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Cancer Risk in Pakistan Due to Natural Environmental Pollutants

Akhtar, N.[1*] and Tufail, M.[2]

[1]Health Physics Division, NIAB, Jhang Road, Faisalabad, Pakistan

[2]Pakistan Institute of Engineering and Applied Sciences, P.O. Nilore, Islamabad, Pakistan

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ABSTRACT: Wheat is a staple food in Pakistan. Production of wheat is increased with extensive use of phosphate based fertilizers in agricultural fields. Activity mass concentration of primordial radionuclides due to use of phosphate fertilizers in soil enhances the external gamma dose and due to the consumption of wheat food grown on these soils also increases the internal dose. Different types of soil, including saline and normal soil in the districts of Lahore and Faisalabad in Punjab were selected for this study. The technique of gamma ray spectroscopy was used for the determination of s levels of radioactivity ^{226}Ra, ^{232}Th, ^{40}K, and the nuclear fallout ^{137}Cs in soil, wheat and wheat made products. Radioactivity in flour, chapatti, bread, nan and rusk was determined. Maximum activity was found in the chapatti sample of highly fertilized soil. Calculations were made for the determination of external absorbed dose in air from soil and internal absorbed dose in human body due to the consumption of wheat and wheat products. The average value of wheat consumption of 140 kg was used in the estimation of ingestion dose. The value of the ingestion dose due to highly fertilized soil was 206.1 μSv/Yr, while the total ingestion dose due to unfertilized farm's food was 146.3 μSv/Yr. Risk assessment to man due to ingestion of wheat was also calculated. The cancer risk assessment due to ingestion of wheat food grown on highly fertilized soils comes as additional sufferings of 14 persons in cancer per million.

Key words: HPGe Detector, Gamma Ray Spectroscopy, Phosphate Fertilizers, Wheat Consumption, Ingestion Dose and Risk Assessment

INTRODUCTION

Lots of studies have focused on direct and indirect effects of agriculture on degradation of water quality (Ahmed and Al-Hajri, 2009; Shegefti *et al.,* 2010; Asi *et al.,* 2008; Tava *et al.,* 2008; Banaee *et al.,* 2008; Dutta and Dalal, 2008; Obire *et al.,* 2008). In order to study the Impact of natural radioactivity on the food we eat, we have to study the impact of natural radioactive pollution due to phosphate fertilizers on soils and their uptake by plants. Different studies surveys in many countries of the world have done to assess the background radiation status of the soil of the particular area according to UNSCEAR reports,(2000 and 2006). Man obtains his food mainly from soil. Phosphate fertilizers have relatively high concentrations of natural radionuclides, particularly isotope of radium (226Ra), which is a daughter product of uranium (238U). Tzortzis described (2003) that the natural source of phosphorus is phosphate rock, found in sedimentary rock formations. Wheat is the most important food crop of the world. The largest cropped area is devoted to wheat crop and the quantity produced is more than any other crops in the world. In Pakistan, wheat is most important single crop. Wheat is a staple food of Pakistani diet, which provides about 72% of the total calories and protein in the daily average diet (Akhtar *et al.,* 2007 and Samer *et al.,* 2008). About 80% of the total wheat is consumed in the form of unleavened flat bread locally known as "Chapatti" while the rest 20% goes for other bakery products like bread, rusk, nan, etc. (Akhtar *et al.,* 2007 and Tufail *et al.,* 2009). The intake of food produced in the cultivated and uncultivated soils is the largest contributor to radiation doses received by human beings.

The possible effects of ionizing radiation due to naturally occurring radionuclides have been a cause of growing concern. Initiation and development of radiation injury starts, from sub-cellular apparatus such as molecules of proteins, carbohydrates, fats, inorganic salts, membrane system, etc. The result to the sub-cellular structure and constituents provokes a chain of developments finally resulting in and manifestation of morphological and functional changes in the cell. The damage develops into tissue damage leading to the possible malfunctioning of the organ/organ systems and ultimately organism as a whole as given

*Corresponding author E-mail: drnasimakhtar@rocketmail.com

in ICRP and EPA reports (2005, 2001). On temporal scale the physical absorption of energy on molecular level takes 10^{-6} seconds, cellular changes in the cell are affected in 10^{-5} seconds, cellular damage and physiological changes takes place in second to hours and days and long term, the delayed effect may take years to appear (Hattori,1997).

