Cadmium (Cd) Version 1.6 11 April 2015

Cadmium is an unnecessary element for humans, animals and plants. Uptake occurs mainly through food with excessive amounts causing serious health problems such as diarrhoea, stomach pain, severe vomiting, bone fracture, reproductive failure and possibly infertility. In severe cases, damage can occur in the central nervous and immune systems, and psychological disorders.

Cadmium is a shiny, silvery-white, ductile, metal. Its surface has a bluish tinge and the metal is soft enough to be cut with a knife, but it 'dusts' into air. 75% of cadmium is used in the manufacture of batteries, the remaining 25% is used in the production of pigments, coatings, plating and as stabilisers for plastics. Cadmium also has the ability to absorb neutrons, so it is used as a barrier to control nuclear fission.

As you can see in this chart, historical sources of phosphate rock have been very high in both cadmium and fluorine. Numerous studies have shown that long term use of phosphate fertilisers has increased cadmium and fluorine concentrations in NZ topsoil. A national survey done in 1994 (by Roberts et al) of cadmium in pasture and non-agricultural topsoil showed that pasture topsoil that had received regular phosphate fertiliser inputs contained a cadmium concentration ranging from 0.04 – 1.53mg cadmium/kg. In comparison, non-agricultural soil receiving no fertiliser had cadmium concentration of 0.02 – 0.77mg Cd/kg. This gap between the two represents an increase of 120%.

In a study of irrigated pasture grazing sheep that had been annually top-dressed with different rates of single superphosphate SSP for 44 years, it was noticed that the topsoil cadmium increased from 0.05 to 0.45 as a result of SSP application. An increase of 800%

The rates of cadmium accumulation in New Zealand topsoil as a result of phosphate fertiliser applications appears to be higher than elsewhere, probably due to the higher rates of phosphate fertiliser used on our volcanic soils. Total cadmium and fluorine concentrations in regularly fertilised topsoil show a positive correlation with total phosphate concentrations. Various charts show the cadmium and fluorine levels have increased with the increased application of phosphate fertilisers.

What does this mean?

One can only guess at the long term effects on human health from the continued use of phosphate imported from those countries listed above. New Zealand already has one of the highest levels of cadmium in agricultural soils. Today, the majority of phosphate rock imported into NZ, comes from Morocco.

Before you buy phosphate in any of its various forms (Superphosphate, Triple superphosphate, DAP, RPR, dicalcicphosphate) ask your supplier to show you an analysis of the cadmium levels in their product and disclose the country of origin. It is advisable to avoid the use of Dicalcic super. It is made from SSP and TSP which has some of the highest levels of cadmium. It is also made using limestone rock. Research shows that increasing the soil pH by too much increases the cadmium uptake from the soil to the plants and from there into the food chain.

We should be aware of the potential future trade implications. If our trading partners decide that the cadmium levels in our soils are too high, import restrictions on our primary produce could follow.

The obvious answer is to stop importing and using phosphate rock from those countries that have high levels of cadmium. There is research available that shows certain mycorrhiza fungi absorb cadmium from the soil and store it in their mycelium. This prevents plant uptake of cadmium.

Instead of spending more money on research into use of phosphate on NZ soils, we should be researching how to repair the damage already done to the soils by overuse of phosphate fertilisers.

All Phosphate rock (PR) fertilisers contain hazardous elements including heavy metals, e.g. cadmium (Cd), chromium (Cr), mercury (Hg) and lead (Pb), and radioactive elements, e.g. uranium (U), that are considered to be toxic to human and animal health. The amounts of these hazardous elements vary widely among PR sources and even in the same deposit.

Among the hazardous heavy metals in P fertilisers, Cd is probably the most researched. This is because of it's potentially high toxicity to human health from consuming foods that are derived from crops fertilised with P fertilisers containing a significant amount of Cd. Most of the studies on Cd

uptake by crops have used water-soluble P fertilisers such as TSP, SSP, diamonium phosphate and mono-ammonium phosphate. However, the Cd reaction with soil treated with PR differs significantly from that with water-soluble P fertilisers because apatite-bound Cd in PR is water insoluble. Iretskaya et al. (1998) reported highly reactive North Carolina PR containing 47 mg of Cd per kilogram was as effective as SSP produced from the same PR in increasing grain yield of upland rice, but that the Cd concentration in rice grain with the PR was only about half of that with SSP. Thus, the information on Cd availability from water-soluble P sources cannot be implied directly to PR application.

