Bull. Environ. Contam. Toxicol. (1994) 53:332–336

Environmental Contamination and Toxicology

Levels of Iron, Silver, Zinc, and Lead in Oranges and Avocados from Two Gold-Rich Towns Compared with Levels in an Adjacent Gold-Deficient Town

A. A. Golow, J. N. Laryea

Department of Chemistry, University of Science and Technology, Kumasi, Ghana

Received: 3 February 1993/Accepted: 15 March 1994

Fruits such as oranges and avocados are important sources of drinks and food in the Ghanaian Society. If such fruits contain various types of metals they may augument the types and amounts of them in the human body. The metals present in the fruits may be dependent on what is in the soils from which they are grown. If the soils contain toxic metals like lead, mercury and cadmium then the consumers may be poisoned as happened in the "Ouchi - ouchi", disease in Japan (Thinker 1971) and similar episodes.

In the area under study, the Geological Survey indicates the presence of 2.5 ppm of lead, 10 - 20 ppm of copper and less than 15 ppm of nickel (Woodfield 1966, Moon et al 1967). Even though the presence of silver was not reported in commercial amounts 6.5 - 7.5% of the metal is obtained as a byproduct in the production of gold at the Ashanti Goldfields Corporation's mine at Obuasi (Kesse 1985). This might be due to the fact that silver sometimes is alloyed with gold as in South Africa (Holderness 1963). Cotton et al (1980) also confirm that like gold, silver occurs as sulphides in combination with the sulphides of the Cu, Ni and so on. Thus since copper and nickel are present in the area traces of silver will certainly occur. In the same manner even though zinc was not reported to be present in the area since it is usually associated with lead as sulphide of zinc blend trace amounts of it are likely to occur in the area.

Of the four metals measured, iron and zinc are essential for citrus. Their absence from the soil may cause deficiencies in the crop (Bryan, Sinclair 1961). The extractable iron and zinc in the area of study were 90 and 1.8 mg/kg., Sillanpaa (1982). These levels are said to be on the low side for the healthy growth of crops. Silver and lead are not essential for crops and hence not determined in the soil chemistry of the area.

The investigation reported here is the comparison of the levels of some metals in oranges and avocados from farms in Obuasi and Konongo with those from farms in Kumasi City. This is part of a

Correspondence to: A. A. Golow

project aimed at finding out differences in the metal contents of various food crops grown in various regions of the country. Konongo and Obuasi have soils which are rich in gold but Kumasi city, which is not too distant from these towns, does not have gold in its soil.

MATERIALS AND METHODS

Samples of Citrus sinesis, oranges and Persea americana, avocados were harvested from six different farms in the various parts of each of Kumasi city, Obuasi and Konongo towns and were conveyed to the laboratory. That is 18 farms were sampled in the three towns. Ten fruits were harvested from each tree.

In the laboratory the fleshy portions of the fruits were separated from the peels. The peels and the fleshy portions of the fruits were put into separate petri dishes and dried in the oven at 100 - 105 °C to constant weight. The dried samples were ground to powder in a porcelain mortar with pestle. Weighed portions of the powder were put into boiling tubes in triplicate. To each sample in the boiling tube were added 15 mL of concentrated AnalaR HNO_3 in a fume cupboard. The contents of the tubes were stirred with a glass rod until the evolution of brown fumes ceased and only thin separable fibers in some cases were seen. The tubes were stoppered and kept in a locker for 2 - 3 days. The tubes together with their contents were heated in a sand bath to effect complete dissolution. The digest was allowed to cool and made up to 50 mL in a graduated flask with double distilled water.

The metals in the treated samples were determined in the Atomic Absorption Spectrophotometer, AAS 3, Carl Zeiss Jena. Standard solutions for calibration curves were prepared from authentic standard salts in HNO_3 and double distilled water. Measured concentrations of the metals were read from these curves. The instrument was capable of measuring the metals to lower than 0.01 ppm with 74 - 98% recoveries. The means and the ranges of the metals in the fleshy portions and in the peels were calculated separately (Snedecor et al 1967).

