CHAPTER VI.

DISCUSSION AND CONCLUDING REMARKS :

6.1. DISCUSSION :

In the present study uranium is found to be present as traces in plants and soils. The trace content of this element in plants, the manner in which radioactive uranium may pass from the soils and plants to man and its possible effects if any are already discussed in Chapter - I.

The results of the present estimation of uranium in different groups of food items have been compared with an another trace element Zinc. Zinc is highly toxic to plants except in a very dilute concentrations, but traces must be present for normal plant metabolism. Deficiency results in dwarfing of vegetative growth and failure of seed formation. In human body a total of 2 - 3 gms. of Zinc is distributed throughout the body. It is an essential nutrient, functioning primarily as a constituent of numerous enzyme systems. Deficiency results in hypogonadism and dwarfism. There is available data on the average Zinc content of certain crops grown in India.[1] The results are presented in table 6.1.

The concentration of zinc and uranium in different food items differ widely. But the concentration gradient in cereals and pulses are identical. It shows poor agreement with that of vegetables and fruits. The disagreement may be specific due to the differences in their usual mineral requirements or uneven translocation and storage in different organs of the plant.

TABLE 6.1

Average concentration of Zinc and Uranium
In different groups of food items.

Items studied	Average concentration in ppm.	
	Zinc	Uranium
1. Cereals	27.8	0.25
2. Pulses	34.8	0.31
3. Vegetables	28.2	0.42 (Underground)
		0.34 (Leafy)
4. Fruits	36.6	0.44 (Vegetables)

Some plants accumulate high concentration of particular elements in certain parts. Some plants appear to extract usually large amounts of certain elements from the soil (Examples are given in chapter I, Table 1.1.)

The results of the present estimation have also been compared with normal human blood, cow milk, natural water from different sources and human urine[4-16,31] which are shown in table 6.2.

It is observed from the table 6.2 that human beings receive more uranium from the food items than through milk and water. The uranium contents in normal human blood has been found to be low. The low uranium contents in human blood and cow milk may be due to the loss of uranium by excretion. Chapman and Hammons[17] studied the metabolism of uranium injested by dairy cattle in their normal diet and concluded that on the average the milk receive only 0.2 percent of the estimated uranium intake per day, whereas greater than 99% of the dietary intake was excreted through the faeces. Welford[18] in a study of 26 persons with no occupational or other known exposure to uranium, found that their urinary excretion varied from 0.03 to 0.3 μg/litre of urine.

The uranium that occurs naturally in soil are incorporated metabolically into plants and ultimately find their way into the bodies of animals, including man. But from the body of the animals and man this element is excreted in sufficient amount by natural processes. Therefore, like some

TABLE 6.2

Uranium contents of normal Human Blood, Urine, Cow Milk, Water from natural sources and food items.

	Workers	Method/ Detector	Samples	U. conc. in gm/ml.
1.	Hoffman (1943)	Fluorescence Spectrometry	Normal human blood	0.1×10^{-9}
2.	Newman (1949)	Fluorescence Spectrometry	Normal human blood	14×10^{-9}
3.	Price and Strahal (1968)	Activation analysis	Normal human blood	5×10^{-10}
4.	Carpenter and cheek (1970)	SSNTD	Normal human blood	86.1×10^{-9}
5.	Hamilton (1970)	SSNTD	Normal human blood	8.4×10^{-10}
6.	Prasad et.al. (1979)	SSNTD	Normal human blood	$(8.9 - 17.9) \times 10^{-10}$
7.	Koul and Chadderton (1979)	SSNTD	Normal human blood	$(3.5 - 6.00) \times 10^{-10}$
8.	Chakarvarti et.al.(1980)	SSNTD	Normal human blood	$(9 \times 18) \times 10^{-10}$
9.	Raremo et.al. (1984)	SSNTD	Normal human blood	$(4 - 8.4) \times 10^{-10}$
10.	Segovia et.al. (1986)	SSNTD	Normal human blood.	9.1×10^{-10}
11.	Das (1988)	SSNTD	Normal human blood.	$(6.4 - 9.5) \times 10^{-10}$

(TABLE - 6.2 contd.)

	Workers	Method/ Detector	Samples	U.conc. in gm/ml.
12.	Fleischer & Delany (1976)	SSNTD	Natural water from different sources	0.80 - 5.27 ppb
13.	Hanifa (1985)	SSNTD	Cow milk	0.08 - 0.15 ppb
14.	Dubey et al. (1989)	SSNTD	Urine of normal person	0.037 ± 0.002 - 0.068 ± 0.003 x 10^{-9}
15.	Present Investigation	SSNTD	Cereals	0.19 - 0.30 ppm
			Pulses	0.16 - 0.55 ppm
			Underground Vegetables	0.25 - 0.62 ppm
			Leafy Vegetables	0.16 - 0.55 ppm
			Fruit Vegetables	0.37 - 0.52 ppm

other heavy trace elements, uranium is not a cumulative poison. (Some heavy trace elements which are cumulative poison[19] to mammals are presented in table 6.3.)

