

PRESS KIT :

**Copper, a vital trace element to
keep you in optimum health**

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Copper: a Mineral Essential for Good Health

Copper is an essential – vitally important - trace element required for survival by all organisms. One of the most significant, and yet perhaps one of the least well-known benefits of copper is its role as an essential micronutrient, and the extremely important role it plays in helping to maintain good health from infancy through to old age. Copper plays an essential role in many body functions, ranging from protecting cells from oxidative damage, normal functioning of the brain/nervous system and the cardiovascular system to the transport of iron. It is also necessary for bone growth and strength, and our immune functions.

Copper and organism : how it work ?

Copper is incorporated into a large number of proteins for both catalytic and structural purposes. At least 20 enzymes have a functionality that is dependent on copper, although this is not always clearly known. These include:

- superoxide dismutase (SOD), an enzyme present in most human cells which protects the body from oxidative damage. Concentrations are high in brain, thyroid and liver tissue.
- lysyl oxidase, an enzyme involved in cross-linking mechanisms required for connective tissue stability. Reduced activity of this enzyme is linked to numerous structural abnormalities in many tissues including the bone and cardiovascular system.
- cytochrome c oxidase, an enzyme which catalyses the reduction of oxygen to water, an essential step in cellular respiration. Activity is highest in the heart and high in the brain and liver.

About Copper deficiency

The essentiality of copper has been recognised since 1928, but is best illustrated by Menkes disease, a very rare genetic disorder, which results in entrapment of copper in the cells of the intestine. The clinical features of Menkes include impaired mental development, abnormalities in connective tissue development (skin, bone and hair), general failure to thrive and early death in childhood. Indeed, this genetic disease points out the essentiality of copper for optimal development.

Further insights into the role of copper have come from investigating the effects of depletion and supplementation in animal models and humans. Such investigations

show that copper has a wide range of essential functions critical for normal physiological function and good health. These are reviewed below:

Copper as a protection against oxidative stress

Copper has an essential antioxidant role through superoxide dismutase combating oxidative stress by helping to neutralize free radicals that would otherwise cause severe cellular damage. Evidence that copper deficiency leads to increased lipid oxidation continues to accumulate from animal studies. Similarly, studies show that copper supplementation can increase the oxidative defences of people. Many of the consequences of copper deficiency are thought to be associated with increased oxidative stress.

The brain and central nervous system need copper

Copper appears to play multiple roles in the health of the central nervous system, particularly brain tissue. Copper is required for the formation and maintenance of myelin, the protective layer covering neurons. Copper-dependent enzymes are also necessary for the synthesis of neurotransmitters – the chemical messengers that allow communication between nerve cells.

Cardiovascular health facing to copper deficiency

A large body of evidence suggests that copper has essential structural and functional roles throughout the cardiovascular system.

Copper is important for the structural integrity of the heart and blood vessels. Cross-linking of arterial collagen and elastine require the copper-dependent enzyme lysyl oxidase. Among the many documented anatomical changes produced by copper deficiency are cardiac enlargement, arteries with smooth muscle degeneration and ventricular and coronary artery aneurysms (abnormal swelling of a portion of the blood vessel caused by weakness of the vessel wall).

Many functional aspects of the heart and circulation are adversely affected by copper deficiency. Men fed a diet low in copper experience cardiac arrhythmias – abnormal electrical rhythms. Copper also affects normal cholesterol metabolism: healthy adults fed a diet low in copper show increased levels of LDL cholesterol (the bad type) and reduced levels of HDL cholesterol (the good type). Low copper intake has also been shown to adversely affect glucose metabolism and blood pressure regulation. Copper is also needed for normal blood clotting. The clotting factors V and VIII depend on copper for normal function, and studies show that atrial thrombosis is more frequent in animals fed copper-deficient diets. Furthermore, patients who died from myocardial infarction (MI) have been shown to have significantly lower copper concentration in heart tissue than those who died of other causes. However, it is not known if the copper deficiency caused the MI or was the result of underlying heart disease.

Many of the undesirable changes observed in humans occur with diets containing close to 1 mg of copper per day in humans. This has led to suggestions that marginal copper deficiency may play a role in the development of cardiovascular disease.

Copper for Iron transport and against anaemia

Copper also promotes normal red blood cell formation. It helps convert iron to its ferric form – the most useful type – and also helps transport iron to and from tissues. Copper deficiency can result in anaemia and tissue iron overload. In fact, anaemia is one of the most common clinical manifestations of copper deficiency.

Copper's contribution to bone health

Copper also has an important role in the health of the skeleton, and through the action of lysyl oxidase, is essential for the formation of strong flexible connective tissue needed to give bone its strength. Bone abnormalities are associated with copper deficiency in low-birth-weight infants and in young children.