RESULTS AND DISCUSSION

With the exception of the avocados from Konongo, the mean metal levels in the peels of the fruits, see Tables 1 - 3, were higher than those in the fleshy portions. The fruits from Obuasi had the highest levels of iron and then followed those from Konongo and lastly by those from Kumasi City. Sillanpaa (1982) claimed there was no iron deficiency in the area and the extractable iron from the soil was about 90 mg/kg and that pot grown wheat had 65 ppm of the metal. The higher levels of iron found in Obuasi and Konongo was from the soils. These amounts were, however, much lower than what was found in pot grown wheat in the area. In Obuasi, gold occurs in combination with FeS_2 and FeAsS and hence the higher levels of iron found there than in Konongo where gold

Table 1. Mean levels in mg/kg of iron, silver, zinc and lead in oranges and avocados from farms in Kumasi city in 1991

	Fe		Ag		Zn		Pb	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Orange flesh	6.1	2-9.6	0.8	0.1-1.5	3.9	0.9-6.9	1.3	0.4-2.2
Orange peels	7.9	5-7.8	0.9	0.1-1.7	3.3	0.3-6.3	1.2	0.8-1.6
Avocado flesh	5.9	1-4.2	0.7	0.0-1.2	1.8	0.8-3.3	0.9	0.6-1.2
Avocado peels	7.3	5-8.7	1.9	1.3-2.4	2.3	2.1-4.5	1.2	0.4-2.4

Table 2. Mean levels in mg/kg of iron, silver, zinc and lead in oranges and avocados from farms in Obuasi in 1991

	Fe		Ag		Zn		Pb	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Orange flesh	19.2	5-25.7	2.2	1 - 3.4	3.2	0.6-5.8	1.3	0.8-1.8
Orange peels	20.5	15-26.0	3.3	1 - 5.0	3.8	2 - 5.1	0.8	0.2-1.5
Avocado flesh	16.4	11-21.5	3.5	0.3-6.7	1.1	1 - 1.3	1.1	0.3-1.9
Avocado peels	21.4	11-31.1	2.0	1 - 2.9	1.5	1 - 2.1	2.2	1.9-2.5

Table 3. Mean levels in mg/kg of iron, silver, zinc and lead in oranges and avocados from farms in Konongo in 1991

	Fe		Ag		Zn		Pb	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Orange flesh	10.0	3-17.1	1.4	1.2-1.8	39.1	34-43.5	1.9	0.6-3.2
Orange peels	12.4	4-20.6	1.7	1 - 2.3	35.6	34-36.4	1.5	1 - 1.9
Avocado flesh	11.6	2-20.7	1.2	1 - 1.4	34.0	30-37.8	0.7	0.3-1.1
Avocado peels	9.6	1-17.6	1.7	1.7-1.8	30.2	27-33.1	1.3	1 - 1.5

occurs mainly as native gold. FeS_2 is auriferous and a valuable gold ore (Kesse 1985).

Obuasi fruits had the highest levels of silver which in turn was followed by Konongo fruits and then Kumasi fruits. The two gold mining towns thus had higher levels of silver than the nongold Kumasi City. The higher levels of silver in Obuasi and Konongo fruits might be due to the occurrence of gold which is associated with silver (Kesse 1985). The highest levels in Obuasi fruits might be due to the fact that the Obuasi gold mine contained more of FeAsS and FeS_2. The Konongo fruits had less silver than Obuasi because the Konongo mine had, as already stated, predominantely less arsenopyrites which might have trapped silver atoms. The presence of silver in Konongo fruits suggests also that the silver might be present in traces with gold (Holderness 1963). Except at Obuasi the peels tended to contain more silver than the fleshy portions.

