Trace Elements in Plants and Soil in Relation to Cancer

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SUMMARY

The possible carcinogenic role of trace elements in indigenous snuffs has been investigated. Relatively large amounts of chromium and nickel, both recognised nasal carcinogens, have been found.

These trace elements, in addition to the aromatic hydrocarbons previously reported, would appear to make our indigenous snuffs highly carcinogenic.

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The possible role of trace elements in the genesis of cancer has not received sufficient attention in Southern Africa. I certainly did not consider them in my search for environmental carcinogens until recently. A few years ago I was approached by the Swaziland Agricultural Department for my opinion on the danger of adding considerable quantities of zinc to the fertilisers issued by the department. Swaziland soil is deficient in zinc and it was thought that its addition to the fertilisers might increase the yield per acre by 15% or even more. Apparently someone had read in the *Reader's Digest* that Japanese workers had related excess zinc in drinking water to stomach cancer. My reply was that increasing the yield per acre was much more important for the health of the people than the slight risk of producing the odd stomach cancer in the next generation.

The work of Stocks, Davies and Wynne Griffiths in Wales and North Devon on the role of zinc in soil is much more convincing, but did not alter my advice to the Agricultural Department.

When it was suggested that in the Transkei molybdenum deficiency in the soil was related to a high incidence of oesophageal cancer, I decided to look into things in Swaziland. We did not have sufficient cases of oesophageal cancer to map, but much to our surprise the molybdenum-rich areas produced four times as many primary liver cancer cases as the molybdenum-deficient areas.

CARCINOGENS IN SNUFF

In the middle sixties there appeared some interesting studies by French workers on the role of magnesium: 'More magnesium for less cancer' was the slogan. I should like to give some details of our trace element studies on the snuffs used by our indigenous population. We all know that antral cancer is more common in Blacks than in Whites. Table I gives the percentages of the respiratory tract cancers seen in the Radiation Therapy Department of the Johannesburg General Hospital from 1949 to 1954. It should be noted that cancer of the paranasal sinuses was diagnosed in over half of the Black patients, whereas lung cancer was found in two-thirds of the White patients.

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TABLE I. PERCENTAGE RESPIRATORY TRACT MALIGNANCY IN JOHANNESBURG HOSPITAL, 1949 - 1954 (226 CASES)

	Blacks	Whites
Sinuses	**54**	**5**
Nasopharynx	**14**	**10**
Larynx	**15**	**18**
Lungs	**17**	**67**

Table II demonstrates the dramatic changes which took place during the next 18 years. Lung cancer in the Blacks increased from 8% in 1950 to 52% in 1968, whereas cancer of the paranasal sinuses decreased from 73% to 13% in the same years.

It must be admitted that this was a selected group of patients treated in the Radiation Therapy Department, but the figures are comparable statistically.

These changes have taken place in a semi-sophisticated urbanised Black population, and are not necessarily applicable to rural areas. In the latter, lung cancer, though increasing slightly in incidence, is still relatively rare.

Tables III and IV give the results of our tests for aromatic hydrocarbons in some Swazi snuffs. The amounts of aromatic hydrocarbons especially 3,4-benzpyrene were extremely high, more than in cigarette smoke condensate and approaching that of chimney soot.

It would appear that the observation made by Percival Potts on scrotal cancer in chimney sweepers nearly 200 years ago, is being repeated, except that the carcinogens are being applied to another anatomical region.

At this stage it was thought that we had the answer to the aetiology of antral cancer. However, in man our experience has been that aetiological factors are likely to be multifactorial. At the suggestion of several American workers it was decided to test these samples for trace elements. Much to our surprise a second set of possible carcinogens came to light.

Table V tabulates the results of trace element studies of the three most important Swazi snuffs. Chromium and nickel, well-known nasal carcinogens, were well represented in all three snuffs tested. Copper, lead, zinc and cadmium were also present in relatively large quantities.

Table VI gives the results obtained from samples of American snuffs. It is obvious that apart from zinc, the trace elements studied were present in much larger quantities in the indigenous snuffs.

