9 Deficiency diseases

Deficits can occur in the elementary building and fuel compounds of the body: carbohydrates, fats and proteins, in vitamins (avitaminosis) and in minerals/electrolytes. As a civil engineer you are much involved with the problems of deficiency diseases related to water management, irrigation and agriculture, but you are also involved solving the problems through facilitating efficient agriculture. The five most important deficiency diseases are:

1. Anaemia

Anaemia by iron deficiency. Not enough of haemoglobin, the red colour compound of blood of which the iron ion is a compound, is formed by a deficit of the Fe_3^+ ion. Symptoms (of the disease) are: pale skin and mucous membranes, tired and listless, short of breath, no appetite, stomach and intestine disorders. Therapy: iron intake through medicine or diet (liver, green vegetables, fruit).

The cause however is often not a too little intake of iron, but a too big loss, for example through worms or malaria parasite (see there). Along with this form of anaemia there are many others (such as a deficit of folium acid or the lacking of 'intrinsic factor' from the stomach wall); we will not go into that in this lecture book.

2. Endemic goitre

Enlargement of the thyroid gland (at the front of the neck) by a deficit of iodine (hypothyroid). Starting young (because the mother already had a deficiency) the child grows into a slow, fat dwarf (cretin). The symptoms by adults are: low metabolism, cold, psychological arrears, deaf-muteness. Therapy: iodine in the diet of fish, shellfish, crustacean and seaweed (in The Netherlands in baking salt and domestic salt). We find the disease over the whole world, little around coasts, however in many deeper parts of continents, especially in mountain areas (Andes, Himalayas). Mark that too much of iodine causes hyperthyroid; this can be a life threatening condition. The cause can be a physical one, however the diet can have an influence as well (Japan: seaweed, Wales: kelp).

3. Kwashiorkor

Meaning 'red boy', because the disease loses the pigment of for example the skin and the hair. This is a serious consequence of protein deficiency in food. This leads to oedema (well-known photo) for example: a swollen stomach, as a result of stomach fluid leaking into the abdomen when it is not kept in the lymph's by insufficient osmotic suction of proteins; furthermore it leads to apathy and irritability. Therapy and prevention: protein rich diet, such as meat, fish, eggs, beans and nuts. In many developing countries milk (powder) is not a

good solution, because the enzyme lactase is not actively produced after the infant period. This enzyme divides milk components in separate parts, especially lactose (milk sugar).

4. Marasmus

Emaciation by serious caloric malnutrition. This is seen on horrible photographs of people in concentration camps. The symptoms are: Grow arrears, loss of hypodermic fat, decreasing of muscle volume (hypo trophy and atrophy). Prevention and therapy are in this case also clear. It is of course necessary to carefully start building up a diet, especially of the fats in food.

5. Vitamin A deficiency

An avitaminosis. The most noticeable symptom is xerophthalmy (ξεροs = xeros= dry, οφθαλμοs = ophthalmos = eye) or xerosis, or blisters on the cornea, which can lead to blindness. Along with this there are many millions of people with night blindness (nyctalopy) by deficiency of vitamin A. This vitamin produces the rhodopsinogen, which, transmitted into rhodopsin, gives impulses in the rods of the retina. These are then led to the cerebral cortex, which results in sensation of light. The rods provide us the only light sensation (black and white) in the night. A little deficiency already causes skin abnormalities. The last few years it became clear that vitamin A is also essential for our defense against infection diseases, such as contagious airways disorders. Many children in developing countries are strongly exposed to danger of infection also because of too little vitamin A in their diet. Infamous is coconut oil. When this is the only cooking oil, there is too little vitamin A in the diet. Prevention and therapy: egg yellow, liver, carrots, green vegetables and fruit. Mark that also dairy products are good for the ones that can take it (lactase deficiency). There can be a surplus of vitamin A as well. Such poisonings are a characteristic of fat solving vitamins. The others are vitamin D, E and K (ADEK). Infamous is the vitamin A poisoning of eating liver of pool bears.

6. Other vitamins

A few other vitamins and their related diseases. The vitamins are named after realizing they are essential living components (vita = life). They were practically numbered after the alphabet. We follow this classification. Be aware that danger of a surplus (poisoning) occurs by fat solving vitamins A, D, E and K (ADEK).

7. Vitamin B1

Preferably called now thiamine. A deficit of thiamine causes beriberi, which especially occurs by populations who eat geslepen rice. The skin of the rice contains, as it is much of the vitamin. Our country fellows Eijkman, Grijns and Vorderman discovered this in Indonesia. The disease causes neuritis, weakness and tiredness. Alcoholics also sometimes have too little intake of this vitamin resulting in having the same mentioned symptoms.

8. The vitamin B2 complex

Existing of a complex of a big number of different types.

Nowadays they are preferably called by their own names. The most important ones in relation with deficiency - the old numbering mentioned behind - are the vitamins riboflavin (B2), niacin (B3), pyridoxine (B6) and cyanocobalamin (B12) and folium acid or otherwise foline acid (no number). Vitamin B1 as well as the vitamin B2 complex is found in brewer's yeast (microscopic slides).

B2 Riboflavin sits in fresh vegetables and milk. A deficit leads to for example tongue infection, which is also seen by pellagra (see below).