The main objective of the study was to determine the uptake of the natural and man made radioisotope from the soil to wheat produce. The presence of radionuclides in soil is a source of radioactivity intake of human beings by direct and indirect ways. The diet is a source of intake of radium radioactivity and human exposure.

The area under investigation consisted of four sites including two saline, one normal with and one without fertilizers treatments. These sites were selected in such a way that most of them were already been receiving fertilizer for the last many years in different amounts. Fertilizers were applied by means of spreader machines, so that each soil profile receive uniform amount of fertilizer. The sampling was done at the two Bio Saline Research Stations of Nuclear Institute for Agriculture and Biology (NIAB) and normal fertilized soil getting 500 kg/ha/Yr of phosphate fertilizers and where regular cultivation practices have been going on for last thirty-five years, named as site-1. The location of the area is 3124/ N and 73°05/ E (Akhtar, 2006). The area is a part of natural unit known as the Indus Plains, which represent a vast geosynclines lying between the Himalayan foothills and center core of the Indian subcontinent.

First Bio Saline station was established by NIAB in 1990 near the city of Lahore, in the province of Punjab, where regular cultivation practices by adding 400 kg ha/Yr have been going on for the last 22 years; was regarded as site 2. The district lies at 31° 15' and 31° 45' latitude and 74° 01' and 74° 39' longitude (Nasim, 2006). The district is bounded by Sheikhupura, on the east by India and on the south by Kasur . The Lahore district, is the second largest district of the country, and is regarded as the cultural nucleus of Punjab. The soil of study area consists of ten hectares, along the famous Bari Rakh Branch (BRB) canal also called Rakh Branch. The name of this village (where study site-2 lies) is Rakh Dera Chal, which is situated at 30 km from the historical city of Lahore. The other area Pakka Anna, village (study sites- 2 and 3) under study consisted of 10 hectares of saline soil located at a distance of 34 km in the south west of famous city of Faisalabad, in the Punjab province of Pakistan. This area is called the Bio Saline Research station number 2, which has been established by Nuclear Institute for Agriculture and Biology in 1992, about 10 years after the establishment of first station, the land was acquired from government of the Punjab in 1992. The variation of soil salinity is very high. The position of the area is 31° 24' latitude and 73° 05' longitudes at an elevation of 190 m from sea level. It was not cultivated earlier but laying barren since decades. The shallow ground water is brackish, having high salt concentration. It is thus unfit for irrigation. Pakka Anna station contained two types of soils (Nasim, 2006). The saline soil cultivated with 237 kg/ha /Yr of phosphate fertilizers is regarded as site 3. The soil cultivated for one year without fertilizer was named as barren or virgin soil and regarded as site 4.

MATERIALS & METHODS

Soil sampling was carried out in the months of May–June in 2003. Sampling from the soil patches was done using the sandard sampling methods (AQCS, 2000). The area was divided into 25 locations. The sampling was done from 0–25 cm with an increment of 5 cm. The chosen sampling sites were plain land, from where the vegetation was removed. Total number of soil samples was 125. Wheat grown in the respective soils was also taken. Wheat samples were divided into wheat flour, chapatti, bread, nan and rusk. In this way total number of wheat samples was 100. The samples were mixed to prepare one representative soil sample as per standard sampling methodology (AQCS, 2000]) The samples were properly marked, cataloged and brought to Health Physics Laboratory at NIAB, Faisalabad, Pakistan.

The collected samples were dried on plastic sheets at room temperature for several days (Akhtar *et al.*, 2006). To remove moisture, samples were heated in an electric oven at 110 °C up to 48 hours depending on the depth of soil until the sample attained constant weight. After drying the samples were crushed, ground and pulverized to a predetermined particle size by the analytical requirements and then passed through a sieve of 200 mm mesh size. The homogenized soil samples were packed in plastic containers having same geometry as that for the reference materials as dictated by the calibration requirement as given by Knoll (2000). These containers were sealed hermetically so that ^{222}Rn produced from ^{226}Ra decay would not result in gas leakage. After ensuring secular equilibrium among the progenies of ^{238}U and ^{232}Th series (60 days), these sealed samples were ready for analysis.

