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A Study of Lead Content in Soils and Grass around Roadside Locations in and around Kuala Lumpur

K. S. LOW, C. K. LEE and M. YUSOF BIN HJ. ARSHAD
Department of Chemistry, Faculty of Science and Environmental Studies, Universiti Pertanian Malaysia

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RINGKASAN

Analisa contoh-contoh rumput Axonopus compressus, *Beauv. dan tanah di dalam dan di sekitar Kuala Lumpur menunjukkan bahawa taburan zarah plumbum dipengaruhi oleh padatnya lalulintas. Adalah jelas bahawa di setengah-setengah tempat, pengangkutan plumbum pada rumput telah meningkat kepada paras racun terhadap lembu manakala di lain-lain tempat masih menuju paras ini.*

Paras plumbum pada rumput di Jalan Tembusu adalah setinggi 200 ppm manakala pada tanah di kawasan yang sama adalah lebih daripada 700 ppm.

SUMMARY

Analysis of samples of the grass Axonopus compressus, *Beauv. and soil in and around Kuala Lumpur shows the distribution of particulate lead to be strongly influenced by traffic density. In certain areas the lead contamination in grass has reached the toxic level for cattle; other areas are approaching similar levels.*

Levels of lead in grass (as high as 200 ppm) at Jalan Tembusu were recorded while soil in the same area gave a value greater than 700 ppm.

INTRODUCTION

Lead, one of the non-ferrous metals is widely used in storage batteries and lead alkyl (tetraethyl lead) as an antiknock in petrol. Acidic water passing through old lead pipes can accumulate a high level of the element. Lead is also widely distributed through its use in pigment, dyes and glass. It is used in combination with arsenic (lead arsenate) in sprays though this practice is less common to-day. Man, animals and plants have no nutritional requirement for this element. Traces of lead are almost ubiquitious in nature and small amounts are found in normal foods. It is harmful to man and animals even at relatively low concentrations and its toxic effects are well documented (Smith and Waldron, 1974; Chisolm, 1971). Lead, particularly Pb^{2+}, is a general metabolic poison and is cumulative in man. It inhibits enzyme necessary for the formation of haemoglobin through its strong interaction with SH groups. Since Pb^{2+} can replace Ca^{2+} in bones, it tends to accumulate there. It may be remobilized long after the initial absorption, e.g. under conditions of abnormally high calcium metabolism such as feverish illness, during cortisone therapy and also in old age.

Automobile exhausts are the chief source of atmospheric lead pollution. Numerous studies of the effects of lead content in soils and plants have been carried out in U.S.A. (Smith and Waldron, 1974; Graham and Kalman, 1974), Australia (Wylie and Bell, 1973; Noller and Smythe, 1974) and New Zealand (Ward *et al.*, 1974, 1975).

The lead content of petrol in Malaysia varies from 0.7 – 0.85 g/dm^3. It was reported (Heng, 1979) that in 1978, 813 tonnes of lead were added to Malaysian petrol, 73% (589 tonnes) of which were emitted into the atmosphere.

The lead situation in Malaysia has been left unexamined and a preliminary survey of lead accumulated in soils and plants at various roadside locations in and around Kuala Lumpur was undertaken in 1979.

Key to authors' names: Low, K. S., Lee, C. K. and Arshad, M. Y.

MATERIALS AND METHODS

Soil and grass samples were collected in 1979 from the following locations shown in Fig. 1. They were Jalan Hishamuddin, Jalan Damansara, Jalan Tembusu, Jalan Kebun Bunga, Jalan Raja, Jalan Birch, Bulatan Edinburgh, Jalan Bangsar, Jalan Brickfield, Kuala Lumpur-Seremban Highway and Universiti Pertanian Malaysia. There are no industrial plants emitting lead in these areas, thus motor vehicles exhausts can be regarded as the only source of lead pollution.