The soil in which these plants grew was also tested, and contained less of these trace elements. It would appear that these plants have a selectivity for trace elements, and in particular chromium and nickel.

TABLE II. PERCENTAGES SHOWING CHANGE IN THE RELATIVE FREQUENCY OF RESPIRATORY TRACT CARCINOMAS IN BLACKS AND WHITES, 1950 - 1968*

	Whites			Blacks		
	1950	1950 - 63	1968	1950	1950 - 63	1968
Paranasal sinuses	5	5	1	73	37	13
Nasopharynx	10	7	3	8	13	7
Larynx	18	22	14	11	22	28
Lungs	67	66	82	8	28	52
	100	100	100	100	100	100

* Records of the Department of Radiation Therapy, Johannesburg Hospital.

TABLE III. COMPARATIVE COMPOSITION OF SNUFF, ALOE STEMS, TOBACCO AND ASH (PARTS PER MILLION)

	Zulu snuff		Venda snuff		Aloe stems		Tobacco		Aloe ash		Ash from Shi Tehava Misisi
	1	2	1	2	1	2*	1	2*	1	2	
Anthracene	0,05	0,07	—	0,01	Present	0,002	0,01	0,02	0,003	—	0,007
Pyrene	0,56	0,58	0,08	0,09	0,017	0,024	0,03	0,049	0,003	0,0015	0,020
Fluoranthene	0,80	—	0,12	0,15	0,034	0,085	0,110	0,108	0,006	0,006	0,018
3,4 - benzpyrene	0,27	0,25	Present	Present	Present	0,004	0,006	0,010	0,002	0,002	0,013
1,12 - benzperylene	0,14	—	—	—	—	—	—	—	—	—	—

* This material was dry, and hence gave some higher values.

TABLE IV. RELATIVE PROPORTIONS OF HYDROCARBONS TAKING PYRENE AS UNITY

	Zulu snuff		Venda snuff		Cigarette smoke condensate	Chimney soot
	1	2	1	2		
Anthracene	0,12	0,09	—	0,11	1,0	0,2
Fluoranthene	—	1,4	1,5	1,6	—	1,3
3,4 - benzpyrene	0,43	0,48	—	—	0,1	0,55
1,12 - benzperylene	—	0,25	—	—	—	0,35

TABLE V. TRACE METAL CONTENT OF SWAZI SNUFF AND ASH IN MICROGRAMS PER GRAM (ppm)*

Type	% Ash	Copper	Chromium	Lead	Zinc	Cadmium	Nickel
Aloe snuff	28,9	25	9	8	65	1,4	43
Ubhoco snuff	33,9	63	84	8	50	1,5	87
Amaranthus snuff	31,4	16	13	6	47	1,1	25
Aloe asht	85,8	13	17	39	129	2,6	112
Ubhoco asht	46,9	89	259	40	164	2,8	94
Amaranthus asht	76,8	31	38	42	968	2,7	58

* The trace metal content of both the snuff and the incinerated plant ash is expressed in terms of their natural state as used.
† Ash—incinerated plant material as used by the consumer.

TABLE VI. SAMPLES OF AMERICAN SNUFF ANALYSED FOR TRACE ELEMENTS IN MICROGRAMS PER GRAM (ppm)

Type	% Ash	Copper	Chromium	Lead	Zinc	Cadmium	Nickel
Buttercup							
Sweet Scotch snuff	24,3	10	1	4	41	0,8	3
Scotch snuff	21,6	12	1	4	27	0,9	2
Railroad mills							
Sweet Scotch snuff	22,7	9	2	4	40	0,7	2

CONCLUSION

We thus have two sets of possible carcinogens — aromatic hydrocarbons and noxious trace elements — which may play a part in the genesis of cancer of the accessory sinuses.

More tests will have to be carried out on snuffs from other parts of Southern Africa before definite conclusions can be made, but it would appear that a good case has been made for the carcinogenicity of indigenous snuffs.