Radiometric analysis of these samples was performed using PC based, high resolution gamma spectrometry system comprising of High Purity Germanium (HPGe) coaxial detector (relative efficiency: 30%, active volume: 180 cubic centimeter with beryllium-end window and FWHM: 2.0 keV at 1332 keV for ^{60}Co)

(Verdoya *et al.*, 2009). The detector was shielded by 8 cm thick lead having inner lining of 0.5 cm thick copper plate covered with 1 mm aluminum to absorb the X-rays from lead and copper. The inner size of shielding cavity was 30 × 30 × 30 cm as given in [IAEA report and mentioned by Gillmore, (2003, 2008). The detector was given high voltage through preamplifier which was then connected to amplifier to computer based Multi channel analyzer through ADC (analogue to digital converter).

The system was calibrated using IAEA Soil-6. The counting was performed for 65000 seconds both for reference materials and the soil samples. The spectra were analyzed by commercially available software GE-NIE-2000 obtained from Canberra, USA. The detection efficiency of the system 'η' was calculated for each peak corresponding to the energies given in Knoll (2000) using the relation:

$$\eta = \frac{C}{A \times y \times t} \qquad (1)$$

where $C = C_t - C_b$ = net peak counts, here C_t is the peak area (with reference material) and C_b is background counts for the respective peak; y = percent abundance (% yield); t = collection time (sec). The detection efficiency 'η' was plotted as a function of γ ray energy (E) on the log–log graph paper. A polynomial of degree 2 was fitted on the experimental data which is given as follows:

$$\log\eta = 9.002\text{-}1.923(\log E)+6.448\times10^{-2}(\log E)^2 \qquad (2)$$

The reliability of counting efficiency was confirmed using reference material soil-375. The results were within an error of 3–5 %. The lowest limit of detection (LLD) for ^{40}K, ^{137}Cs, ^{232}Th and ^{226}Ra were determined for all tested radioisotopes. Spectrum for every sample was collected for 65000 seconds. The analysis was done with the help of the computer software Gene–2000 and activity mass concentrations for ^{40}K, ^{137}Cs, ^{226}Ra and ^{232}Th was determined using the following relation:

$$A_s = \frac{C}{\eta \times y \times t \times m} \qquad (3)$$

where m is mass of the sample (kg); and the other factors have the same meanings as are in eqn (1).After the spectrum collection, count rates for each detected photo peak and activity per unit mass (specific activity) for the detected nuclides were calculated. For the radionuclide considered, if there are more than one peaks in the energy range of analysis (100–2000 keV), then the peak activities are averaged and the result is the weighted average nuclide activity. The total uncertainty of the radioactivity measurements, which is also applicable to the calculated gamma dose and effective dose rates, was typically in the range 3–10%. Annual effective dose to man from consumption of wheat grain was calculated by Akhtar (2006) using following equation:

$$D = A_s \times I \times C_F \qquad (4)$$

where, D is annual dose (Sv /Yr), A_s is specific activity (Bq/kg), I is annual intake (kg), and C_F is dose conversion factor (Sv/Bq). In Pakistan, wheat grain is consumed in the form of "Chapatti", bread, nan, rusk, biscuits and other bakery items. Grain product is the major diet of the people of Pakistan. The consumption of grain product is relatively more in village population than those who live in cities; therefore, the annual consumption of the product varies from 100 kg to 150 kg. Average annual consumption of grain product reported by United Nations Scientific Committee on Effects Atomic Radiations in UNSCEAR report, (2000) is 140 kg, therefore, 140 kg per year has been considered for the estimation of radiation dose to the adult population in Pakistan.

RESULTS & DISCUSSION

Rocks are radioactive due to naturally occurring radioactive material (NORM) in the earth's crust. The radioactivity of rocks ultimately shifts to soil. The levels to terrestrial background radiation are related to the type of rock from which the soils originate as given by UNSCEAR reports (2000 and 2006). Only the radionuclides present at the time of creation of earth with considerable half-lives and their decay products can be found even today on the earth, e.g. ^{238}U and ^{232}Th series and ^{40}K, (Shirely 1986; IAEA 2003 & Gillmore, 2008). The manmade radioactivity as a result of nuclear explosions has also contaminated the earth's crust. Natural and manmade radioactivity was investigated in the soil and the wheat products of the area under study by mean of gamma ray spectrometer. To assess the implications of the extended use of phosphate fertilizers, on human health, we performed radioactivity measurements in soil, wheat and wheat products from pastures treated with and without phosphates fertilizers. The natural radionuclides of interest are the uranium and thorium series and ^{40}K whereas the manmade radionuclide ^{137}Cs, which was determined in the cultivated, fertilized soil of the Nuclear Institute for Agriculture and Biology (NIAB) in the city of Faisalabad, BSRS-1 in Lahore and BSRS-II in district of Faisalabad in the Punjab province of Pakistan. The measured activity concentration of the radionuclides of concern is given in Table 1. Activity levels were found to follow log normal distribution. The natural environmental higher levels of radiation are associated with igneous rocks, such as granite and lower level with sedimentary rocks. The highest concentration of ^{40}K was found in the sedimentary muddy material. In subcontinent soils the contents of potassium are more. This may be due to presence of radioactivity in fertilizers (Tufail *et al;* 2006a, 2006b, 2007 & 2009).

