A comparison of radioactive elements in US and Swedish smokeless tobacco products

MOLA M.[1], FAIZI A.[1], RODU B.[2], MCADAM K.[1], BENZING R.[3] and PRIOR G.[3]

[1] British American Tobacco, Group R&D, Regents Park Rd, Southampton, SO158TL, UK
[2] University of Louisville, James G. Brown Cancer Centre, 529 South Jackson Street, Louisville KY, 40202, USA
[3] Scientifics Limited, 551 South Becquerel Avenue, Harwell Science and Innovation Campus, Didcot, OX110TB, UK

Corresponding author: michele_mola@bat.com

INTRODUCTION

A total of 28 toxicants have been reported in smokeless tobacco products (STPs), including the radioactive isotopes **^{210}Po**, **^{235}U** and **^{238}U** (1). According to the International Agency for Research on Cancer (IARC), these three isotopes are classified as Group 1 carcinogens (2). In contrast to the significant body of historic information available on the levels of radioactive elements in tobacco leaf and cigarettes, there is not much information available on STPs. A limited number of studies have been carried out on STPs and activities for these three isotopes, ranging from 6 mBq/g to 74 mBq/g for snuff and natural tobacco, have been reported (3). Given the lack of comprehensive or recent data in this area, an up to date survey was conducted to reflect current STPs on the market.

EXPERIMENTAL

The survey was conducted by sampling 70 STPs from the US and Sweden:

- 32 Swedish products, of which 10 loose snus and 22 pouched snus
- 38 US products, of which 13 chewing tobaccos, 5 dry snuffs, 3 pellet products, 16 moist snuffs and 1 plug product
- Swedish products were sourced from Swedish retail websites, imported into the UK and kept frozen at -20C until tested. These products represent 7 different manufacturers which are indicative of ~89% of market share in Sweden
- US products were sourced from US shops, imported and kept frozen. These products represent 9 different manufacturers which are indicative of ~88% of market share in the US

In order to provide a more complete picture than the historical literature, several commonly occurring α radioisotopes typically found in vegetable materials (**^{232}Th**, **^{230}Th**, **^{228}Th**, **^{234}U**, and **^{226}Ra**) and one β emitter (**^{210}Pb**), commonly considered to be in radioactive equilibrium with ^{210}Po, were also examined. All results were reported on a wet weight basis.

Determination of ^{210}Po

^{210}Po was measured by α-spectrometry after acid digestion and addition of ^{208}Po internal standard (IS), redissolution in HCl and autodeposition of the ^{208}Po onto a silver disc.

Determination of ^{232}Th, ^{230}Th and ^{228}Th

Thorium isotopes were measured by α-spectrometry after addition of ^{229}Th IS, ashing, acid digestion, purification by ion chromatography and electrodeposition.

Determination of ^{234}U, ^{235}U and ^{238}U

Uranium isotopes were measured by α-spectrometry after addition of ^{232}U IS, ashing, acid digestion and purification and separation by ion chromatography.

Determination of ^{226}Ra

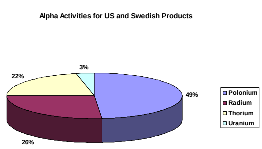
^{226}Ra was measured by gas flow proportional counting after addition of ^{133}Ba IS, acid digestion and purification by precipitation.

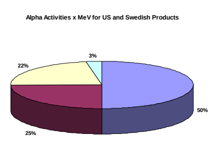
Determination of ^{210}Pb

^{210}Pb was measured by gas flow proportional counting after acid digestion, ashing, purification and separation by ion chromatography.

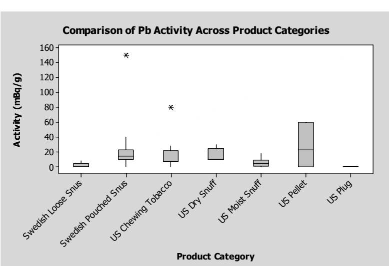
RESULTS AND DISCUSSION

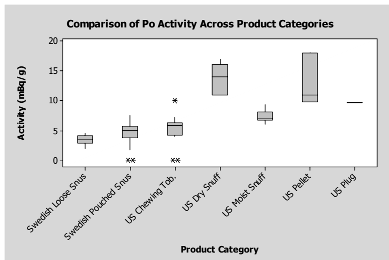
In the chart on the left the activities of the α species in mBq (≡ disintegrations per thousand seconds) are shown. This chart represents the sum of α activities for both US and Swedish products. Polonium is the largest single contributor to α particle emission for both US and Swedish products.

