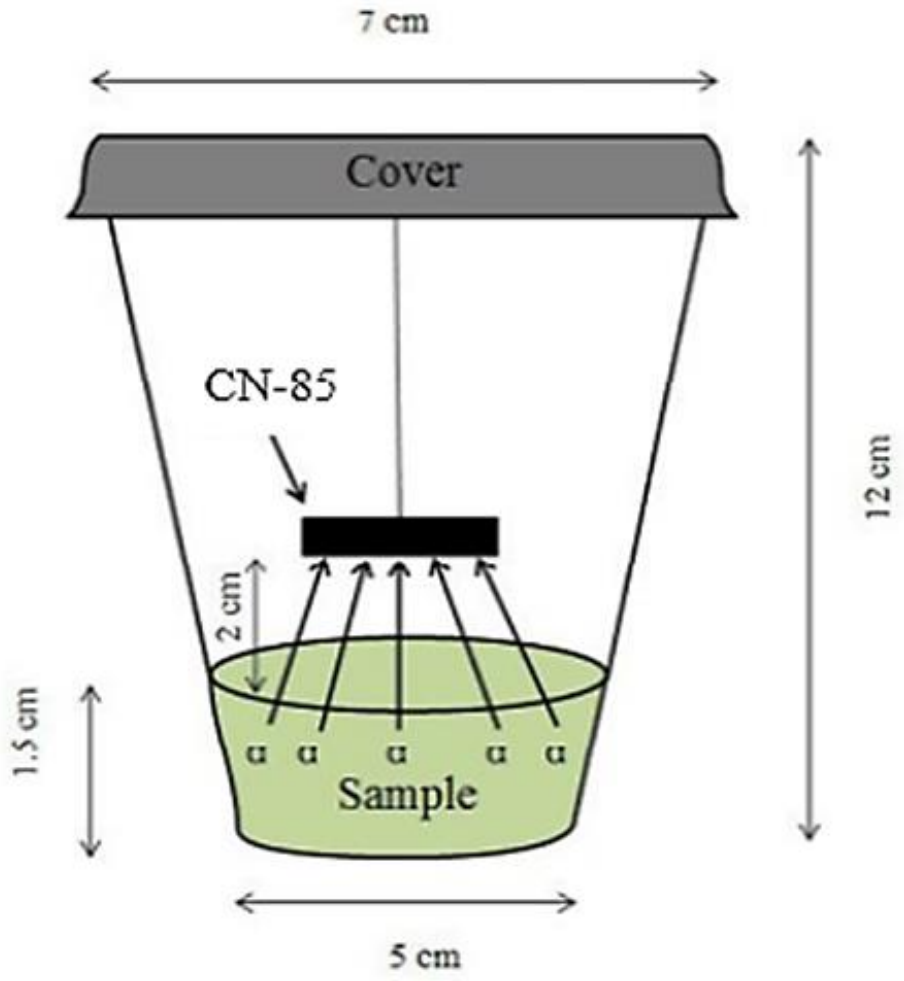


Figure 1. The CN-85 detector are placed 2 cm the sample

2. 2. Chemical etching

After 60 days, the detectors were etched by water bath using NaOH solution of 2.5 N at 60 °C. After the etching process, the tracks were seen by a microscope with a 400× magnification unit.

The tracks density of the samples was calculated using the following equation:

$$\rho = \frac{N_{Ave}}{a} \quad (1)$$

where:

ρ: Track density

N_{Ave}: Avarage number of total pits (tracks)

a: Area of field view

3. RESULTS AND DISCUTION

After etching, the detectors were viewed using microscope to see alpha tracks in the detectors. An arbitrary detector was etched to get the best etching time: Alpha tracks were seen at 15 min of etching, but the density was low and the track diameter was small, thus etching time was increased until reaching the highest density of the tracks and found the best etching time which is 40 minutes. The images of the numbers of tracks at each etching hour are shown in **Figure 2**; the track density versus etching time is shown in **Table 1**. The Relationship between the track density and etching time is shown in **Figure 3**.

