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# QUANTITATIVE MEASUREMENT OF NATURAL RADIOACTIVITY IN VEGETABLE AND MEAT BEFORE AND AFTER COOKING

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The effect of cooking in natural radioactivity was studied in different items used as human diet. The samples of meat and vegetables used in the Faisalabad City were collected from various places and markets. The detection was made after different processing conditions including washed, peel off, fried (hot) and fried (cold) for chicken, beef and mutton by using Geiger Muller Radalert 100 detector available in the Nuclear Institute of Agriculture & Biology NIAB, Faisalabad. The activity concentration decreases from fried (hot) to fried cold for both meat and vegetables. From the above study it was clear that only washing can reduce the level of activity. Relatively high level of natural radioactivity was observed in the chicken (43.33$\pm$0.87 Bq/kg) developed under controlled diet than the desi chicken showing the activity concentration (40.27$\pm$0.27 Bq/kg) for fried cold condition. Among white meat, fish (39.24$\pm$0.27 Bq/kg) having least activity concentration in fried cold condition. From the data it is observed that fish can be used as a human diet to control the activity level. More over activity level can be controlled by taking diet that is not to hot.

**Key words:** Radioactivity, vegetables, fruit, meat, soil

## INTRODUCTION

Humans have been exposed to radiation from natural sources since the dawn of time. The sources include the ground we walk on, the air we breathe, and the food we eat. Everything on the earth contains a small amount of radioactive material. Heavy metals and gamma radioactive elements are found in fruits, vegetables and plants (Chibowski, 2000). The main contribution to the individual dose is caused by inhalation of radon and its daughters in the vicinity of the uranium mine (Brajnik *et al.,* 1988). The presence of $Ra^{226}$ in drinking water may sometimes make important contribution to natural background radiation exposures. The radiation doses originate from drinking tap water and bottled mineral water (Marvoi *et al.,* 1997).

Radioactivity in the soil adds to the background level of radiation to which human being are exposed in any environment and the main contribution to the background radiation in the soil is the gamma ray from radioactive elements of the uranium and thorium series and from radioactive potassium (Oyedele, 2006). The fertilizer also enhances the activity concentration in soil as they contain potassium, radium, thorium the most common radionuclide. Gamma ray activity mass concentration have been determined in phosphate rock and fertilizer samples collected from different fertilizer manufacturing factories and suppliers in Pakistan (Tufail *et al.,* 2006). The radiocaesium present in contaminated soil is absorbed by the roots of plant and is transferred to the shoots, and become the part of food chain (Guivarch *et al.,* 1999). When food crops are grown in the contaminated soil, the activity is shifted from the soil to the roots and than in shoots. Ultimately the activity is transferred to the human diet (Nasim-Akhtar and Tufail, 2007).

For cereal samples radioactivity concentration lies in the range of 1-3.5 pCi/kg of $pb^{210}$ per composite meal (Lalit *et al*., 1980**).** Tea was found to contain higher concentration of $Sr^{90}$ and $Cs^{137}$ radioisotopes compared to other food stuffs having vegetative origin. Levels in tea are compared with those in leafy vegetables from both India and Japan. The levels were also considered from the view point of health hazard (Lalit and Ramachandran, 1985).

Naturally occurring radionuclide $Th^{232}$, $U^{238}$, $Pb^{210}$, $Ra^{226}$ and $Ra^{238}$ are present in leafy vegetables, fruit, root, bean and rice, and derived products like sugar, coffee, manioc flour, wheat flour, corn flour and pasta. The annual effective dose due to the ingestion of vegetables and their derived products with the long-lived natural radionuclide is 14.5µSv (Santos *et al.,* 2002).

The estimation of exposures of humans to the various sources of radiation is very important (El-Taher and Uosif, 2006). More than one hundred different food stuffs (meat, vegetables, cereals, seafood etc.) had

been collected during 1998, 1999, 2000 and analyzed for radioactivity as part of national food monitoring program in Syria (Al-Masri *et al.,* 2004.).

The aim of the present work was to analyze the activity levels of different food stuffs as a part of national food. Since the primary factor contributing to the internal effective dose in human organism is contaminated food. Therefore the use of a diet, giving a radionuclide control is an important means of protection. For this purpose the maximum and least activity measurements have been made in meat and vegetables both in fried (hot) and fried (cold) conditions.

## MATERIALS AND METHODS

The samples consisted of vegetables and meat were collected from various places and markets of Faisalabad and were analyzed in washed, peels off, boiled and fried (hot and cold) form. All the samples were weighed before detection was made. The analysis was done before and after cooking and also for hot and cool condition. The Geiger Muller detector was used for the determination of activity concentration (Winkelmann *et al.,* 1998). The detector has sixty percent efficiency with the background count rate of 20 counts per minute. The amount one kilogram of the vegetable samples (egg plant, bottle gourd, potatoes and bell pepper) was taken. The activity was determined for both washed/unwashed and cutting form. The activity concentration of boiled water used for washing was about 3.25 Bq/L. The samples were than dried in Kisan Sun Flower cooking oil up to the temperature of 110 degree centigrade and than cooled to room temperature of about 38 degree centigrade. The activity concentration was determined for both fried (hot) and fried (cold) condition. The meat samples were washed and fried, and activity concentration was determined for washed, unwashed, fried hot and fried cold condition.