The distribution of uranium in different parts of the same plants have also been investigated in the present study. The average uranium contents of the soils and plant organs are presented in table 6.4.

The soil samples are found to contain high amount of uranium (2.67 ppm). It may be mentioned in this connection that for soil, global average value of uranium is 3.0 ppm.[33] Rocks generally contain high percentage of uranium eg. normal granite contain 4 ppm uranium and in phosphate rocks uranium contents may go as high as 120 ppm in some places.[20] Soils are formed by withering rocks. As rocks withered, the uranium is oxidised to U^{+6} valance. It is highly soluble in this form and thus mixes up with the soil. This accounts for the high concentration of uranium in the soil.

Amongst the different parts of the plants, leaves show higher uranium contents (0.74 ppm). This may be due to greater translocation of this element into the leaves. Another probability for this higher uranium content may be due to foliar deposition and their penetration through the stomata or even diffusion through the leaf epidermis from the atmosphere.

In other organs of the plants uranium contents on average vary from 0.45 ppm (fruits) to 0.68 ppm (roots). Radioactive study with other trace elements also support the

TABLE 6.3

Toxicity of some heavy Trace elements.

	Elements	Land Plants (ppm)	Toxicity.
1.	Mercury	0.015 ppm (Stock and Cucuel, 1943; Suzuku,1961)	Very toxic to green plants. A cumulative poison in mammals.
2.	Lead	2.7 ppm (Sinyakova,1945, Lounamaa, 1956; Cannon, 1960)	Very Toxic to plants. Moderately toxic to mammals where it acts as a cumulative poison.
3.	Plutonium	0.4 - 2.2 ppm (ludwieg, 1962)	Probably the most toxic of all elements to mammals ; a cumulative poison.
4.	Cadmium	0.6 ppm (Lounamaa,1956)	Moderately toxic to all all organisms; a cumulative poison in mammals.

TABLE 6.4

Average Uranium contents of the soils and plant organs.

	Samples	U-contents (ppm).
1.	Soils	2.67
2.	Roots	0.68
3.	Stems	0.48
4.	Leaves	0.74
5.	Grains and seeds	0.60
6.	Fruits	0.45

movement of those elements throughout the plant body. When radioactive micronutrient like radioactive potassium (k^{42}) top dressed in the soil and sprayed foliar to the crops of potato, corn, barley, rice and wheat it was well absorbed by the roots and leaf surfaces and then translocated to different organs of the plants.[21]

The variations in the uranium concentration in different parts of the plants are statistically analysed in Chapter - V. Intervariations in some cases are found to be significant.

The results of the present estimation of uranium in betel leaves and its chewable ingredients are compared with those of earlier workers[22-23] which are shown in table 6.5.

The uranium contents of betel leaves and its chewable ingredients show poor agreement with the results of Chakarvarti et. al.[22-23] The disagreement with the present results may be due to the nature of samples collected or the ecological variations of the environment from where the samples were collected.

Betel nut and lime of Assam show good agreement with the betel nut and lime of Meghalaya. Betel leaf of Meghalaya agree well with the betel leaf collected from Tongla, Dt. Darrang, Assam. The betel leaf which is available throughout Assam and betel leaf which enter into the local market from Bengal show good agreement as regards their uranium contents.

TABLE 6.5

Uranium contents in Betel leaves
And its chewable ingredients.

Workers	Samples	Source	Average Uranium contents(ppm)
1. Chakarvarti et.al(1979 d)	Indian Cigarette tobacco.	Open market, Kurukshetra	0.04 - 0.1
2. Chakarvarti et.al.(1979 f)	Betel leaves and its chewable ingredients	Open market, Kurukshetra	
	(a) Betel leaf		0.01
	(b) Betel nut		0.027
	(c) Lime		0.53
3. Present investigation	Betel leaves and its chewable ingredients		
	(a) Betel leaf (Available throughout Assam.)	Garal, Dt.Kamrup, Assam.	0.77 (Excluding one sample collected from market.)
	(b) Betel leaf (Available in Tongla area, Assam.	Tongla, Dt.Darrang, Assam.	1.02
	(c) Betel leaf (Bengal variety)	Open market, Guwahati	0.59
	(d) Betel leaf (Mitha patti, another Bengal variety.)	Open market, Guwahati.	0.72

(TABLE - 6.5 contd.)