Higher copper blood levels have been linked with higher bone mineral density of the lumbar spine in a cross-sectional study in postmenopausal women¹ and decreased blood levels of copper have been observed in people with bone fractures.

Furthermore, one recent study shows that a dietary copper intake of 0.7 mg per day for just six weeks significantly increases the rate of bone resorption [an indicator of increased bone turnover] in healthy adult males aged between 20 and 59 years. This effect was reversed during a subsequent six-week period of copper supplementation (6.0 mg per day).²

Immune function

The immune system requires copper to perform a number of functions. Copper deficiency has a profound effect on certain white cell populations (neutrophils and macrophages); and neutropenia (a reduction in neutrophil count) may be a clinical sign of copper deficiency in humans. Immune function has been investigated in copper-deficient infants before and after copper supplementation. The phagocytic activity of certain white blood cells - their ability to engulf foreign material - increased after copper supplementation. Other research in healthy young men fed a diet of 0.66 mg copper per day highlighted a decrease in the proliferation of other immune cells (peripheral blood mononuclear cells) during this time. Copper deficiency has also been associated with an increased incidence of severe respiratory infections in infants.

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¹ Howard et al, Low serum copper a risk factor added to low diet calcium in postmenopausal bone loss, *J Trace Element Exp Med* 5: 23-31 1992.

² Baker A et al, Effect of copper intakes on biochemical markers of bone metabolism in healthy adult males, *Eur J Clin Nutr* 1999; 53: 408-412.

Copper in Adult Diets: Are We Getting Enough?

Copper is an essential nutrient required for the functioning of many enzymes in the body. This means the body demands regular intake of dietary copper in order to maintain health.

Normal copper requirements

National and international authorities have defined standards for copper intake at levels judged to be adequate for maintaining health. The EU population reference intake for copper is 1.1 mg/day.¹ The US National Academy of Sciences issued its first RDA for copper in 2001 recommending that adults consume 0.9 mg of copper every day, pregnant women 1.0 mg and nursing mothers 1.3 mg² NAS also established a Tolerable Upper Limit for copper of 10 mg/day.

Dietary sources of copper

The actual content of copper in foods varies widely depending on the food itself, growing conditions and the type of processing used. Generally, the richest dietary sources of copper include seafood (especially shellfish such as oysters and crab which concentrate copper from seawater by filter feeding), organ meats (such as liver), whole grains, nuts, raisins, and legumes (beans and lentils) and chocolate. Other food sources that contain copper include potatoes, peas, red meat, mushrooms, some dark green leafy vegetables (such as kale), and some fruits (such as coconuts, papaya, and apples). Tea, rice, and chicken are relatively low in copper but provide a reasonable amount of copper to the body because they are consumed in significant amounts.

Breakfast cereals are important sources of copper although they are rarely supplemented with this mineral, while iron and zinc fortification is very common. Since increased intake of these other nutrients can deplete necessary copper in the body, it is important to make sure that a balanced diet includes copper-rich foods. Corn flakes are the lowest in copper: as a general rule, copper in cereals seems to parallel the amount of crude fibre - high fibre tends to mean high copper, oats being a case in point. Dairy products are low in copper although the bioavailability in maternal milk is high for the young of its own species.

¹ Scientific Committee for Food. Nutrient and Energy Intakes for the European Community. Luxembourg: Office for Official Publications of the European Communities, 1993.

² Food and Nutrition Board Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium and Zinc. Washington, DC. National Academy Press; 2001: 7. 1-7.27.

Food	Mean copper content [mg/kg]¹
Beef	1.1
Lamb	1.6
Beef liver	39
Beef kidney	3.7
Apples	0.25
Bananas	0.95
Potatoes	0.96
Carrots	0.61
Lettuce	0.72
Cod	0.19
Flour	1.5
Cocoa powder	36.4
Cow's milk	0.06

Sources: Jorhem L Sundstrom B Levels of lead, cadmium, zinc, copper, nickel, chromium, manganese, and cobalt found in foods on the Swedish market 1983-1990, *J Food Compos Anal* 1993; 6: 223-241/ Lurie DG et al The copper content of foods based on a critical evaluation of published analytical data, *J Food Comp Anal* 1989; 2: 298-316.

Vitamin/mineral preparations, according to one recent survey, contribute only 3.6% of mean daily copper intake in women and 1.7% in men.

Absorption and distribution

Dietary copper is absorbed in the stomach and small intestine and distributed to copper-requiring proteins with apparently little storage of excess copper in the body. In general, the human gastrointestinal tract can absorb 30-40 % of ingested copper from the typical Western diet; the rest is excreted through faeces. However, absorption is more efficient when dietary intake is low. Excess of other minerals/ vitamins, most notably zinc, can affect copper absorption as it directly competes with copper for absorption. The liver is critical to maintain copper balance, ensuring it is available for incorporation into body proteins but that excess is excreted in the bile.