The following chart is from http://agriculturalnutrients.co.nz/wp-content/uploads/2013/08/cadmium-source1.jpg.

Cadmium is a naturally occurring very toxic heavy metal that has no useful function in soils, plants, animals or humans.

In mammals, cadmium is almost absent at birth, but accumulates with age, especially in the liver and kidneys where it can cause health problems. As with other heavy metals, it adversely affects the brain.

Excess cadmium also builds up in the kidneys of old animals, and especially in the fat of old sheep. Sheep graze pasture shorter than cattle so consume more soil, some of which have Cd. A build up in soils has caused older sheep to have their kidneys and livers rejected as a human food. Cd can cause human kidney damage and upset male hormones.

Some soils have high levels from sludge and atmosphere in polluted areas, and some from the older high Cd phosphate fertilisers such as Nauru Island's and North Carolina reactive phosphate.

Fertiliser levels vary from 2 ppm to 100 ppm. Ask about cadmium levels in different phosphate fertilisers before buying it. Currently in New Zealand Gafsa is the only reactive phosphate and has

Unfortunately there were high levels of Cd in Nauru Island (90 ppm) and North Carolina (48) phosphates pre 1990's, so it is still in some soils.

USA Integrated Agricultural Management Specialist, Dr Katherine Buckley, says the Brandon study confirms European research that suggests farmyard manure can render cadmium less available to plants by binding it in the organic matter. This is another example of how beneficial organic farming is by increasing organic matter in soils.

Some weeds take up more cadmium than pasture does. As with some other minerals, fast growing pasture takes up less than slow growing pasture.

The world standards state that no more than 10 ppm cadmium should be in any food to be fed to animals that produce food.

John Turner, consultant to Hill Laboratory, wrote, "Paul C Chiy and Clive J C Phillips found that fertilising with sodium (salt) reduced the concentrations of cadmium in soils."

The maximum amount of cadmium allowed in human food in New Zealand is 1 ppm and in Australia 0.5 ppm and in the UK 0.2 ppm.

Some foods from some countries exceed 0.5 ppm, so are rejected by Australia.

Cadmium (Cd) is regarded as one of the most toxic trace elements in the environment. The increased emissions resulting from its production, use, and disposal, combined with its persistence in the environment, and it's relatively rapid uptake and accumulation by food chain crops contribute to its potential environmental hazards. Cadmium may find its way to the human population through food and beverage, drinking water, air, and cigarette smoking. Although acute Cd toxicity caused by food consumption is rare, chronic exposure to high Cd levels in food can significantly increase the accumulation of Cd in certain body organs. When the concentration in the human body reaches levels considered to be harmful (> 200 p,g/gm wet weight in the kidney cortex according to Kjellstrom and Nordberg, 1978), cadmium-induced kidney damage, skeletal disorders as well as other diseases may result.

Municipal sewage sludge can contain from 2 to 3,500 mg Cd/kg sludge with medians of 5 to 20 mg/kg (Page. 1974; Sommers. 1977; Logan and Chaney 1984).

Some mines, some industrial areas and cigarette smoke are major polluters.

phosphate Rock (PR)	Cd (mg kg $^{-1}$)	F (%)	P (%)
Kola PR	0.2		17.2
Chatham Rise PR	2	3.0	8.9
North Florida PR	3	4.0	13.3
Phalaborwa PR	3		17.2
Jordan PR	5	3.8	14.0
Egypt (Quasar PR	8	4.0	12.7
Mexico PR	8	4.1	14.0
Makatea PR	10	3.2	13.0
Sechura PR	11	3.4	13.1
Arad PR	12	4.0	14.1
Khouribga PR	15		13.8
Syria PR	16		13.3
Algeria PR	18		12.5
Gaffs PR	38	4.1	13.4
Morocco(Boucraa)PR	38		15.7
Youssoufia PR	40		14.2
North Carolina PR	41	3.5	13.0
Christmas Island PR	43	2.2	15.3
Togo PR	60		15.9
Taiba PR	75		15.9
Senegal PR	87		
Ocean Island PR	99		
Nauru PR	100	3.0	15.6
SSP	5-30	1.08-1.84	9.0
TSP	70	1.3-2.4	21
DAP	7-75	1.2-3.0	20