The average concentration of ^{40}K in the NIAB, Lahore fertilized, Faisalabad fertilized saline, and undisturbed saline soil of Faisalabad determined were, 643.60, 597.50, 563.90 and 550.0 Bq/kg respectively. Besides potassium, the other naturally occurring radionuclides measured, were ^{226}Ra and ^{232}Th. Radium–226 (a member of ^{238}U series having half life of 1620 y) is considered as the highly radiotoxic natural radionuclide (Gillmore; 2008). The average value of the measured activity of ^{226}Ra in the fertile and virgin soil of NIAB, Lahore, and Pakka Anna were 34.40, 30.60, 26.40 and 20.90 Bq/kg, respectively. The average measured specific activity of ^{232}Th ($T_{1/2} = 1.4 \times 10^{10}$ yr) for the above mentioned soils were 57.18, 55.10, 49.30 and 42.60 Bq/kg respectively. The data shows that the average activity value of ^{232}Th is about two times higher than that of ^{226}Ra this may be due to longer half life of ^{232}Th than ^{226}Ra. The activity concentration of ^{40}K in soil is in order of magnitude higher than that of ^{226}Ra and ^{232}Th for all soils. It has been known since early in this century that phosphate rocks contain substantial concentration of uranium, thorium, radium, and their decay products (Tzortzis *et al ;*2003; Tufail *et al;* 2006a; 2006b & Ibraham, 2009). Since phosphate rock is an important raw material used for the manufacturing of different types of phosphatic fertilizers, therefore, when this rock is processed into fertilizers, most of the uranium and some of the radium accompanies the fertilizers (Tufail *et al;* 2006a and Akhtar; 2006). It has also been estimated that phosphatic fertilizers applied to the agriculture fields in recommended amounts could raise radioactivity level in soils (Akhtar *et al;* 2005 & 2007). The average activity of ^{137}Cs in all the above soils samples was found to be 2.56, BDL, 4.50 and 1.25 Bq/kg respectively. The reasons of existence of ^{137}Cs in these soils are that these soils

Table 1. Activity Concentration of different Radionuclides in Soils Treated with different amounts of Fertilizers

Sample ID	Depth (cm)	Activity concentration (Bq/kg)			
		^{40}K	^{232}Th	^{226}Ra	^{137}Cs
Normal Soil of Faisalabad (S-1)					
N1	0—5	642.6	58.0	31.4	3.1
N2	5—10	614.4	60.2	29.1	2.5
N3	10—15	629.8	61.6	38.6	2.7
N4	15—20	660.5	60.3	32.6	2.4
N5	20—25	670.7	55.8	29.1	2.1
Mean		643.6	57.18	34.4	2.1
Saline Fertilized Soil Lahore (S-2)					
L1	0—5	586.3	48.5	34.7	< LLD
L2	5—10	594.9	59.7	29.2	< LLD
L3	10—15	575.8	51.6	35.5	< LLD
L4	15—20	602.6	52.6	26.2	< LLD
L5	20—25	590.3	54.5	26.5	< LLD
Mean		597.5	55.1	30.60	< LLD
Saline fertilized Soil of Faisalabad (S-3)					
F1	0—5	583.7	50.6	20.6	5.03
F2	5—10	600.6	55.8	32.4	4.55
F3	10—15	599.5	61.9	30.3	5.15
F4	15—20	545.8	45.6	32.6	4.05
F5	20—25	563.2	57.41	27.3	3.98
Mean		563.9	49.3	26.4	5.03
Saline unfertilized Soil of Faisalabad (S-4)					
V1	0—5	547.8	43.3	16.2	3.57
V2	5—10	499.2	42.5	20.0	3.63
V3	10—15	542.7	51.3	20.5	< LLD
V4	15—20	596.5	43.7	21.3	< LLD
V5	20—25	604.2	50.6	20.6	< LLD
Mean		550.0	42.6	20.9	1.25

may have the nuclear fallout in the past. The land was fertilized and cultivated regularly; the excess amount may be leached out by irrigation water.