Copper and the Western diet

Surveys show that mean daily copper intakes of European adults are between 1.0 and 2.26 mg for men and between 0.9 and 1.1 mg for females. Most studies found intakes at the lower end of that range, indicating that diets in Western countries provide copper below or in the low range of the WHO recommended daily requirements.³

This suggests there may be a significant number of individuals with marginal copper intakes. Calculations based on surveys of 849 individual diets from Europe and North America, in which the copper content was measured by chemical analysis, indicated

³ Environmental Health Criteria 200. Copper. World Health Organization, Geneva, 1998.

that more than 30% of diets provide less than 1.0 mg of copper per day⁴. Indeed the recent report published by the World Health Organization recently said that based on available data on human exposure worldwide, but particularly in Europe and the Americas, there is a greater risk of health effects from deficiency of copper intake than excess.¹³

The failure of many diets to meet daily copper requirements reflects the fact that the richest sources of copper are not typically consumed in Western diets. Consequently, the copper provided by plant-based foods and dairy products contribute proportionately more to copper intake than would be expected considering their relatively low content and poor availability. Plant foods in general provide about 60% of the copper in Western diets. Several studies show that copper intake is higher in vegetarian and vegan diets.

Who is at risk of copper deficiency?

The nutritional concept of empty calories is far from new; few foods are as free of copper as fats and oils. Consequently, eating a diet that is rich in highly processed convenience and/or fast foods and low in plant foods puts individuals in danger of suboptimal copper intake. Processed grains, for example, contain less copper than whole grains because much copper is removed with the bran fraction and seed coat.

Other groups at high risk of copper deficiency include:

- Premature babies because foetuses bank copper during the latter months of pregnancy
- Infants recovering from malnutrition associated with chronic diarrhoea
- Pregnant and nursing women particularly if they avoid copper-rich foods
- Individuals with chronic digestive problems who may be unable to absorb sufficient amounts of copper
- Older adults with reduced dietary intake and compromised nutrient bioavailability resulting from the use of multiple medications and increased excretion
- People using excessive amounts of iron and zinc supplements

Increasing dietary intake of copper

Diets low in copper can be improved by appropriate food selection. As previously apparent, copper is available in a wide array of fresh and light-processed food. The principles of the food pyramid should be adhered to. The base of the pyramid is made up of cereals and potatoes and presents foods that should make up the bulk of the diet. Fruit, vegetables and berries which are rich in vitamins and minerals but low in energy make up the next layer and should be consumed daily. The second layer includes meat, fish and dairy products that provide essential nutrients. Ideally

⁴ Klevay LM et al, Copper in the western diet, in : Trace Elements in Man and Animals, 8ed, M. Anke, D. Meissner & CF Mills, pp.207-210, Gersdorf, Germany: Verlag Media Touristik.

fat-free or low fat varieties should be consumed. At the top of the pyramid are fat and sugar-containing foods, which contain lots of energy but little essential nutrients.

While lettuce is low in copper, the nutritional quality of lettuce salads can be enhanced by adding legumes such as garbanzo beans or mushrooms, nuts and seeds. A small portion of liver can change a diet from copper deficient to sufficient. A chocolate bar with nuts is a surprisingly effective means of increasing copper intake.

The role of supplements in the healthy population

All essential nutrients if taken in excess may pose a health risk. Copper supplements may be medically relevant for premature or low birth weight individuals and malnourished young children. They should also be considered for individuals who have illnesses that reduce digestion, elderly people who are unable to eat sufficient quantities of food and dieters/anorexics. Copper supplementation should always be administered under medical supervision and caution should be exercised not to exceed the recommended doses.

Typically multivitamin/multimineral supplements contain 2 mg of copper as copper oxide. Consumers should be aware that copper in the oxide form is not as well absorbed into the body as other copper salts, such as copper sulphate, so that a portion of the daily 2 mg supplement of copper oxide may not be effective.

It is important to recognise that taking large doses of zinc or iron can interfere with copper metabolism. High levels of zinc – an increasingly popular ingredient of cold remedies - block the absorption of copper by the body increasing the risk of copper deficiency. Large doses of iron can also affect copper balance. The US National Academy of Sciences suggests a ratio of approximately 30 mg of iron per day, 15 mg of zinc, and 2 mg of copper for proper balance.

Excess copper

The body has developed sophisticated regulatory mechanisms to maintain copper balance. While copper toxicity in humans is rare, it takes the form of stomach disturbances, nausea and diarrhoea.⁵

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⁵ Environmental Health Criteria 200. Copper. World Health Organization, Geneva 1998.