The grass investigated was *Axonopus compressus*, Beauv. All grass samples were divided into two parts. One part was washed with non-ionic detergent followed by distilled water to remove surface contaminants.

Both samples were dried at 105°C for 24 hours in an oven and ground into powder using an aluminium mill. The powdered sample (1 g) was placed in a beaker and treated with approximately 10 cm^3 of a solution of concentrated HNO_3 and $HClO_4$ in a ratio of 4:1 (v:v). The beaker was covered with a watch glass, heated to slow boiling until digestion was complete. The residue was washed with 1% HNO_3 and filtered (Little and Martin, 1972). A blank solution treated in the same way was used as a control.

All soil samples were dried for three days at 60°C and sieved (60 mesh). Samples of soil weighing approximately 0.1 g were digested in 1:1 (v:v) mixture of concentrated HNO_3 and HF (10 cm^3 HNO_3 : 10 cm^3 HF).

Samples were evaporated to dryness in propylene beakers suspended in water bath. The residue was dissolved in 5 cm^3 of 2M HCl and analysed for lead. For the blank solution, the same procedure was carried out without the soil sample (Ward *et al.*, 1974).

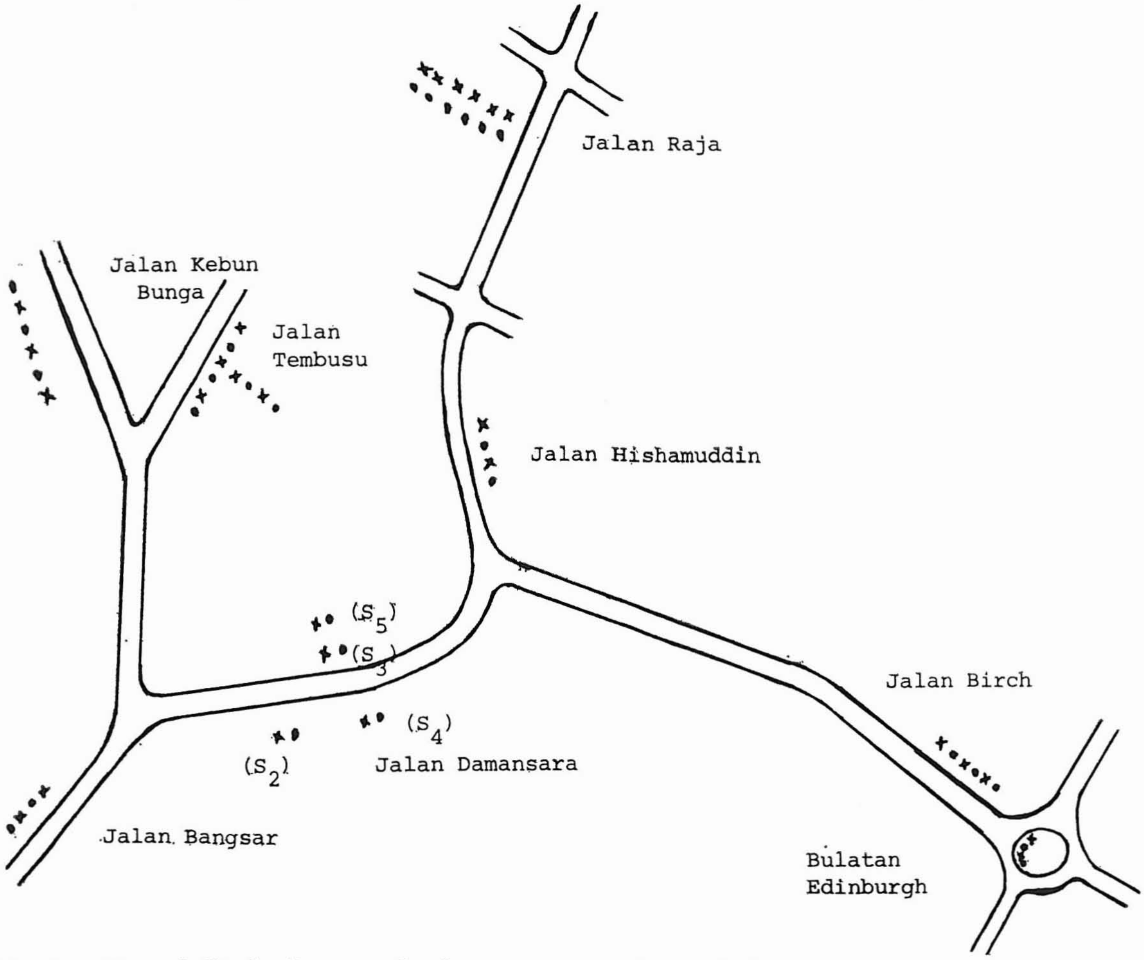

Fig. 1. Map of Kuala Lumpur showing some areas where soil (×) and Grass (●) samples were collected for lead pollution estimation.

Duplicates or triplicates were carried out. The filtrate was then analyzed for lead at 217.0 nm wavelength using a IL651 Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

Concentrations of lead found in soil and grass *Axonopus compressus* Beauv. are shown in Table 1.

Lead in grass

Of all the areas investigated in Kuala Lumpur, it was found that grass grown along Jalan Tembusu showed the highest concentration of lead (233.5 ppm) in unwashed samples as contrasted to 24.4 ppm from that obtained in the vicinity of Universiti Pertanian Malaysia. No actual traffic volumes were available at sites studied but it is known that traffic density is very much higher at Jalan Tembusu than in the area of Universiti Pertanian Malaysia.