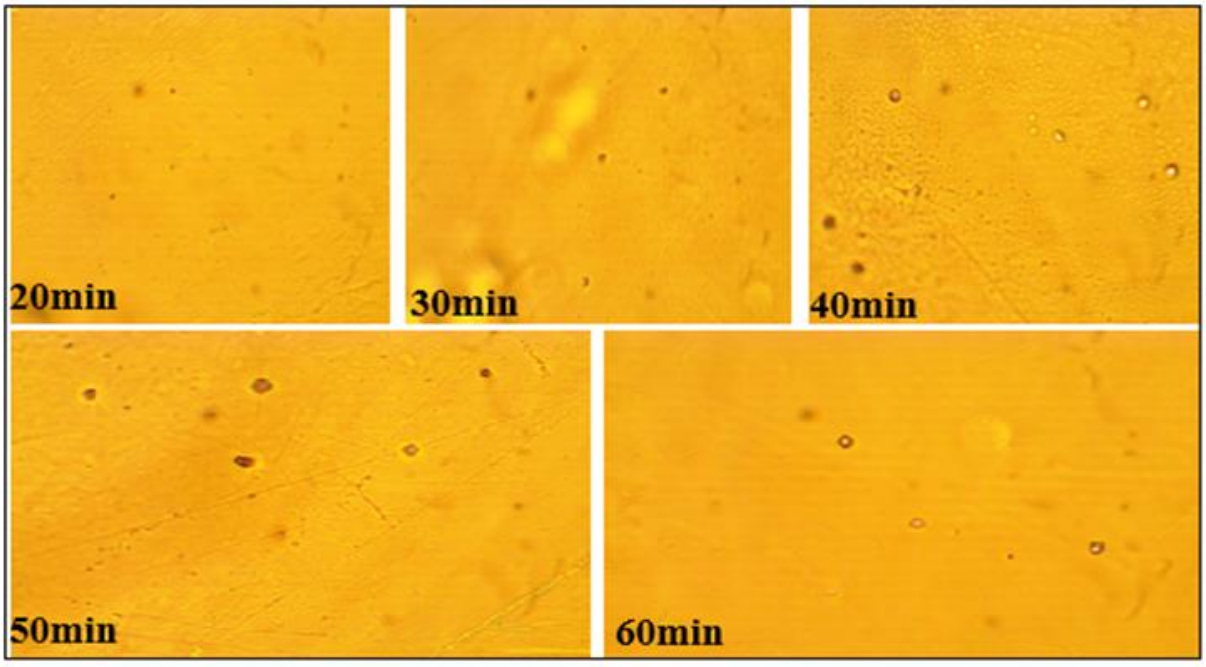


Figure 2. Images of the registered tracks at each etching time

Table 1. Number of the tracks and track density versus etching time

Etching Time (minute)	No. of tracks	Track density (teack·mm^{-2})
15	8.2	157.6
20	8.5	163.4
25	9.4	180.7
30	9.9	190.3
35	11.2	215.3

40	**12.8**	**246.1**
45	10	192.3
50	9.8	188.4
55	8.7	174
60	8.3	159.6

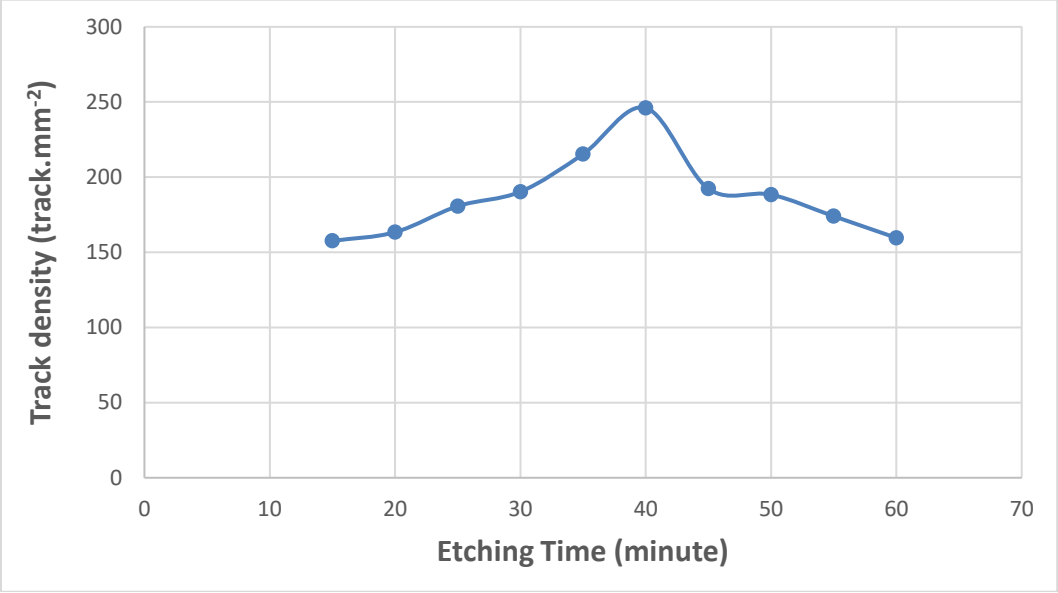


Figure 3. Relationship between the track densities versus etching time

The highest mean value of alpha emission rate is found in chicken samples (231.96 Bq·m^{-2}), while the less mean value is found in sheep samples (179.41 Bq·m^{-2}) as shown in **Table 3**.