Mineral Supplement: the Winning Team

Copper, Iron and Zinc

With the cold and flu season, experts regularly advise consumers to supplement their diet with care. Leading nutritionists say not to forget copper as an essential element.

In recent years, zinc has become a popular ingredient of cold remedies as a result of its potential to boost immunity. Nevertheless, few people were aware that excess zinc inhibited the body's ability to absorb copper. Zinc and copper are both absorbed from the diet across the gastrointestinal tract by the same mechanism. So if you flood the body with zinc by using a high dose supplement, your absorption of copper will be lowered. The danger is that this may trigger a copper deficiency state, particularly if zinc supplements are used for prolonged periods of time.

Copper is essential to help the body process iron. Without adequate copper, iron cannot be properly converted into its usable form to transport oxygen, suggesting that many people who take iron supplements may not be getting the benefit they think they are if copper intake is not increased at the same time.

Check supplement labels carefully to ensure that if zinc or iron is included on a multivitamin and mineral supplement that copper is listed too. "The best approach, explained Carl Keen, Chairman, Department of Nutrition at the University of California at Davis, USA, is to think of the minerals Zinc, iron & copper as a trio – don't take one without the other."¹

And it is also important to pay close attention to the amount of supplements taken on a daily basis and keep in line with official recommended daily allowances. The specialist comments: "Anyone who may be taking minerals at a higher level should do so under the supervision of a doctor to ensure appropriate balance. For example the US National Academy of Sciences recently advised that if an iron supplement of more than 30 mg per day was taken, people should add approximately 15 mg of zinc and 2 mg of copper for proper balance.

¹ Communication in Stockholm, 16th October 2002, 'Copper and health Press Conference: What Copper Means for Your Health'.

Copper, a Vital Nutrient for Prenatal Development

Copper deficiency can adversely affect the normal course of pregnancy. Moreover, while the cause of most human developmental defects is still not clear, a significant number may be related to suboptimal nutrition. Deficits in many micronutrients including copper may be responsible. Consequently, the copper requirements of the pregnant mother, and her foetus, are an important area of ongoing research interest.

Copper requirements *in utero*

During pregnancy, the foetus is fully dependent on the maternal copper supply. The unborn baby accumulates copper at the rate of 0.05 mg/kg per day principally over the last trimester of pregnancy and by full term amasses close to 15 mg of copper. More than half of the copper – about 9 mg - is stored in the liver. These stores are used during early infancy when copper intake is low. The brain is the second site for copper accumulation during foetal life.

How copper affect prenatal development?

The essentiality of copper for prenatal development is well established. Last year, scientists at the University of Michigan Medical School, USA, reported that copper and a gene called *Ctr1*, which codes for a protein needed to help transport copper inside cells, are essential for normal embryonic development in mice. Mice who lack this gene exhibit profound growth and developmental defects and die in utero in mid-gestation.¹ Investigators suggested that it was likely that human embryos lacking both copies of the gene, which is nearly identical in mice and humans, are aborted spontaneously during pregnancy. In humans, the genetic condition called Menkes disease, which results in copper deficiency thought to be caused by a defect in another copper-transporting gene, profoundly influences prenatal development, and is typically fatal in early childhood.

Both these situations result in severe foetal copper deficiency. However, there are also considerable animal data to indicate that marginal copper deficiency in pregnancy is associated with birth defects and low birth weight. This was first recognised from studies of a disease in lambs called enzootic ataxia (also called swayback) characterised by spastic paralysis, severe unco-ordination and anaemia. The brains of affected animals are typically smaller and show many other abnormalities.² Similar developmental defects have been reported in numerous other species. It has also been recently shown that maternal nicotine exposure results in a reduction in copper content of the neonatal lung, and that copper supplementation during gestation and lactation prevented the adverse effects of nicotine on lung development in rats.

Nevertheless, there remains considerable debate on how and to what extent marginal copper deficiency may affect human prenatal development. Available evidence in the literature is conflicting. One study found that a low copper concentration in pregnant women during mid-gestation was a risk factor for foetal anencephaly or spontaneous

¹ Lee J. et al, Essentiality role for mammalian copper transporter *Ctr1* in copper homeostasis and embryonic development, *proc Natl Acad Sci*, 2001, 98(12): 6842-7.

² Keen CL et al, Effect of copper deficiency on prenatal development and pregnancy outcome, *Am J Clin Nutr*, 1998;67:1003S-1011S.

abortion. One Australian study showed no relationship of copper to birth defects but did show an effect with high concentrations of zinc. Another study found that mothers giving birth to low-birth-weight babies had higher plasma copper than did mothers of heavier babies, possibly an indication that the placental transport system had failed.