The high concentration of lead in grass bordering the Kuala Lumpur-Seremban Highway reflects the high traffic density in that area.

Of the four sites studied along Jalan Damansara, grass at site S_3 showed a distinctly greater lead contamination than the other areas. This reflects the importance of sampling methods. Site S_5 which is on a higher level than site S_3 showed less contamination. A value of 78.7 ppm of lead was recorded at site S_5 compared to 169.8 ppm of lead at S_3.

A similar observation was made at Jalan Tembusu. Samples collected at the fringe of the road showed a very high concentration of lead (233.5 ppm) as against 31.2 ppm of lead found in grass collected above the road level. Samples showed that direct discharge of car exhausts and deposits of most of the heavier particulates occurred at the road fringe.

The grass bordering Jalan Kebun Bunga showed relatively little lead contamination despite its proximity to Jalan Tembusu. The traffic density is heavy along this road. The low level of lead is probably due to regular grass cutting which rendered the sampled grass to have a shorter exposure to lead fallout from car exhausts. Noller and Smythe (1974) noted low lead con-

TABLE 1

Lead in grass and soil bordering Kuala Lumpur roads.

Location	Soil	Lead Content (ppm dry weight) Grass		
		washed	unwashed	%Pb removed by washing
Jalan Hishamuddin	189.7	41.3	65.7	37.1
Jalan Damansara	139.3 (S2)	41.3	75.8	45.5
	346.2 (S3)	134.6	169.8	17.6
	155.1 (S4)	73.7	101.4	27.3
	150.3 (S5)	31.2	78.7	60.4
Jalan Tembusu	56.8 (above road level)	24.9	31.2	20.2
	770.6 (roadside)	108.6	233.5	53.4
Jalan Kebun Bunga	61.7	20.6	35.2	41.2
Jalan Birch	608.8	80.0	127.6	37.3
Bulatan Edinburgh	569 (divider)	74.5	106.2	31.2
	326.6 (fringe of circle)	75.5	82.5	30.1
Jalan Bangsar	251.4	55.5	80.9	31.4
Jalan Brickfield	650.0	103.5	120.3	14.0
Universiti Pertanian Malaysia	6.3	8.5	25.4	66.5
Kuala Lumpur-Seremban Highway	133.5	98.0	189.1	48.2

tamination of grass in heavy traffic areas when the grass was mown regularly so that fresh growth was always available at the time of sampling.