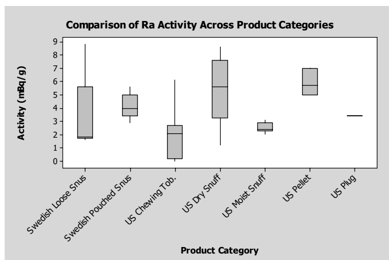


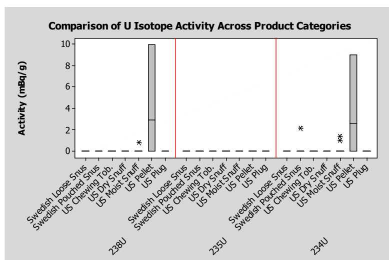


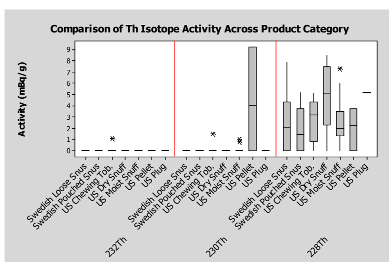
In the chart on the right individual activities were multiplied by the relative energy (in MeV) of the α particles released by the relevant isotopes to show the relevant burden of the α emitters. Once again, polonium provides the highest burden. Results for ^{210}Pb and the activities of each α emitter for each product category are presented below.











The combined α activity for the measured radioisotopes ranged from <12 mBq/g to 50 mBq/g for both Swedish and US STPs. Of all the product categories, pellets were the only products in which ^{230}Th, ^{234}U and ^{238}U were detected. This could be due to the high mineral content. All the other product categories had values of uranium activity below detection limits.

^{210}Po values were below 20 mBq/g for all products. Dry snuff and pellets were the categories with the highest levels of ^{210}Po activity, whilst loose and pouched snus had the lowest levels. Previous data for ^{210}Po is only available for dry snuff and moist snuff (3). The historic range for dry snuff (3 samples) was 8.5-14.4 mBq/g. The values detected in the current study for dry snuff (5 samples) ranged from 11-17 mBq/g. The historic range for moist snuff, based on 5 samples, was 5.9-45.1 mBq/g.
Moist snuff values for ^{210}Po, based on 16 samples in the current study, gave a range of 6.1-9.4 mBq/g.
Therefore, historical values for ^{210}Po in dry snuff are comparable to the values found in our study, whilst for moist snuff the upper limit in our current study is much lower than the previous data.

^{238}U and ^{235}U were reported historically only in Indian snuff (4). The values reported for the two isotopes were about 74 mBq/g for each.
In our studies, levels of ^{235}U were all below detection limits for all product categories. Pellets were the only products which showed a detectable level of ^{238}U activity, which ranged from 2.9-10 mBq/g and ^{234}U, with levels ranging from 2.6-9 mBq/g. These values are considerably lower than literature values.

^{226}Ra levels were reasonably similar across product types.
^{232}Th was below detection limits for all categories and ^{228}Th levels were highest for dry snuff. ^{230}Th was detected in pellets only, with a range of 4-9.2 mBq/g.
No historical data was available for the thorium isotopes and ^{226}Ra in smokeless tobacco products.

The β activity of ^{210}Pb ranged from <5 mBq/g to 150 mBq/g. The values found seem to be comparable across all product categories. Once again, no historical data was available for ^{210}Pb in STPs.

CONCLUSIONS

A comprehensive investigation of the levels of radioactivity in contemporary US and Swedish STPs has been carried out. A number of α emitting isotopes were identified in STPs, albeit at very low levels of activity. α activity in current STPs was mainly due to ^{210}Po, accounting for ~50% of total α activity. Some differences in levels have been identified across different product categories. β emission from ^{210}Pb is also present, and the values were comparable across product categories.

REFERENCES

(1) IARC Monographs on the Evaluation of Carcinogenic Risk to Humans, IARC Press, Lyon, France, Volume 89, 2007, 55-60
(2) www.iarc.fr
(3) Brunnemann K.D. and Hoffmann D., Chemical Composition of Smokeless Tobacco Products, Smoking and Tobacco Control Monograph No. 2, 1992, 96-108
(4) Sharma et al., Study of Trace Amounts of U in Snuff, Health Physics, Vol.48, No. 6, June 1985, 811-812