These conflicting findings have highlighted the need for further studies directed towards understanding the essential role of copper in pregnancy and to identify the effects of marginal copper deficiency during pregnancy. There are also calls to determine the outcome of modest copper supplementation in pregnancy in large population groups. Multinutrient supplements have been shown to reduce the frequency of birth defects and maternal complications as evidenced by studies showing that folic acid supplements routinely recommended during pregnancy in some countries can reduce the risk of neural tube defects such as spina bifida. This in itself underscores the possible benefits that can be obtained through improving the maternal diet.

Maternal diet during pregnancy

Copper sufficiency in the foetus is essential for normal growth and development, and women should be aware that pregnancy increases the body's need for copper. The recommended oral intake for pregnant women reflects this and is higher than for non-pregnant women. The necessary amounts can be provided by a balanced healthy diet as normally advised during pregnancy. Indeed reviews of dietary intake in pregnancy found copper intakes ranging between 1.39 and 2.8 mg per day.

Nevertheless, it is likely that a considerable number of women may be receiving sub-optimal copper nutrition and this may contribute to pregnancy complications.

It is also particularly important that pregnant women are aware that dietary interactions with other nutrients including trace minerals, such as iron and zinc, may affect copper availability. Zinc supplementation is common and may cause copper deficiency. A study in 2000³ found that treating anaemic women in the third trimester of pregnancy with iron supplements decreases copper absorption in foetuses, causing copper deficiencies that could potentially adversely affect the health of newborn children. These results heighten sensitivities regarding the need for proper nourishment in pregnant women, and demonstrate the need for integrative nutrient management ideally supervised by a medical professional. In particular, copper levels should always be monitored in patients when iron supplements are prescribed by physicians.

On the basis of existing evidence, researchers at the Rowett Research Institute in Scotland recently concluded that it was critical to convince legislators that copper deficiency is a much more serious problem than copper overload in most human diets including the diet of pregnant women and their offspring.⁴

Ongoing research

A unique partnership between the Rowett Research Institute, based in Aberdeen, and the University of California, Davis, USA, is examining further the role and importance of copper in the normal development of babies during pregnancy. The International Copper Association is funding this project, which is just one of several being undertaken at the Institute to investigate the links between maternal nutrition and foetal growth and development.

³ Copper Metabolism and Requirements in the Pregnant Mother, Her Fetus and Children A critical review *International Copper Association* 2001.

⁴ Copper Metabolism and Requirements in the Pregnant Mother, Her Fetus and Children A critical review *International Copper Association*, 2001.

Copper and Infant Health

Copper is an essential part of any diet and plays a key role in many biological processes in the body. It is particularly important during periods of intense growth and development.

Copper intake postnatally

The copper requirements of newborn babies are met by the copper that is available in milk. Breast milk is the best source of copper needed to complement the baby's internal stores after birth. The mean concentration of copper in breast milk is 0.32 mg per litre. Breast-fed infants usually consume about 300 to 400 ml milk per day during the first few weeks, rapidly increasing to 700-880 ml. Although copper concentration of breast milk is low compared with fortified infant formulas – copper absorption is much higher due to its higher bioavailability, allowing better absorption.

As a result of the recognition of the important role that copper plays in growth and development, most infant formulas today have a copper content of 0.4 to 0.6 mg per litre. Formulas for premature infants are more generously fortified with copper and may contain 1- 2 mg of copper per litre. These are usually intended for premature infants during their rapid catch-up growth phase. However, the final content of all infant formulas can vary because most are supplied in powder form to be reconstituted with household water. As a cautious protective measure, it has been recommended that in making up formula feeds that use of first draw water should be avoided, and if the copper content of the local water supply exceeds 1 mg/l, either a low copper formula or bottled water should be used.¹

Despite the availability of copper in milk, the concentration of copper in the infant liver drops steadily probably because the copper supply from the diet rarely meets the requirements for rapid growth typical of this stage.

Cow's milk is very low in copper and has a low bioavailability, which means early weaning to cow's milk can lead to copper deficiency in infants. Weaning foods, like easily digestible vegetable preparations, tend to contain more copper than the milk-based diets of early life. Most of the higher intakes are from vegetarian diets.

¹ Copper Metabolism and Requirements in the Pregnant Mother, Her Fetus and Children A critical review *International Copper Association* 2001.

Copper deficiency: which are babies at risk?

Full-term infants are generally believed to possess adequate copper stores to last through weaning regardless of their dietary intake. However, a recent review article² suggested that this might not be generally true as a combination of low copper intake and low bioavailability may lead to copper deficiency.