The average values of activity of ^{40}K for the wheat grown in all the above mentioned soils obtained were 120.84, 117.50, 102.52 and 96.20 Bq/kg, respectively. The values of ^{40}K in chapatti from the wheat in the same soils were 107.75, 97.51, 87.53 and 52.53 Bq/kg, respectively. Activity comparison of the bread samples from the wheat of the same soils was 71.50, 67.50, 59.00 and 40.50 Bq/kg respectively. The values measured in nan were 65.02, 55.02, 50.01and 40.00 Bq/kg respectively. The levels of activity in rusk samples were 57.29, 54.68, 45.01 and 33.06 Bq/kg. The values of all other determined radionuclides have been shown in Table 2. It is clear from the data that the radioactivity taken up by the wheat grains ranges from 10-13 % of the total activity present in the soil. The value of the manmade radioisotope ^{137}Cs varies from 20-35% of the total activity measured in soil.

Ingestion dose was calculated and values for four selected sites are shown in the Table 3. The soil getting 500 kg/ha/yr for 35 years of continuous use of the phosphate fertilizers was regarded as the highly fertilized area. The ingestion dose due to consumption of wheat grown on this area calculated as 206.1 µSv/Yr. It is clear from the data the contribution of ^{40}K to ingestion dose was greater then 50 %. The remaining 41- 49 % dose was shared equally by ^{232}Th and ^{226}Ra respectively, in all selected sites. The least value of ingestion dose due to wheat consumption grown on unfertilized soils came as 146.3 µSv/Yr. The difference between the ingestion doses due to fertilizers use is 60 µSv/Yr. Doses of ^{262}Ra and ^{232}Th are greater than the range specified by repot ([UNSCEAR; 2006). By using the values of ingestion doses and external gamma doses cancer risk assessment was done.

Research and biological knowledge of molecular and cellular mechanisms confirm that cancer is a highly complex multi step process and it is likely to be occurring at low level of external as well as internal radiation. This makes unlikely the hypothesis that low level radiation or any contributor to DNA damage enhances the probability of cancer (Cuttler; 2006). Cancer incidence is defined as the probability of contracting a fatal cancer individuals or groups of individuals. The annual fatal cancer risk varies from group to group and from individual to individual. The average individual risk due to the internal and external doses due to the application of fertilizers in the soils is defined as number of the consequences due to cancer in the total number of residents as described in (Akhtar;2006), is mathematically given as,

$$F_{cr} = I_C \times P_A \quad (5)$$

Table 2.Activity Mass Concentration in different Wheat Food Stuff

Sampling Site	Radionuclide	Activity mass concentration (Bq/kg)				
		Soil	Wheat Products			
			Chapatti	Bread	Nan	Rusk
Site 1	^{40}K	643.60	107.75	71.50	65.02	57.29
	^{232}Th	57.18	1.25	1.20	1.01	0.91
	^{226}Ra	34.45	0.97	0.86	0.71	0.58
Site 2	^{40}K	597.50	97.51	67.50	55.02	54.68
	^{232}Th	55.18	1.23	1.05	0.95	0.75
	^{226}Ra	30.60	0.89	0.78	0.67	0.50
Site 3	^{40}K	563.96	87.53	59.00	50.01	45.01
	^{232}Th	49.38	1.00	0.98	0.85	0.74
	^{226}Ra	26.40	0.94	0.73	0.57	0.50
Site 4	^{40}K	550.08	52.53	40.50	40.00	33.06
	^{232}Th	42.68	0.45	0.45	0.37	0.25
	^{226}Ra	20.96	0.36	0.36	0.25	0.20

Table 3. Ingestion Doses due to Consumption of Wheat Food Grown on Fertilizer Soils