Samples at Jalan Birch and Bulatan Edinburgh showed relatively high lead contamination which may not be entirely due to high traffic volumes but to slow moving traffic at peak hours causing a higher fraction of exhausted lead to be distributed to the environment.

Motto and co-workers (1970) reported 664–68 ppm Pb in grass within the distance of 0–67.5 m from one of the U.S.A. highways. Graham and Kilman (1984) found levels of lead in forage grasses taken from roads in a U.S.A. suburban setting nearly 200 times that of the natural background levels (5 ppm). Although the levels of lead contamination in grass bordering Kuala Lumpur roads are not as high as those reported by the American workers, they are very much higher than those obtained by Australian workers. The highest lead level observed in Rhodes grass samples in Brisbane was 64 ppm (Wylie and Bell, 1973) and grass bordering roads in Sydney showed the highest value of 140.5 ppm (Noller and Smythe, 1974).

A level of 100 ppm of lead in grass is considered lethal to cattle if such grass is consumed over a period of time (Gordon and Roberts, 1971). Bini (1973) reported that dairy cattle fed with hay contaminated by lead from car exhausts were able to eliminate most of the lead through digestion in a short time. However, after four weeks, the lead content of milk was found to increase fourfold. Some 146 mg of lead per animal per day was estimated to be absorbed from untreated hay containing 10 ppm Pb whereas nearly ten times this amount was ingested from roadside grass containing 100 ppm Pb.

Although cattle grazing is not common in the city, it is frequently seen to take place on the outskirts of Kuala Lumpur. Cattle grazing is not an uncommon sight along the Kuala Lumpur-Seremban Highway. In these areas the level of lead in grass (189.1 ppm) surpasses the amount that is potentially hazardous to the cattle, if local forage grasses are the only source of food. In these areas deposition of lead on grass examined almost certainly originated from automobile exhausts. Very little of the lead in soil is taken up by plants (Page and Grange, 1971). There is no known industrial source of lead contamination in these areas. This finding indicates that lead contamination in forage grass is not only hazardous to grazing cattle in near heavy traffic roads but also suggests the need for monitoring the lead content of milk and beef marketed for human consumption.

That 18–66% of the lead could be removed by washing indicates that a significant fraction of the lead is in the form of easily removable particulate matter. Ward *et al.* (1975) found that 70–90% of the lead contents of plants could be removed by washing. Motto *et al.*, (1970) reported that washing removed about 50% of lead in grass samples. The effectiveness of washing techniques in removing lead from plants is related to the nature of the plant's surface.

The washed grass collected at Universiti Pertanian Malaysia vicinity showed a low value of 8.5 ppm of lead, in the region of the natural lead content of vegetation of 5 ppm, a value reported by Motto *et al.* (1970).

The environmental lead levels diminished exponentially with distance from the road. This is evidenced from Fig. 2 which shows lead content in grass along Jalan Raja, Kuala Lumpur, as a function of distance from the road. This relationship has also been reported by other workers (Motto *et al.*, 1970; Graham and Kalman, 1974)