Nevertheless, it is clear that copper deficiency is more frequent in preterm infants especially those with low birth weights. Premature birth reduces the time that the foetus has to accumulate copper in its liver. At the same time, the requirements of such babies are higher due to their high growth rate compared with full-term infants. Preterm infants are born with serum copper concentration somewhat lower than in full-term infants. Serum levels also tend to remain low for up to four to six months after birth. Copper deficiency is rare in breast-fed infants.

Other factors that are frequently associated with copper deficiency in infants include low birth weight, short duration of breast feeding, cow milk consumption, consumption of highly refined carbohydrate-based diets, increased losses of nutrients as a result of diarrhoeal disease and frequent infections. The literature shows that of these the most common cause of copper deficiency is an insufficient copper supply during the nutritional recovery of malnourished children. It is therefore important that infants who are recovering from malnutrition associated with chronic diarrhoea should avoid a diet primarily of cow's milk because of its very low copper levels.

The interaction between iron and copper may also be a concern in pediatric nutrition. Iron fortification and supplementation is common for infants and children, whereas copper intake may be low. However without adequate copper, iron cannot be properly converted into its usable form and absorbed by the body.

The consequences of copper deficiency

In humans, most of the reports of clinically evident copper deficiency concern young children particularly those with low birth weight. The characteristic feature of copper deficiency in infants is anaemia that does not respond to iron supplementation. Bone abnormalities are also common, including osteoporosis and other bone lesions. Copper deficiency is also associated with impaired weight gain in infants recovering from malnutrition and infants with low copper who receive supplements showed significant catch up for weight, although not length. Neutropenia (reduction in neutrophil white blood cell count, weakening the immune system) is common and copper deficiency is associated with an increased incidence of infection. Neurological damage, however, is evident only after prolonged and severe deficiency. No studies

² Lonnerdal B Copper nutrition during infancy and childhood *Am J Clin Nutr* 1998; 67: 1046S-53S.

regarding the effects of postnatal acquired copper deficiency on psychomotor development in humans have been published. Our knowledge of the effects of marginal deficiency is small but growing rapidly.

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Copper and Its Therapeutic Potential in Postmenopausal Osteoporosis

Copper may have an important therapeutic role in helping to reduce the development and progression of postmenopausal osteoporosis.

About osteoporosis

Osteoporosis is a disease of the bone characterised by a decrease in bone density and associated with a high risk of fracture. Every 30 seconds, someone in the European Union has a fracture as a result of osteoporosis according to the International Osteoporosis Foundation, who also says that 20% of women over 50 and 13% of men will experience an osteoporotic fracture of the spine, hip or wrist in their life-time. Although incurable, treatments aim to reduce further bone loss and /or stimulate bone formation.

In men and women more than 10 years past the menopause, nutrition seems to play a key role in rates of bone loss. The most important nutrient identified to date is calcium, which is often given as a supplement administered with vitamin D. However, it is well established that copper has an important role in the metabolism of the skeleton and there is increasing evidence linking marginal copper deficiency with osteoporosis.

Copper may help to avoid postmenopausal osteoporosis

Observational studies show that serum copper levels in elderly people with bone fractures are significantly lower than those of age-matched controls. Postmenopausal women whose diets had a high copper intake had significantly greater bone mineral densities than those with a low dietary intake even when both groups' calcium intake was similar. Moreover, a low dietary intake of copper over a period of six weeks significantly increased the rate of bone resorption – an early indicator of increased bone turnover - in healthy adult males aged between 20 and 59 years.¹

Several studies support the idea that increased copper intakes may reduce the rate of postmenopausal osteoporosis. For example, one study showed that copper supplementation with an additional 3 mg per day for two years in women aged between 45 and 56 years reduced loss of bone mineral density at the lumbar spine. The usual dietary intake of these women was about 1 mg a day. Another study revealed that a mixture of trace minerals including copper, manganese and zinc given alongside calcium for two years increased bone mineral density by 1.48 % compared to a loss of 1.25 % in a group given calcium alone and a loss of 3.53% in women given placebo.

Such findings raise important questions about the possible therapeutic role of copper for osteoporosis. The role of copper may be particularly important because calcium supplementation alone may accentuate the problem of reduced copper levels by impairing the retention of copper by the body.

¹ Baker A et al, Effect of dietary copper intake on biochemical markers of bone metabolism in healthy adult males, Eur J Clin Nutr, 1999 ;53:408-412.

About the European Copper Institute

The European Copper Institute is a joint venture between the world's mining companies (represented by the International Copper Association, Ltd) and the leading European fabricators. Its mission is to promote copper's benefits to modern society across Europe, through its Brussels office and a network of 11 Copper Development Associations.

ECI is active in 4 key areas in Europe:

- Health
- Electric & Electronics
- Building Construction & Automotive
- Environment

The ECI Health Programme

ECI's health programme is primarily directed at understanding any potential effects on humans. Results are used to improve human health by contributing to regulatory initiatives both at EU and at world level.