Table 3. Track density and alpha emission rate of the bone samples

No.	Types	Code sample	No. of tracks	Track density (teack·mm^{-2})
1	**Beef**	**B1**	**8.4**	**161.5**
2		**B2**	**9.2**	**176.9**
3		**B3**	**7.5**	**144.2**
4		**B4**	**9.1**	**175**
5		**B5**	**10.2**	**196.1**

6		**B6**	**10.6**	**203.8**
Mean			**9.166**	**176.269**
7	**Sheep**	**S1**	**8.7**	**167.3**
8		**S2**	**7.5**	**144.2**
9		**S3**	**8.6**	**162.3**
10		**S4**	**8.3**	**159.6**
11		**S5**	**7.9**	**151.9**
12		**S6**	**8.5**	**163.4**
Mean			**8.250**	**158.653**
13	**Chicken**	**C1**	**12.8**	**246.1**
14		**C2**	**9.8**	**188.4**
15		**C3**	**9.3**	**178.8**
Mean			**10.633**	**204.480**

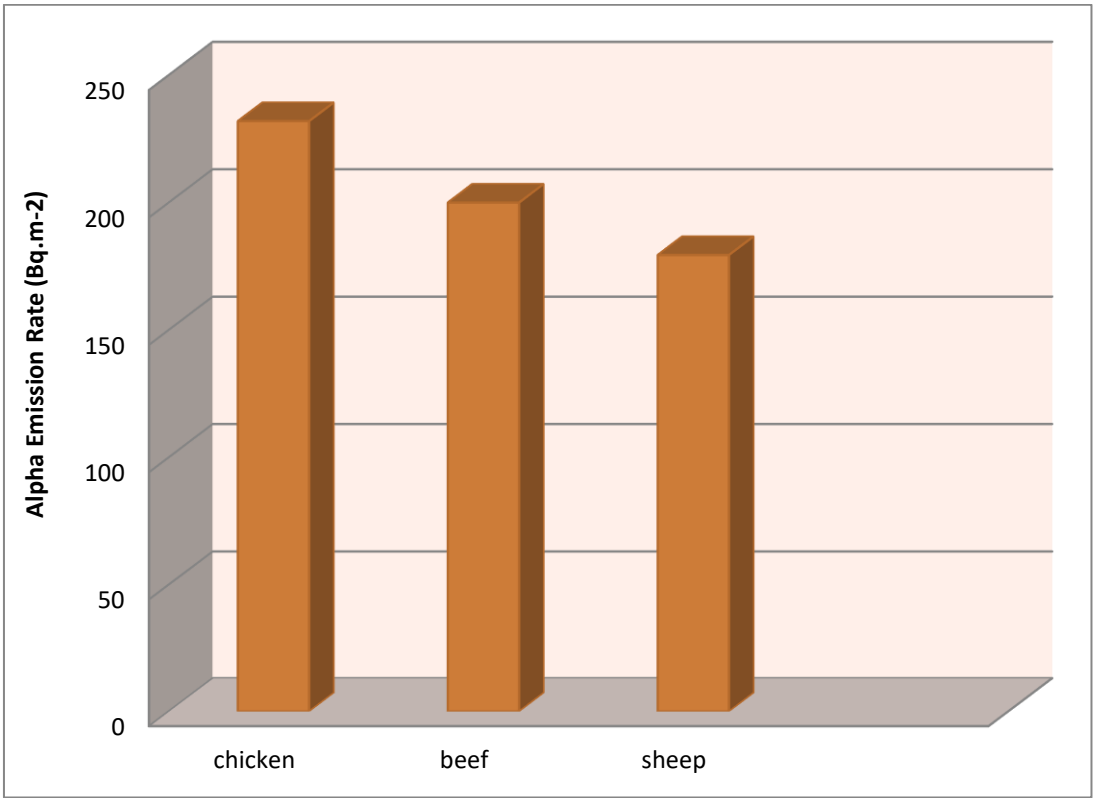


Figure 4. Mean alpha emission rate of the bones samples using CN-85 on distance 2 cm from bone sample

4. CONCLUSIONS

1) The optimum etching time of the CN-85 detector, when used to detect the natural alpha particles emitted from radioactive isotopes exist in the samples is 40 minutes.
2) The diameters of the tracks developed at CN-85 detector were all almost equal.
3) The highest track density was found in the chicken, beef, and sheep, respectively.