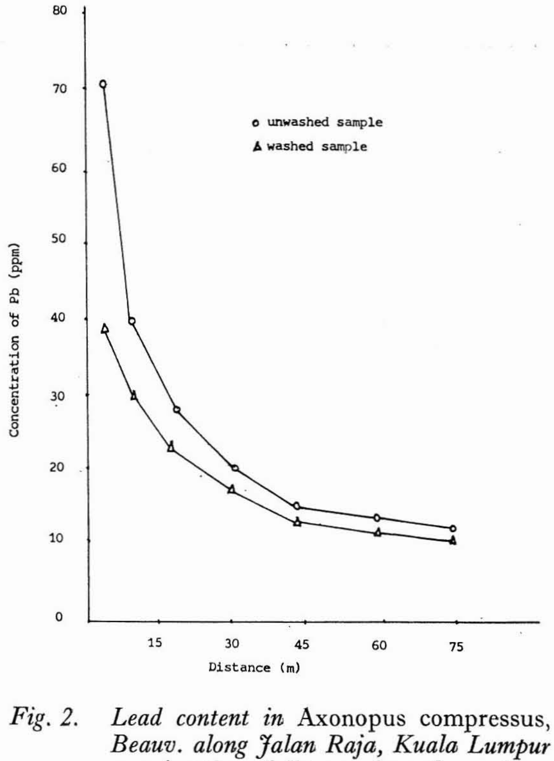

Fig. 2. Lead content in Axonopus compressus, *Beauv. along Jalan Raja, Kuala Lumpur as a function of distance from the road.*

Edwards (1971) reported that half of the particulate matter containing lead from automobile exhausts falls out from the air within a few hundred feet of the roadways in a matter of minutes. Beyond several hundred feet from the roadway, soil lead levels and hence grass lead levels are not easily detectable from those of the 'background' soil or grass. This is clearly borne out from our study which showed that at 75 m the lead levels in washed and unwashed samples were 10.9 and 12.6 ppm respectively. This would mean that vegetables and fruit trees grown some distance from the highway would not be polluted by lead emitted from car exhausts to a hazardous level.

Lead in Soil

The lead level in soil around Jalan Tembusu was greater than 700 ppm. Around Bulatan Edinburgh and Jalan Birch values of about 500 ppm of lead were recorded. While no actual traffic density around these places was available, it is generally found that traffic density at Jalan Birch and its surrounding is higher than it is at Jalan Tembusu. The higher value of lead at Jalan Tembusu was probably due to the sampling site where exhaust discharge was greatest. The soil directly above Jalan Tembusu showed relatively low lead value of 56.8 ppm suggesting the particulates were restricted in movement by the rather steep slope. A similar relationship was also noted in grass in the same area. Other areas showed relatively high concentrations of lead, greater than 100 ppm. The soil around Universiti Pertanian Malaysia showed 6.3 ppm of lead. This probably reflects the lead concentration in a pollution-free natural surrounding. Fleischer (1973) reported the natural concentration of lead varied with the type of material. Limestone shows an average of 9 ppm while soils have a value of 15 ppm of lead.

Cannon and Bowles (1962) recorded lead in soil along a highway in New York as containing between 100–1000 ppm Pb (average 515 ppm). Hence the level of lead contamination in and around Kuala Lumpur is becoming increasingly critical as the number of vehicles on the roads increases.

The lead concentration in the 5-cm core of soil taken at various distances from Jalan Raja indicates a rapid decrease of lead content at 45 m from the roadside, a finding similar to that of Wylie and Bell (1973) and Motto *et al.*, (1970). This finding also parallels that with regard to the decrease of lead content in grass studied in the same areas.

The 'background' lead appears to be 240 ppm (see Fig. 3).

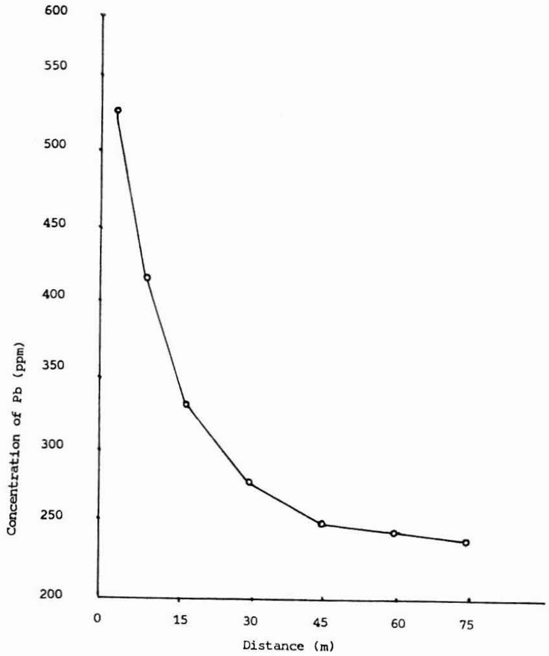

Fig. 3. Lead content in soil along Jalan Raja, Kuala Lumpur, as a function of distance from the road.