The ECI Electric & Electronics Programme

- 1) Energy efficiency, with the target of saving 50 TWh/yr, equivalent to 20 million tonnes of CO² each year.
- 2) Power quality: an ECI & Leonardo adult education programme involving leading academia, industry and vocational institutes, aimed at reducing electrical disturbances, with the target of saving 10 billion euro/year for European business.
- 3) Safety & functionality: a steady programme of housing renovation to improve domestic electrical safety standards in Europe.

The ECI Building Construction & Automotive Programme

Renewable energies: a programme to communicate copper's superior electrical conductivity as a key player in harnessing solar and wind energy.

Automotive sector: a programme to communicate copper's role in improving the safety and convenience of modern cars and in making possible the future electric car.

Piping systems: a promotion and research programme to communicate copper's durability and natural antibacterial properties in providing safety and hygiene in drinking water, heating and gas distribution systems.

The ECI Environmental Programme

ECI's environmental programme is primarily directed at understanding any potential impacts in soil and water. Results are used to contribute to regulatory debates both at the EU and at national level. All research is carried out with the support of prominent scientists.

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Copper-Rich Recipes

Peanut Butter and Banana Cookies

Preparation time: 10 minutes

Cooking time: 10-15 minutes

Makes about 28

125g butter, softened
150g caster sugar
1 egg, beaten
1 level tsp baking powder
125g crunchy peanut butter
150g plain white flour
100g dried banana chunks, roughly chopped
28 raw shelled peanuts

1. Place all the ingredients except the banana into a food processor and process until well blended. Stir in the banana.
2. Roll the dough into balls around the size of a walnut and place on lightly greased baking sheets, allowing enough space for the mixture to spread as it bakes. Using the palm of your hand flatten the mixture slightly.
3. Press a whole peanut into the middle of each cookie and bake at 190°C/375°F/gas Mark 5 for 10-15 minutes or until just beginning to brown around the edges.
4. Allow to cool slightly, then using a palette knife, transfer to a wire rack to cool completely.

**Per biscuit: 126 calorie, 8g fat (of which 3g saturated fat), 0.5g fibre
0.05mg copper**

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3 Seed Flapjacks

Preparation time: 10min

Cooking time: 25-30min

Makes 15 small squares

250g unsalted butter
250g light brown soft sugar
4 level tbsp golden syrup
425g porridge oats
75g pumpkin seeds
75g sunflower seeds
50g sesame seeds

1. Lightly grease a 20 x 28cm baking tin. Melt the butter, sugar and syrup in a heavy based saucepan until dissolved.
2. Remove from the heat, add the remaining ingredients and mix well.
3. Spoon the mixture into the prepared tin, level the surface and bake in the oven at 180°C/350°F/Gas Mark 4 for 25-30 minutes or until golden brown. The mixture will still be very soft in the centre.
4. Leave to cool in the tin for 10 min, then cut into 15 squares. When cold, transfer to an airtight container. Don't try to remove the bars from the tin while they are still warm because they will break.

Per flapjack: 390 calorie, 22g fat (of which 10g saturated fat), 3g fibre, 0.3mg copper

-3-

Tomato and Pesto Tarts

Preparation time: 10mins

Cooking time: 10-15min

Serves 4

375g packet ready made puff pastry
a little beaten egg
4 heaped tsp green fresh pesto
20 cherry tomatoes, halved
Salt and freshly ground black pepper
4 heaped tsp pine nuts, lightly toasted
Fresh rocket to serve

1. Heat the oven to 200°C/400°F/gas mark 6.
2. Roll out the pastry and cut into four circles, 10cm in diameter (a standard saucer is usually a good size). With the point of a sharp knife, mark another circle to make border of 1 cm, brush the border with beaten egg. Put them onto a baking tray and prick the centre of each one with a fork.
3. Spread the middle with the pesto. Arrange the tomatoes over the pastry, cut side down and season with salt and freshly ground pepper. Scatter over the pine nuts.
4. Transfer to the oven and bake for 10-15 minutes. Serve with a fresh rocket salad.