The pattern displayed by zinc was very striking. Kumasi and Obuasi fruits contained nearly the same levels of the metal but the Konongo fruits had exceptionally higher levels, Tables 1 - 3. No obvious explanation comes to the mind. The levels of zinc found in Kumasi and Obuasi fruits however were close to the 2 ppm which was measured in Valencia oranges grown in Florida, Sinclair (1961).

Lead tended to be higher in the peels of avocados than in the fleshy portions in the three towns but the opposite was the condition in the oranges. Lead did not show much variation from one town to another and hence it appeared nearly uniform. The lead contents of the soils might not be very different that is about 2.5 ppm. Probably the influence by contamination due to lead aerosols from the combustion of leaded gasoline in petrol engines (Gish et al 1973, Thomas et al 1967, Chow, Daines et al 1979) did not reach the farms from which the fruits were harvested. The farms were generally far from main roads. The levels of lead measured were thus due to amounts absorbed from the natural levels in the soils. The amounts of lead in both the peels and the fleshy portions were less than 5 ppm which according to Patterson (1965) may be toxic to humans.

With respect to iron and zinc which are essential metals, a whole fruit of orange and avocado will be more nutritious than the peeled ones. The implication is that, orange jam will be more nutritious than orange juice because portions of the processed peels are added to the marmalade.

The peels of avocados are, however, too hard and are not eaten by man. Though the levels of silver and lead are not high enough to be toxic, it would be safer to consume the fruits without the peels to avoid poisoning since most of the metals are not metabolized and if not excreted may accumulate (Somers et al 1971, Abelson 1970).

REFERENCE

Abelson PH [1970] Methyl mercury. Science 169: 237 - 239
Bryan OC [1961] Malnutrition symptoms of citrus. Bulletin No. 93 State of Florida Department of Agriculture, Doyle Tallahasse.
Chow TJ [1970] Lead accumulation in roadside soil and grass. Nature 225: 295 - 296.
Chow TJ, Earl JL [1979] Lead aerosols in the atmosphere: Increasing concentration. Science 169: 577 - 579.
Cotton FA, Wilkinson G [1980] Advanced Inorganic Chemistry: A comprehensive Text. John Wiley and Sons.
Daines RH, Motto H, Chilko DM [1970] Atmospheric lead: Its relationship to traffic volume and proximity to high ways. Environ Sci Technol 4; 318 - 321.
Gish CD, Christenson RE [1973] Cadmium, nickel, lead and zinc in earthworms from roadside soil. Environ Sci Technol 7: 1060 - 1062.
Holderness A [1963] Inorganic and Physical Chemistry. Heinemann London, Melbourne.
Kesse GO [1985] The mineral and rock resources of Ghana. AA Balkema Rotterdam.
Moon PA, Manson D [1967] Ghana Geological Survey Bulletin No. 31 State Publishing Corporation, Accra, Ghana.
Patterson CC [1965] Contaminated and natural lead environments of man. Arch Environ Hlth 11: 344 - 346.
Sillanpaa M [1982] Micronutrients and the nutrient status of soils: A global study. Food and Agriculture Organization of the United Nations, Rome.
Sinclair WB [1961] The Orange: Its Biochemistry and Physiology. The Regents of the University of California.
Snedecor GW, Cochran WG [1967] Statistical methods. The Iowa State University Press. AMES, IOWA USA.
Somers E, Smith DM [1971] Source and occurrence of environmental contamination. Fd Cosmet Toxicol 9: 185 - 189.
Thomas HV, Melmore BK, Heidbreder GA [1967] Blood lead of persons living near free ways. Arch Environ Hlth 15: 695 - 699.
Tinker J, [1971] "Ouchi - Ouchi" Your cadmium is showing. New Scientist and Science J, April 22: 186 - 188
Woodfield PD [1966] Ghana Geological Survey Bulletin No. 30 State Publishing Corporation, Accra.