CONCLUSION

Considerable accumulation of lead were found in soil and grass adjacent to high traffic density areas in and around Kuala Lumpur. In many areas lead concentrations in grass have reached the level considered harmful to livestock. This would also pose an immediate threat to human health. As traffic densities on many roads in Kuala Lumpur are likely to increase, lead pollution will become more serious. Hence a more detailed survey of atmospheric lead in Kuala Lumpur is needed. This survey is currently being undertaken.

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REFERENCES

BINI, G. (1973): Lead in the rural environment – 1. *Inter. J. Environmental Studies,* **5:** 59–61.

CANNON, H. L., BOWLES, J. S. (1962): Contamination of vegetation by tetraethyl lead. *Science, N.Y.* **137**: 765–766.

CHILSOM, J. J. (1971): Lead poisoning. *Scient. Am.* **224**: 15–23.

EDWARDS, H. W., CORRIN, M. L., GRANT, L. O., HARTMAN, L. M., RETTER, E. R., SKOGEROBOE, R. K., WILBER, C. G., ZIMAHL, R. L. (1971): Impact on man of environmental contamination caused by lead. Interim report for period ending 30 June, 1971. NSF G1–4, Fort Collins, Colorado State University.

FLEISCHER, M. (1973): Natural sources of some trace elements in the environment, cycling and control of metals. Proceedings of Environmental Resources Conference, Columbus, Ohio, Oct 31, Nov 2, 1972. Cincinnati, Ohio: Natural Environmental Research Centre, Feb.

GOODMAN, G. T., ROBERTS, T. M. (1971): Plants and soils as indicators of metals in air. *Nature*. **231**: 287–292.

GRAHAM, D. L., KALMAN, S. M. (1974): Lead in forage grass from suburban area in Northern California. *Environ. Pollut.* **7**: 209–215.

HENG, H. (1979): The mechanical monster. The Malay Mail. April, 11.

LITTLE, P., MARTIN, M. H. (1972): A survey of Zn, Pb, and Cd in soil and natural vegetation around a smelting complex. *Environ. Pollut.* **3**: 241–254.

MOTTO, H. L., DAINES, R. H., CHILKO, M. D., MOTTO, C. K. (1970): Lead in soils and plants: its relationship to traffic volume and proximity to highways. *Environ. Sci. and Technol.* **4**: 231–237.

NOLLER, B. N., SMYTHE, L. E. (1974): Distribution of lead in vegetation bordering roads in Sydney metropolitan area. *Search*. **3**: 108–109.

PAGE, A. C., GANJE, T. J. (1971): Lead quantities in plants, soil and air near some major highways in Southern California. *Hilgardia*. **41**: 1–30.

SMITH, D. B., WALDRON, N. A. (1974): Lead behaviour and criminality. *Ecologist*. **10**: 367–377.

WARD, N. I., BROOKS, R. R., REEVES, R. D. (1974): Lead from motor vehicle exhausts in trees along a major thouroughfare in Palmerstone North, New Zealand. *Environ. Pollut.* **6**: 149–158.

WARD, N. I., BROOKS, R. R., REEVES, R. D. (1975): Lead in soil and vegetation along a New Zealand state highway with low traffic volume. *Environ. Pollut.* **9**: 243–251.

WYLIE, P. B., BELL, L. C. (1973): The effects of automobile emission on the lead contents of soils and plants in Brisbane area. *Search*. **4**: 161–162.

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