Workers	Samples	Source	Average Uranium contents (ppm)
	(e) Betel leaf (Meghalaya variety)	Nongpoh, Meghalaya.	1.35
	(f) Betel nut (Assam)	Dalibari, Dt.Kamrup, Assam.	1.02
	(g) Betel nut (Meghalaya.)	Nongpoh, Meghalaya.	1.45
	(h) Chewable Tobacco	Open market, Guwahati.	1.05
	(i) Lime (Assam)	Open market, Guwahati.	2.54
	(j) Lime (Meghalaya)	Open market, Shillong.	2.52

The distribution of uranium in betel leaves and its chewable ingredients in this zone of the country seems to be almost uniform. The concentration is much higher than the results reported by Chakarvarti et. al. (1980). Thus the uranium estimation in these materials may be significant.

It has been estimated that one-tenth of world population indulges in betel chewing. The betel chewing population are thus exposed to a higher dose of radioactive uranium than people who do not practise these habits. Betel chewing habit with or without tobacco is primarily responsible for mouth and hypopharyngeal cancers. This habit which is more common in the Brahmaputra valley, Assam seems to have a strong association with Oesophageal cancers.[24]

The association between betel chewing and oral cancers may be in all probability due to constant irritation to the oral mucous membrane, presence of various carcinogenic chemicals in the preparation or radiation effects of uranium trace in the betel chewing ingredients as studied in the present work (Table 5.5. of Chapter - V). Uranium isotopes are alpha emitters. Hence, the presence of uranium have some radiation effects. But uranium is present in too low a concentration (in ppm) to contribute significantly. Still it is prudent to assume that radiation exposure even at low levels for a long period of time bring about some harmful effects.

Uranium and its salts are highly toxic. Natural uranium, in its tetravalent form is unstable. It is oxidised to more toxic hexavalent form.[13] The hexavalent form then combines with active sites (Phosphate group) on the surface of a cell thereby blocking normal metabolic process of cell survival[25] and ultimately causing death of a cell. Generally, the organ affected by the toxic effects of uranium is kidney. Since natural uranium has a low specific activity, chemical damage to the kidney is likely to be more important than radiation damage.[32] However, radiation injury to the lung or kidney must also be considered.[26] The toxicity of uranium compounds varies widely. Some compounds of this element is practically non toxic, while some others are toxic in moderate doses, still some others like $UO_2 F_2$ is toxic in small doses.[27] The lethal dose varies for various compounds e.g. in case of uranyl nitrate hexahydrate, it is 1 to 2 mg/day and for uranyl nitrate it is about 50 mg/day.[28] In general the maximum permissible intake of this element is 40 mg/day.[29]

6.2. CONCLUDING REMARKS :

The present study shows that uranium is present as traces (ppm) in cereals, pulses, underground vegetables, leafy vegetables, fruit vegetables, betel leaves and its chewable ingredients and in soils. Its content is not same but is found to have slight intergroup and intragroup variations.

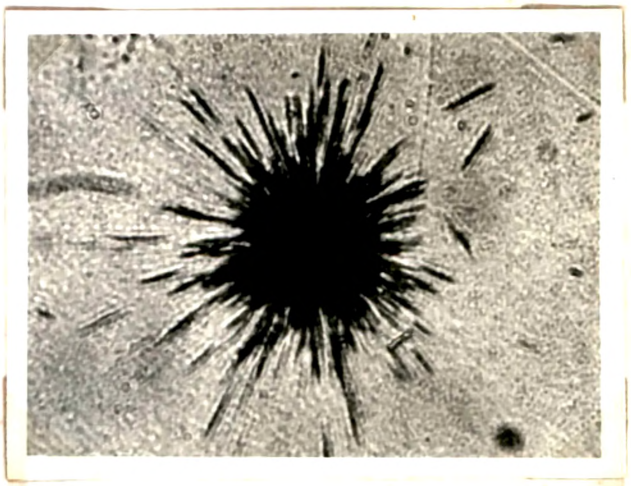
The track distribution in lexan is more or less uniform except for a few occasional stars and clusters which may be due to the presence of uraniferous granules in the sample. The etched fission tracks of lexan are similar to those presented in plate 1.A. and 1.B.

A

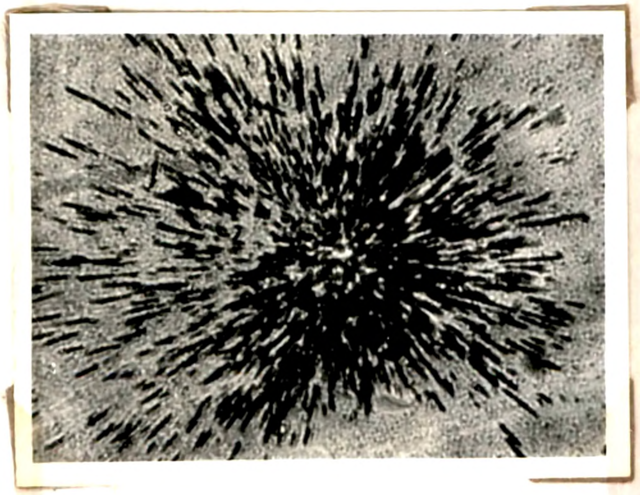
B

Plate 1.A. Microphotographs of uranium fission tracks in Lexan. A.B. normal distribution.