Location	Committed dose (μSv/Yr)			Total
	^{40}K	^{226}Ra	^{232}Th	
Site 1	108.8	49.0	48.3	206.1 ± 2.34
Site 2	105.8	39.2	40.3	185.2 ± 2.30
Site 3	92.3	39.2	46.4	177.9 ± 1.99
Site 4	86.6	25.9	33.8	146.3 ± 1.50
UNSCEAR,2000 Reference value	170	8.0	0.36	

Where F_{cr} = Fatal cancer risk per year, I_{Ce} = Average individual cancer risk
and P_A = Total no. of residents
By subsuming values in equation 5, the value of a risk for Faisalabad comes out as 10×10^{-5} per year, with 5 million residents. Fatal cancer risk per year in 6 million residents, of Lahore district and 0.012 million residents of Pakka Anna with individual risk having values 8.3 10^{-5}. Cancer risk has been calculated by considering the internal doses per year due to the consumption of 140 kg of wheat grown on the cultivated fertilized and unfertilized farm and external doses due to fertilizers from all sites which are given in the Table 5. An Environmental Protection Agency (ICRP; 2005 & EPA; 2005), in an internal document examined the degree to which the risk per unit dose for individual radionuclide agreed with a life time cancer incidence risk for the low doses the estimated risk coefficient considered as 7×10^{-2} cancer per person per sievert, and using equation 5 and 6 average individual cancer risk and fatal cancer risk have been calculated for all four-study sites.
Cancer coefficients are defined as total cancer risk per all sieverts received. Mathematically cancer coefficient is defined as (Rutherford;2002 & Akhtar, 2006).

$$C_c = R S_v^{-1} \times S_v^{-1} \quad (6)$$

Where C_c = The cancer risk coefficient, $R S_v^{-1}$ = Risk per sievert
and F_C/YR = Fatal cancers per year
By subsuming values in eqn 6 from Table 5,cancer coefficients for all study areas have been calculated and are given in other column of Table 5.
Excess deaths due to cancer in any area is defined as (Jamal, 2002 & Akhtar,2006).

$$E_D = C_C \times P_A \quad (7)$$

where, E_C = Excess cancer deaths in any area, C_C = Risk Coefficient

Substituting values in eqn. 7 from the Table 4 and 5, the values have been calculated for all study sites, Faisalabad, Lahore and Pakka Anna the Calculated values of excess cancer risk are given in Table 5. From the table it is clear that the average individual risk cancer risk at Faisalabad is more then other study areas. By using the total population of the Lahore, Faisalabad and Pakka Anna as six million, 5 million and 10000 persons respectively who consume the wheat grown there.
The Applying the conversion factors given in report (UNSCEAR,2006) by using eqn. 4, the ingestion dose due to each radionuclide has been computed and is presented in Table 5.

From the Table 5 it is clear that the risk coefficient has a direct link with the number of sieverts. The dose for the highly fertilized farms of Faisalabad is greater than the other study sites. The public of Faisalabad is at a more risk then public around Lahore. The public of Pakka Anna is at least risk than the population around Lahore and Faisalabad. If the wheat food consumed is from the unfertilized fields, then risk coefficient is minimum. The data shows that excess risk per year is maximum at the consumption of wheat food stuff grown on the highly fertilized soils. The excess risk is estimated as death of 14 persons per year in the population of one million. The excess cancer risk for Dera Rakh Chall (District Lahore) population has 13 persons per year in 1 million (Akhtar,2006). The Pakka Anna population has less fear of excess cancer, 12 in I million, by using wheat food from less fertilized area. The least amount of risk (10 in 1 million) was posed by the population consuming food from unfertilized fields. The net excess cancer risk form the consumption of food in fertilized fields comes out as 4 persons in one million.

CONCLUSION

The activity concentration determined on the highly fertilized area was maximum for all radionuclides determined. Activity determination on other sides also confirms the enhancement of radiation levels due to the application of phosphate fertilizers. The net rise in the activity of highly fertilized soil (site-1) for ^{40}K, ^{232}Th, and ^{226}Ra came as 93.00, 15.50 and 13.40 Bq/kg. The food stuff of wheat grown on fertilized fields follow the patterns for all sides as: Grain < Chapatti < Bread < Nan < Rusk The ingestion dose committed

Table 4. Residents of Area, Average Deaths per year, Average Individual Cancer Risk