Human Health

Cadmium is a toxic heavy metal that can be toxic, even more so than lead, both of which like mercury, are hard to get out of the body so should be avoided in fertilisers and supplements. Excess cadmium apparently upsets male hormones and can cause kidney damage. Supplementing with magnesium decreases the concentrations of cadmium and lead in the body.

The maximum allowed in human food in New Zealand is 1 ppm and in Australia 0.5 ppm. Some foods from some countries exceed the 0.5 ppm, so are rejected by Australia. The UK maximum allowed is 0.2 ppm.

Cadmium has been found in some plastic toys and some food containers, and worst of all in some health supplements. Before I found this, a third of those I was taking had heavy metals.

I got an itch around my waste after wearing Vanheusen underpants and went to an alternative health specialist about what became a pain around my waste. He saw I was wearing Vanheusen underpants and told me that men had stopped wearing underpants because of the pain from them and they later found that it was only Vanheusens doing it.

He'd found that the rubber waste band contained cadmium.

I took some to a specialist who measures heavy metals in supplements and clothing and he confirmed that the band had a cadmium level of seven when it should be zero.

I Googled and found a lot of negative criticisms about Vanheusen clothing apparently made in India, including rashes and a shirt "withdrawal" because they had used xxx to stop shirts getting wrinkles.

Googling revealed that formaldehyde to reduce creasing, has been found in Vanheusen clothing.

I got some Jockey underpants measured and they measure zero so were clear.

Sources

Avoid companies that sell poor quality items. Unfortunately, there can be variations within consignments. Ask for an analysis.

Australian and USA studies showed that potassium chloride increased the uptakes of Cd, while potassium sulphate decreased Cd uptake by 30% in potatoes in Australia.

Cd uptake is significantly higher in acid soils. CAN and Ammonium fertilisers cause more Cd uptake than ammonium sulphate (sulphate of ammonia).

Cadmium is in phosphate fertilisers at levels as high as 48 mg per kg in that from Nauru Island where it all came from originally, and then from North Carolina until some of us campaigned to change to that from South America or North Africa. Some Waikato soils got up to 1 mg per kg. Lime and zinc reduce Cd levels in soils.

On a dry weight basis the concentration of cadmium in food chain crops grown in non-contaminated soils (except those soils unusually naturally elevated in Cd) range from 0.01 to 1.0 mg/kg. Leafy vegetables (lettuce, spinach) usually show the highest Cd concentrations, grains (wheat, oats, barley) show the lowest concentrations and root vegetables (carrot, radish, onion, potato) are intermediate between the two extremes. Concentrations of Cd in crops grown on soils elevated in Cd, either naturally or from anthropogenic sources, may accumulate substantially greater than 1.0 mg/kg. The amounts accumulated depend upon the level of Cd present in the root zone of the soil, the crop species, and the chemical properties of the soil.

Cadmium concentrations in healthy persons without excessive cadmium exposure are generally less than 1 µg/L in either blood or urine. The ACGIH biological exposure indices for blood and urine cadmium levels are 5 µg/L and 5 µg/g creatinine, respectively, in random specimens.

Persons who have sustained renal damage due to chronic cadmium exposure often have blood or urine cadmium levels in a range of 25-50 µg/L or 25-75 µg/g creatinine, respectively. These ranges are usually 1000-3000 µg/L and 100-400 µg/L, respectively, in survivors of acute poisoning and may be substantially higher in fatal cases.[11][12]

Higher levels of cadmium may be found near some industrial areas or hazardous waste sites.

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