ACKNOWLEGMETS

Authors would like to thank, Applied Radiation Laboratory, Department of Physics, College of Science, Mustansiriyah University, Iraq, for their support and helping in finishing the manuscript.

References

[1] United Nations Environmental Program (UNEP), 1985. Radiation Doses, Effects and Risks. United Nations.

[2] United Nations Scientific Committee on The Effects of Atomic Radiation, UNSCEAR, 1993, Source, Effects and Risk of Ionizing Radiation. Report to the general Assembly with Scientific Annexes, United Nation.

[3] Archer, V.E., Gillam, J.D., and Wagoner, J.K., 1976. Respiratory disease mortality among uranium Miners. *Annals of the New York Academy of Sciences*, 271(1), 280–293.

[4] Hoskens, E., (1997). Depleted Uranium Shells Make the Desert Glow. Depleted Uranium Education Project, Metal of Dishonor, International Action Center, New York.

[5] Ali Abdulwahab Ridha, Nadhim Khaleel Ibrahim, Auras Muse Omron, and Nada Farhan Kadhum. Measurement the natural radioactivity of Chicken meat samples from Karbala governorate. *World Scientific News* 117 (2019) 196-203

[6] H.A. Hussain, (1989). Alpha Particles Registration Characteristics in a CN-85 Plastic Track Detector. *Isotopenpraxis Isotopes in Environmental and Health Studies*, 25(6), 243-245.

[7] M. Dole, (1979). Gas Sorption and Transport in Glassy Polymers. *Ber Bunsenges. Phys. Chem.* 83, 294-302.

[8] Hasan A. Hadi, Mahmood S. Karim, Ali T. Mahi, and Tareq H. Abood, Measurement of Natural radioactivity in tap water samples for selected regions in Thi-Qar Governorate – Iraq. *World Scientific News* 47(2) 112-122

[9] Nada Farhan Kadhim, Laith A. Jebur, and Ali A. Ridha, 2016. Studying Different Etching Methods Using CR-39 Nuclear Track Detector, *Detection*, 4, 45-53.

[10] R.L. Fleischer, P.B. Price, and R.M. Walker, (1965). Tracks of Charged Particles in Solids. *Science* 149 (3682), 383-393.

[11] R.L. Fleischer., P.B. Price., and R.M. Walker., (1975). Nuclear Tracks in Solids, Principles and Applications, University of California Press, Los Angeles.

[12] Y.D. He and C.I. Hancox, (1995). Measurement of low energy ion tracks in CR-39 plastic with an atomicforce microscope. *Review of Scientific Instruments* 66, 4575-4581.

[13] S. Peng, M. Folkard, S. Gilchrist, R.J. Locke, Z. Yu, and B.D. Michael., (2001). Measurements of the targeting accuracy of the Gray Laboratory charged-particle microbeam. *Nucl. Instr. and Meth.* 179, 145-150.

[14] S.A. Durrani and R.K. Bull, (1987). Solid State Nuclear Track Detection, Principles, methods and Applications, University of Birmingham, UK.

[15] A.F. Hafez and G.I. Kahlil, (1994). Track-hole formation of alpha-particle and recoil nuclei in an LR-115 nuclear track detector exposed to neutrons. *Nucl. Instr. and Meth.* 94, 107-112.

[16] Nada Farhan Kadhim and Laith A. Jebur, (2018). Investigation of the favorable etching time of CN-85 nuclear track detector, *Applied Radiation and Isotopes*, 135, 28–32.

[17] Nada Farhan Kadhum and Auras Muse Omron. Measurement the natural radioactivity of Sheep meat samples from Karbala governorate. *World News of Natural Sciences* 22 (2019) 110-118

[18] Asmaa Ahmad Aziz. Evaluation of radioactivity of cereals and legumes using a nuclear impact detector CN-85. *Iraqi Journal of Physics* Vol 16 No 38 (2018) 139-146