Location	Residents of the area	Average deaths per year due to cancer	Average individual cancer risk
Faisalabad	5 millions	510	10×10^{-5}
Lahore	6 millions	595	9.0×10^{-5}
Pakka Anna Fertilized farm	12000	1	8.3×10^{-5}
Pakka Anna unfertilized farm	12000	1	8.3×10^{-5}

Table 5. Excess Cancer Risks in the Study Areas [life Time Cancer Risk Factor = 0.07]

Sites	External Dose (Sv)	Internal Dose (Sv)	Total Number of Siverts (Sv)	Risk Coefficient	Excess cancer risk in one million
S-1	0.6745×10^{-3}	206×10^{-6}	88×10^{-5}	6.16×10^{-5}	62 ± 2.5
S-2	0.630×10^{-3}	185×10^{-6}	81×10^{-5}	5.67×10^{-5}	57 ± 2.3
S-3	0.573×10^{-3}	177×10^{-6}	75×10^{-5}	5.25×10^{-5}	5 ± 0.15
S-4	0.508×10^{-3}	146×10^{-6}	65×10^{-5}	4.55×10^{-5}	4 ± 0.10

dose by the use wheat food only due to fertilizer came as 60.8 µ Sv/Yr. On the basis of ingestion dose risk assessment was made. The risk assessment was done on the basis of the external doses as well as internal doses due to the consumption of food grown from the fertilized areas. The dose for the highly fertilized farms of Faisalabad was greater then the other study sites, the public of Faisalabad was at a more risk than public around Lahore. The public of Pakka Anna was at least risk than the population around Lahore and Faisalabad.

If the wheat food consumed is from the unfertilized fields no fertilizer was used then the risk coefficient was minimum. If we subtract the value of excess cancer risk from barren soil, which is 4 persons in 1 million, then the net excess cancer risk from the Fisalabad soil is maximum, which are 58 persons in one million. The net excess cancer risk from Lahore saline soil are 53 in 1 million The data shows that excess risk per year was maximum due to the external exposure and the consumption of wheat foodstuff grown on the highly fertilized soils. The data shows that the use of Phosphate fertilizers in our cultivated soils is also a one of the major reason of large number of deaths of public due to cancer now a days.

REFERENCES

Ahmed, T. A. and Al-Hajri, H. H. (2009). Effects of Treated Municipal Wastewater and Sea Water Irrigation on Soil and Plant Characteristics. Int. J. Environ. Res., **3 (4)**, 503-510.

Al–Jundi, J. (2002). Population doses from terrestrial gamma exposure in areas near to old phosphate mine Russaifa, Jordon Rad. Meas., **35 (1),** 23-28.

Akhtar, N. (2006) Radionuclide Pollution due to Fertilizer use in some saline soils of the Punjab and their potent ional risk assessment on Human Health. PhD thesis .Department of Physics Bahauddin Zakariya University Multan, Pakistan.

Akhtar, N. and Tufail, M. (2007). Natural radioactivity iIntake into Wheat Grown on Fertilized Farms in two Districts of Pakistan. Radiat. Protec. Dosi., **123 (1**), 103-112.

Akhtar, N., Tufail, M., Ashraf, M. and Mohsin, I. (2005). Measurement of environmental radioactivity for estimation of radiation exposure from saline soil of Lahore, Pakistan. Radi. Measu., **39 (1)**, 11-14.

Asi, M. R., Hussain, A. and Muhmood, S. T. (2008). Solid phase extraction of pesticide residues in water samples: DDT and its metabolites. Int. J. Environ. Res., **2 (1)**, 43-48.

Banaee, M., Mirvagefei, A. R., Rafei, G. R. and Majazi Amiri, B. (2008). Effect of sub-lethal Diazinon Concentrations on Blood Plasma Biochemistry. Int. J. Environ. Res., **2 (2)**, 189-198.

Dutta, H. M. and Dalal, R. (2008). The Effect of Endosulfan on the Ovary of Bluegill Sunfish: A Histopathological Study (Lepomis macrochirus. Int. J. Environ. Res., **2 (3)**, 215-224.

EPA, (2001). (U.S. Environmental Protection Agency) Risk assessment and risk communications. EPA, 402-R-99.

Gillmore, G. R. (2008). Practical gamma ray dosimetry second edn. Wiley, New York.

Hattori, S. (1997). State of research and perspective on adaptive responses to low doses of ionizing radiation in Japan. Low doses of ionizing radiation biological effects and regulatory control. Vienna: IAEA. Austria.