A



B



C

D

Plate 1.B. Microphotographs of uranium fission tracks in Lexan. A.B.C.D. Different forms of clusters.

It is interesting to note that food items like cereals, pulses, underground vegetables, leafy vegetables and fruit vegetables contain uranium as trace element. Thus human beings receive this radionuclides through foods. The presence of uranium trace in food items is potentially a major source. But as reported earlier this element is eliminated from the body by natural process of excretion. It is prudent, therefore, to assume that like other heavy trace elements (mercury, lead, plutonium and cadmium), uranium is not a cumulative poison.

The estimation of uranium was done in different parts of twenty plants and soils collected from the places where these plants were growing. On average uranium contents in different plant parts were found to vary from 0.45 ppm (fruits) to 0.74 ppm (leaves). Root uptake and foliar deposition is the source by which plants collect their nutrients. It may be noted that during nuclear detonation the foliar absorption is very high.[26] However, the experiment have been conducted in a normal environment, as such one would expect accumulation of uranium by foliar absorption to be less than the root uptake. Again, much variation is not seen in the distribution of uranium in different parts of the plant. This shows that after root uptake and foliar absorption this element is translocated almost uniformly throughout the plant body. There seems to be no critical organ for accumulation of this element. In the soil samples the average uranium contents is found to be higher (2.67 ppm) than the plant organs. This is expected as plants collect trace elements mostly from the soil.

Among the different plants studied betel leaves and its chewable ingredients are found to contain high uranium contents. Average uranium contents in these items collected from Assam and Meghalaya have been presented in table 6.5. Thus oral mucous membrane of the betel chewing population are exposed to a comparatively higher dose of radioactive exposure. But it may be assumed that U-content in betel leaves and its chewable ingredients, is present in a very low concentration (in ppm) to contribute significantly. Since the maximum permissible intake of this element is 40 mg/day, there is no immediate danger as in the case of nuclear detonation. It may be pointed out that there are evidences which suggest the possibility that low level of radiation may be harmless to health or even slightly beneficial.[30] .If this is established beyond doubt then it is more likely that the internal hazards if any, from the uranium dose intake by man through betel leaves and its chewable ingredients will be from its toxicity rather than the radiation effect.[32]

6.3. FUTURE PERSPECTIVE :

The present study indicates that root uptake and foliar deposition may be the two ways by which uranium can contaminate crops that are eaten by man. Much remains to be learnt about the ways in which this radionuclide behaves in passing from the root to the eatable portions of the plant, through the body of the stock animal, and into the milk, meat or eggs consumed by man. There are, however, insufficient data to provide a firm basis for evaluating radiation effects particularly with respect to the biological effects at very low doses. It is not prudent, therefore, to assume that there is a level of radiation exposure below which there is absolutely no effect. The lack of adequate scientific information makes it urgent that additional works be undertaken and new data developed to provide a firmer basis for evaluating biological risk.

In the present investigation samples available under natural environment have been collected. One may, however, conduct similar studies under controlled conditions viz. supplying known uranium contents in solution and sand cultures to see the effects of uranium on growth and developments of plants. Under these circumstances, estimation of uranium in different plant organs and uranium left in the culture solution after plant growth may also be ascertained. So one can derive definite informations regarding root uptake and subsequent translocation and storage of this element in different plant organs. Also with the help of tracer technique, it is hoped that, the specific role played by uranium in plant metabolism in the synthesis of biochemical products may be investigated.

Controlled experiments in collaboration with clinical studies can also help in finding out the significance of presence of uranium in plants and its subsequent entry into the human body. Channelised investigation in this line can help to achieve decisive results as to the action of low levels of radiation exposure by uranium on biological molecules. A quantitative understanding of the food chain transport mechanism is required to predict dose to man from a given concentration in food stuffs.

Variations in the uranium contents and their distribution in different types of plants and their parts could be of species specific character and are likely to be controlled by the genetic nature of the plant. Further, the types of soil collected from different plant habitat may have different potential for abundance of uranium as natural source. Controlled experiments with different plant species and types of soils may reveal highly reliable informations for better planning future programme of work.

Besides uranium, the estimation of other trace elements like radium, lead, caesium, strontium etc. in food items may be made. In future, information from such a study may enrich our knowledge regarding the complex and subtle interrelationships among the various life forms and their physical environment.