## RESULTS AND DISCUSSION

Radioactivity was measured in different vegetables such as egg plant, bottle gourd, potatoes, onions, cucumbers, tomatoes and bell papers in four different conditions, washed and peels off, fried (hot) and fried (cold) (Table 1). In fried (hot) condition, maximum activity (56.11±0.72 Bq/kg) was found in egg plant and the least activity (53±0.42 Bq/kg) was found in the potato. An investigation of activity for different parts of the wheat plant showed non uniform activity distribution of some of the radionuclides in root, shoot and grain (Nasim-Akhtar and Tufail, 2007). The difference in activity concentration of potato and egg plant may be due to the different food parts at different positions. When these fried vegetables were cold up to room temperature, maximum activity (45.11±0.44 Bq/kg) was found in egg plant and least activity (39.2±0.38 Bq/kg) was found in bell pepper. The difference in activity concentration may be due to the different absorbing and radiating power of different colors. The values of radioactivity concentration in different vegetables are shown in Table 1.

The major part of human diet is meat. Fresh meat samples were taken from the market. The radioactivity for meat components was also measured both in fried (hot) and fried (cold) condition (Table 1). The meat stuff used for this purpose consists of chicken, beef, mutton and fish. When the meat was washed, results showed that beef has maximum activity (44.67±0.73 Bq/kg) and chicken has least activity (38.67±0.72 Bq/kg). The difference in activity concentration may be due to difference in diet of both animal and bird. As the cows and buffalos feed is mainly wheat straw, which is contaminated by $^{40}K$, $^{232}Th$ and $^{226}Ra$ radionuclide (Nasim-Akhtar and Tufail, 2007), the activity is thus shifted from the wheat straw to the flesh of animals and birds. Under fried (hot) condition, mutton showed maximum activity (57.47±0.28 Bq/kg) and fish showed least activity (49.62±1.2 Bq/kg).

**Table 1, Natural radioactivity concentration in different vegetables**

| Treatment | Egg plant Bq/kg | Bottle Gourd Bq/kg | Gourd Bq/kg | Potatoes Bq/kg | Bell pepper Bq/kg |
|---|---|---|---|---|---|
| Washing | 51.34±0.79* | 41.42±0.46 | 42.13±0.64 | 47.05±0.72 | $46.2^{0}$±0.93 |
| Cutting | 43.22±1.93 | 38.67±1.30 | $38.8^{0}$±0.33 | 38.18±0.24 | 39.47±0.41 |
| Fried(hot) | 56.11±0.72 | 55.33±0.36 | 53.87±0.33 | $53±0^{0}.42$ | $53.4^{0}$±0.31 |
| Fried (cold) | 45.11±0.44 | $45.1^{0}$± 0.11 | 41.33±1.75 | 40.83±0.87 | $39.2^{0}$±0.38 |

* means ± SD.

**Table 2. Natural radioactivity concentration in different sources of meat**

| Treatments | Fish Bq/kg | Beef Bq/kg | Mutton Bq/kg | Chicken (Boneless) Bq/kg | Chicken (Bones) Bq/kg | Chicken (Desi) Bq/kg |
|---|---|---|---|---|---|---|
| Washed | 43.14±1.06* | 44.67±0.73 | 41.07±0.71 | 40.40±1.82 | 38.67±0.72 | 42.93±0.70 |
| Fried(hot) | 49.62±1.21 | 52.93±0.28 | 57.47±0.28 | 52.67±0.63 | 52.07±0.62 | 51.13±0.41 |
| Fried(cold) | 39.24±0.27 | 45.29±0.37 | 43.13±0.36 | 43.33±0.87 | 45.06±1.14 | 40.27±0.72 |

* valies are means ± SD.

When the same meat was cooled to room temperature maximum activity (45.29±0.37 Bq/kg) was found in beef and least activity (39.24±0.27 Bq/kg) was found in fish. The table below shows the activity trends for all types of meat.

It was also observed that activity concentration in fried meat at room temperature is less than the activity in hot fried meat. The activity trend observed for different condition of meat was as fried (hot) > fried (cold) > washed.

As a measure of radiological protection the Turkish Atomic Energy authority imposed a maximal limit 25.5 Bq/kg for the tea on the market (Ozemre, 1992). Radioactivity concentration values in $^{40}$K measured in food items like baby milk and baby food from Jeddah and Riyadh local market samples were in the range of 33-300 Bq/kg, where as meat (mutton and beef) samples showed 112 Bq/kg (Abdul-Fattah and Abdul-Majid, 1995). The $^{137}$Cs activity of wild boar meat easily achieves hundreds of Bq/kg and occasionally it may even exceed permitted limits (Dvorak *et al*., 2008).

However the data above indicates that the food stuffs having vegetative origin are found to have radioactive concentration in the range 39 to 56 Bq/kg and the meat samples have radioactive concentration in the range between 39 to 57 Bq/kg. Both the vegetative and meat stuffs exceed the safe limits for activity concentration.

## CONCLUSION

From the above data, it is clear that the white meat especially fish can be used as human diet for the control of activity. Beef and mutton should be used in limited amount. The vegetables should be used after washing for removing contaminated soil and dust. Among the vegetables egg plant and bottle guard should not be frequently used. As the activity concentration in fried (cold) food was low for all kinds of food taken under experimentation, so all diet should be taken in cold form rather than hot one.

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