IAEA, (2000). Analytical Quality Control Services (AQCS) of international Atomic Energy Agency. Radionuclides and trace elements in soil. Reference Materials IAEA-375. Vienna, Austria.

IAEA, (2003). (International Atomic Energy Agency) Extent of environmental contamination by naturally occurring radioactive material (NORM) and technological options for mitigation, Technical Reports Series). No. 419. IAEA. Vienna, Austria.

Ibraham, F. Al. H. (2009). Soil radioactivity levels and radiation hazards assessment in the highlands of northen Jorden. Rad. Mesa., **44 (1),** 102-110.

ICRP, (2005). (International Commission on Radiological Protection) Risk values and dose limits for ICRP-60 and NCRP-116.

Jerry, M. C. (2006). Health effects of low level of radiation Proceedings of 27th Annual conference of Canadian Nuclear Society, Toronto, June 11,2006.

Knoll, G. F. (2000) Radiation detection and measurement (third edition) John Wiley & Sons Inc. New Yark. USA.

Michals, T., Haralahos T., Stelios C. and George C. (2003). Gamma ray measurements of Naturally occuring radioactive samples from Cyprus characteristic geological rocks. Radi. Meas., **37(3)**, 221-229.

Obire, O., Ogan, A. and Okigbo, R. N. (2008). Impact of fertilizer plant effluent on water quality. Int. J. Environ. Sci. Tech., **5(1)**, 107-118.

Pullani,V. A., Dafauti, S. Hedge, A. G., Sharma, R. M. and Mishra, U. C. (2005). Uptake and distribution of natural radioactivity in wheat plants from soil. Journal of Environ. Radioac., **79 (3)**, 331-346.

Rutherford, P. (2002). Radiation Risk LNT, Retrieved on 08 September, 2002 from www.philtutherford.com.

Samer, J., Ibraramhinif, A. K., Hamareneh, A. and Dababneh, M. (2008). Natural Radioactivity , Dose assessment and uranium uptake by Agricultural crops at Khan Al-Zabeeb, Jorden. J. Env. Radioac., **99(11**), 1192-1199.

Shegefti, S., Sereshti, H. and Samadi, S. (2010). Determination of Endosulfan in Water Samples Using Dispersive Liquid-liquid Micro-extraction and Experimental Design for Optimization. Int. J. Environ. Res.,**4(2)**,237-246.

Shirley, V. S. (1986). Table of radioactive isotopes. New York: John Wiley & Sons USA.

Tava, S., Narvi, S. S. and Prasad, S. C. (2008). Organochlorines and Organophosphates in Bovine Milk Samples in Allahabad Region. Int. J. Environ. Res., **2 (2)**, 165-168.

Tufail, M., Akhtar, N., Sabiha J. and Tehsin, H. (2007). Natural radioactivity Hazards of building Bricks Fabricated from Saline Soil of two Districts of Pakistan. J. Radiol. Prot., 27 481-492.

Tufail, M., Akhtar, N. and Waqas, M. (2006b) Radioactive Rock Phosphate: The Feed Stock Phosphate Fertilizer used in Pakistan. Health Physics ., **90 (4)**, 361 367.

Tufail, M., Sabiha, J., Aklhtar, N. and Aakhtar, J. (2009) Assessment of annual effective dose from natural Radioactivity intake through Wheat grain Produced in Faisalabad J. Radional Nucl. Chem(in press) .

Tufail, M., Akhtar, N. and Waqas, M. (2006a). Measurement of terrestrial radiation for assessment of gamma Dose from cultivated and barren soils of Faisalabad in Pakistan. Radia. Meas., **41(4),**443-451.

UNSCEAR (2006), United Nations Scientific Committee on 'Effects of Atomic Radiations Sources, Effects and Risk of Ionizing Radiations" with annexes. New York United Nations valume-1. New York: United Nations.

UNSCEAR (2000). (United Nations Scientific Committee on the Effects of Atomic Radiations). Sources effects and risks of ionization radiation. Report to the General Assembly, with Annexes. New York: United Nations.

Verdoya, M., Chiozzip, P., Felice, De. Pasquale, V., Bochiolo, M. and Genovesi I. (2009) Natural Gamma ray spectroscopy as a toll for radiation dose and radon hazard modeling Applied Radi. and Isotopes., **67(1),** 964-968.