Po-210 and Pb-210 - A Situation Report

In reviewing the situation of radioelements in tobacco, one can roughly divide this area of study into three periods. The first period began in 1953 when Mulvany first suggested that β-activity possibly induced lung cancer through smoking. In fact, earlier publications examining radioelements in tobacco are centered in β-activity, especially potassium 40, rubdium 87, strontium 90, and cesium 137. A total of 10 papers were published in this area. However, because of their minute quantity and low activity, no more studies on those elements are in progress. 0000016672

The second period was on α-activity studies beginning in 1960. Several papers were published from 1960 to 1963, but these papers did not arouse much attention. In 1964, when the Surgeon General's Report was released, and in the same year Radford and Hunt's paper was published suggesting the possible effect of Po-210. However, the α-radiation level was still not considered high enough to be of significant concern to the health effect of smokers. Between 1965 to 1972, most studies were concentrated in examining the levels of Po-210 or Pb-210 in tobacco, their source, distribution, translocation, and possible ways of their removal or reduction. During this period, most tobacco and radiologists felt that the level of Po-210 or Pb-210 in cigarette was too low to be of major concern. There are 1,500 known compounds in tobacco and tobacco smoke, and probably 30,000 more compounds were indicated to be present. Tobacco scientists under limited resources, have to place their emphasis on problems of real importance on sound scientific basis.

The third period began in 1974, when the issue of Po-210 and Pb-210 was brought back again, primarily by Martell's report in Nature, and Little, Kennedy and McGandy's paper in Science. So far as the radiation level is concerned, there was no difference on either Po-210 or Pb-210 in the tobacco leaf in recent reports in comparison with earlier ones. There are, however, two main points of interest: (1) The hypothesis of "insoluble" particles, and (2) the hypothesis of "selective localization" of these particles.

These authors did a detailed calculation based on their observation and interpretation. However, more experimental evidence is needed to support the insoluble particle and localization hypothesis. Before I make any comments and suggestions, I wish to call to your attention two other recent papers related to the subject matter. One paper, published in Atomic Energy Review, 1974, 12(1): 75-143, by Parfenov, he stated "For the most part, Po-210 reaches human in food and concentrates to the greatest degree in the skeleton, hair and eyes. Average body burdens are around 8 pc/k . . . Regular smokers may have an intake of Po-210 that is 20-100% higher than normal due to the Po-210 and Pb-210 that are taken in through the respiratory system during cigarette smoking. However, smoking does not increase the Po-210 level in the organism by a factor of more than 1.5 . . . even in the lungs the increase is by a factor of only 2.5. Nevertheless, a number of scientists maintain that Po-210 gives rise to high radiation doses at isolated and small 'hot spots' in the bronchial epithelium . . Experimental

studies show that for lung tumors from Po-210 to occur in animals an accumulation of absorbed dose of the order to 1,000 rem is necessary. However, the most pessimestic calculations do not demonstrate the possibility of this level being reached in the lung of smokers even after 25 years of continuous smoking . . ."

Another paper is by Albert et al, published in Arch. Environ. Health, 1975, (30: 361-367). discussing "short-term effects of cigarette smoking on bronchial clearance in humans". He studied the bronchial clearance of inhaled monodisperse radioactive insoluble particles in nonsmokers and smokers. Comparison of the bronchial clearance times of the two tagged aerosols Technetium (Tc-99) and Gold (Au-198) gave a minimum estimate of a two-fold transient speedup in deep bronchial clearance caused by the cigarette smoking in both smokers and nonsmokers".

In an earlier study conducted with experimental plants growing in a chamber containing 500 times the normal Rn-222 level in the atmosphere, only twice the amount of Pb-210 and Po-210 was found.

From this information as mentioned above, it is evident that there are several different schools of thought and different interpretaitions regarding the exact role of Po-210 and Pb-210 in smoke and health problem. However, there appears to be no disagreement so far as the level of total α-radiation is concerned (0.4 pc/g) although it varies to a certain extent by location of production, genetic makeup, fertilization rate, curing, and post harvest handling.

We are facing a problem which is either of extreme significance or has no major effect at all. We have to examine the available information, and if necessary, to conduct more studies to either confirm or disprove the hypothesis as proposed. Following are my recommendations.

1) Tobacco fertilizer - re-examine the Ra-226 level in phosphate rock and fertilizer mixture. In early 1960's, most tobacco phosphate came from Florida. The current source of phosphorous for most tobacco production is from North Carolina. Samples have been collected and are in the process of evaluation. Should there be a considerable amount of U-238 or Ra-226 present, phosphate should be purified before put on market for any agriculture usage including tobacco production.

2) Make use of the existing animal inhalation experiment at Oak Ridge, examining the levels of α-radiation in cigarette tobacco, ash, butt, smoke, and various animal tissues to determine if there is any evidence of "selective accumulation" of α-particles in certain areas.

3) Provide additional support on the project which is already underway at the New York University Medical Center examining the α-radiation level and possible localization in various human tissues obtained from recently deceased nonsmokers and smokers.

4) α-Particles are in the particulate phase of cigarette smoke. The effectiveness of different filter system needs to be investigated and developed.

5) Many other post-harvest treatments or methods can be used to remove or reduce α-emitters in leaf tobacco. These include

"rinse-off" the waxy surface (if they are on surface as suggested) prior to homogenized leaf curing (HLC); redistribution of α-emitters through HLC and reconstitution; separation and removal of α-emitters at the "slurry" stage, etc. Techniques can be developed without much difficulty.