B3 A deficit of niacin gives pellagra. This usually occurs by maize eating populations; such as parts of South Africa where they nearly only eat maize ('milies' in Afrikaans). Why pellagra occurs in a corn rich diet is unknown. The most prominent symptoms are skin infections, diarrhoea and dementia. Along with these are all sorts of neurological and physiological symptoms. The daily need can partly be covered by our own body.

B6 Pyridoxine deficiency does not occur easily in a normal diet. A number of medicines however can cause deficiency. This can lead to brain disorders and epileptic attacks. The vitamin we obtain from vegetables, grain, meat and liver.

B12 Cyanocobalamin is Folium acid; deficiencies before birth lead to the so-called open backs (spina bifida).

9. Vitamin C

Ascorbic acid that prevents scurvy (a = not, scorbut = scurvy). Well known from the travels to the East and the West in the seventeenth and eighteenth century. Skin and mucous membranes run down and become sensitive for infections. Teeth become loose and bleedings occur such as in kidneys and in skin. The remedy is: fresh vegetables and fruit. The possibility of the intake of fresh water, fruit and vegetables was the reason of the VOC to let Jan van Riebeeck set up the Cape colony in 1652. Nowadays there is a kind of vitamin C rage. Some believe (like the just died Nobel prize winner Linus Pauling) that infection diseases as the flu, but also other diseases, such as cancer can be prevented because of it.

10. Vitamin D

A vitamin that sits in fatty food, like cod liver oil. Humans can produce it themselves in skin under influence of sunlight. The Inuit (Greenland, Alaska) with their dark pigment skins are able to survive for long periods without sun because of their vitamin D rich diet. They watch out for poisoning (fat dissolving vitamin!). Without this diet they would have vanished by

rickets (‘English disease’), which gives aberrations of the pelvis, which can lead to disastrous births. Together with calcium this vitamin provides for a healthy bone structure.

11. Vitamin E

This vitamin sits in a number of foodstuffs. It is namely an anti-oxidant. All sorts of aging processes and formations of toxic metabolites are based on oxidation processes. Anti-oxidants such as vitamin E, selenium and sulphur containing amine acids prevent this. A deficit of the vitamin gives neurological aberrations. A too high doses of this fat dissolving vitamin (ADEK) leads to liver disorders of too early born children and to inclination of bleedings of patients who already use anti coagulation (because vitamin E and vitamin K hinders this).

12. Vitamin K

Green vegetables contain a lot of vitamin K. Intestine bacteria in the thick intestine produce this vitamin. It is essential in the liver for the production of prothrombin, a coagulation factor. A deficit can lead to bleedings. The decoagualation of people who are endangered by thrombosis is possible by administering vitamin K antagonists to these patients. Just born, who get breast-feeding, run a small risk of having a deficit of vitamin K. Every year several infants get a brain hemorrhage as a consequence of this deficiency, if there is no addition given of vitamin K.

13. Other compounds

To prevent rickets and other diseases the diet has to contain calcium (Ca). The bones will loss mass from little movement and weightlessness (astronauts). This gives a chance on fractures. Elderly people, especially women after the menopause, have a chance on osteoporosis and therefore on hip fractures. Diet has to be the solution. In serious cases hormone therapy can be applied (estrogens). Fluorine (F) is a mineral naturally occurring much in water. The concentration differs a lot. In America it was discovered that people with ‘mottled enamel’ (stained teeth) from fluorine in water, had little or no caries. This was the reason for fluoridation of drinking water in our country after a similar investigation in the towns of Tiel and Culemborg. After some time fluoridation of drinking water was forbidden by the law. Nowadays is the usage of fluorine ion toothpaste an important cause of the improvement of the teeth of the youth.

In higher doses (a number of hundred times more than our daily portion) fluorine is poisonous. In the eighteen-century many people from Iceland died from the drinking water poisoned by fluorine after the eruption of the volcano Hekla. Two villages in Ethiopia lie on lava fields. The population had such a high incidence of osteoporosis and bone fractures that they were evacuated.

Our cells maintain a gradient of sodium (Na) and potassium (K) in their membrane. Relatively high concentration of K^+ and low concentrations of Na^+ inside the cell in regard to the surrounding liquid. Conduction in neurons rests on a wave front of out flowing K – and inflowing Na-ions. The wave front of discharges flowing forward over a neuron can reach a velocity up to 20 meters per second.! Deficiencies of Na (hyposodiaemy) can occur through little salt in diet or through sweating a lot. Too low concentration of K (hypopotassiaemy) leads to heart disorders.

Other minerals also have to be present in a certain concentration, like sink, copper, cobalt, manganese, magnesium, and aluminimum. A deficiency (hypo-…emy) and a surplus (hyper-...-emy) lead to various diseases.

14. Cholesterol

The most well known “medical” molecule of the eighties and nineties. It looks like the corticosteroids and only partly comes from our food. Most of it is produced in the body from fatty acids. The compound is amongst other things needed for the formation of cell membranes. Epidemiologists have clearly proved that high cholesterol in serum is associated with a higher chance of cardiovascular diseases. This is valid for the lighter variant of the molecule, the heavier one on the contrary should work out in advantage. This is correlated with the formation of ‘plaques’ in the vascular wall, which degenerates to sclerotic patches (‘hardening of the arteries’). Unfortunately it is not clear of the reduction of a relatively high cholesterol proportion in serum is without risk at all. Everyone seems to have his own (variable) cholesterol proportion fluctuating around a certain number. This ‘belongs’ to that person, including the higher chance of the named disorders.