**Per tart: 570 calorie, 40g fat (of which 1g saturated fat), 1g fibre,
0.4mg copper**

-4-

Mushroom Risotto

Preparation time: 10min

Cooking time: 30-35min

Serves 4

25g packet dried mushrooms
50g butter
1 onion, finely chopped
1 clove garlic, peeled and finely chopped
400g exotic mushrooms, roughly chopped
300g arborio (risotto) rice
2 tbsp olive oil
1.2 litre vegetable stock
Salt and freshly ground black pepper
50g grated Parmesan cheese
juice and zest of ½ a lemon
shavings of fresh Parmesan and, to garnish

1. Put the dried mushrooms in a small bowl and pour over 150ml boiling water and leave to rehydrate for at least 20 minutes. Drain well.
2. Heat the butter in a large heavy based saucepan. Add the onion and cook for 5 minutes.
3. Heat the vegetable stock in a separate pan. Add the fresh and dried mushrooms to the pan with the onion and stir fry for 2-3minutes. Add the rice and seasoning and continue to cook, stirring, for 1-2 mins.
4. Add just enough stock to cover the rice and continue to cook, stirring continually, until most of the stock has been absorbed. Continue adding the stock in this way until it is almost completely absorbed and the rice is tender.
5. Remove from the heat and stir in the Parmesan cheese, lemon juice and zest. Garnish with shavings of fresh Parmesan and serve immediately.

Per serving: 430 calorie, 12g fat (of which 6g saturated fat), 1.5g fibre, 0.8mg copper

-5-

Almond and Chocolate Torte

Preparation time: 20 min

Cooking time: 60-70 min

Serves 10-12

200g 70% cocoa solid dark chocolate
2 tsp instant coffee granules
200g caster sugar
200g unsalted butter, softened
4 eggs, separated
200g ground almonds
100g cornflour, sieved
icing sugar for dusting
crème fraiche and fresh raspberries, to serve

1. Lightly grease a 23cm (9in) loose bottomed shallow cake tin. Line the base with greaseproof paper. Preheat the oven to 180°C/350°F/gas mark 4
2. Put the coffee granules into a medium heatproof bowl add a tablespoon of boiling water and stir to dissolve. Break the chocolate into the bowl and place over a pan of simmering water to melt
3. Cream the butter and sugar until pale and fluffy. Beat in the eggs yolks, one at a time. Stir in the chocolate, almonds and cornflour.
4. In a large clean bowl whisk the egg whites until they make soft peaks. Fold in a quarter of the whisked egg whites into the chocolate mixture to loosen it, then carefully fold in the remainder. Pour into the prepared tin and bake for 60-70 minutes or until it springs back when touched. Cover with greaseproof paper or foil after 40 minutes.
5. Allow the cake to cool completely before carefully removing from the tin.
6. To serve cut the cake into wedges, dust with a little icing sugar and serve with crème fraiche and a few fresh raspberries.

Per serving: 525 calorie, 36g fat (of which 16g saturated fat), 1.5g fibre, 0.4mg copper

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Seared Scallops with Minted Pea Purée

Preparation time: 10mins

Cooking time: 10mins

Serves 4

25g butter
2 shallots or ½ small onion, finely chopped
300g fresh or frozen peas
8 leaves fresh mint
150mls crème fraîche
Salt and freshly ground black pepper
20 large shelled scallops
1 tbsp olive oil
a little extra virgin olive oil, to drizzle
fresh mint, to garnish

1. Melt the butter in small pan and cook the shallots over a medium heat for 5 mins or until soft.
2. Place the peas and 2 mint leaves in a large pan of boiling salted water and cook for 5 mins or very tender. Drain well then transfer to a blender or food processor, along with the remaining mint, shallots, crème fraîche and seasoning to taste. Blend to make a coarse purée. Return to a clean pan and gently reheat.
3. Brush the scallops with a little olive oil and place on a hot griddle and sear for 2 minutes each side or until browned and cooked through.
4. To serve, spoon the purée onto the middle of a large white plate, arrange 5 scallops, around the edge of the plate. Garnish with fresh mint sprigs and a grinding of black pepper.

Per serving: 395 calorie, 23g fat (of which 4g saturated fat), 4g fibre, 0.3mg copper

-7-

Prawns with Griddled Courgettes and a Lemon Dressing

Preparation time: 15 min

Cooking time: 10min

Serves 4

7 tbsp olive oil
6 large courgettes, thinly sliced lengthways
Salt and freshly ground black pepper
1 clove of garlic, peeled
Zest and juice of small 1 lemon, scrubbed
2 spring onions, roughly chopped
450g cooked and peeled King prawns

1. Place the courgettes in a large bowl, drizzle over 2 tbsp of olive oil, add seasoning to taste and mix well (the easiest way to do this is using your hands).
2. Cook the courgettes in batches on a hot griddle pan, for 2-3 minutes each side or until just tender.
3. Place the garlic, spring onions, lemon flesh and remaining oil in a blender or food processor and process until smooth.
4. Heat a wok or large frying pan, add the prawns and lemon dressing and stir fry for 1-2 minutes.
5. Arrange the courgettes in a small pile on a serving plate and top with the prawns. Garnish with lemon zest.

Per serving: 334 calorie, 22g fat (of which 3g saturated fat), 1g fibre, 0.9mg copper