

podle množství:

majoritní prvky (makroelementy)

> 100 mg/kg (ppm) = 0.01 %

Na, K, Mg, Ca, Cl, P, S

minoritní prvky

10 – 100 mg/kg

Fe, Zn

stopové prvky (mikroelementy)

< 10 mg/kg

Al, As, B, Cd, Co, Cr, Cu, F,
Hg, I, Mn, Mo, Ni, Pb, Se, Sn

ultrastopové prvky < 1 µg/kg (ppb)

| Prvek | Celkové množství | Jednotka |
|-------|------------------|----------|
| Ca | 1000-1500 | g |
| Mg | 25-40 | g |
| K | 140-180 | g |
| Na | 70-100 | g |
| P | 420-840 | g |
| S | cca 140 | g |
| Cl | 70-110 | g |
| Fe | 3-5 | g |
| Zn | 1,4-3 | g |
| F | 0,8-2,5 | g |
| Si | 1,4 | g |
| Cu | 100-180 | mg |
| Mn | 10-20 | mg |
| Mo | 5-10 | mg |
| Co | 1-1,5 | mg |
| Ni | 10 | mg |
| Cr | 5 | mg |
| V | < 1-20 | mg |
| I | 10-30 | mg |
| Se | 10-20 | mg |

podle **fyziologického** hlediska:

esenciální prvky

Na, K, Mg, Ca, P, S, Fe, Zn, Mn, Cu,
Ni, Co, Mo, Cr, Se, I, F, B, Si

neesenciální prvky (indiferentní)

Li, Rb, Cs, Ti, Au, Sn, Bi, Te, Br, Al

toxické prvky

As, Cd, Hg, Pb

A Bacterium That Can Grow by Using Arsenic Instead of Phosphorus

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Life is mostly composed of the elements carbon, hydrogen, nitrogen, oxygen, sulfur, and phosphorus. Although these six elements make up nucleic acids, proteins, and lipids and thus the bulk of living matter, it is theoretically possible that some other elements in the periodic table could serve the same functions. Here, we describe a bacterium, strain GFAJ-1 of the Halomonadaceae, isolated from Mono Lake, California, that is able to substitute arsenic for phosphorus to sustain its growth. Our data show evidence for arsenate in macromolecules that normally contain phosphate, most notably nucleic acids and proteins. Exchange of one of the major bio-elements may have profound evolutionary and geochemical importance.

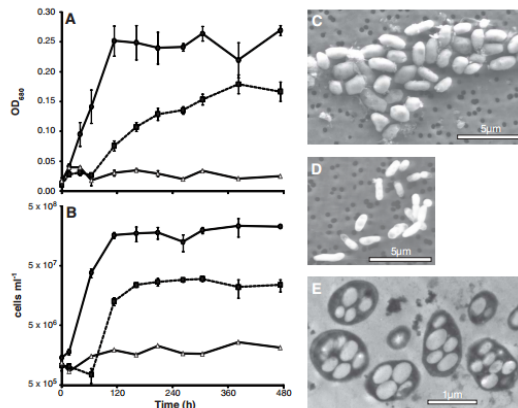
Biological dependence on the six major nutrient elements carbon, hydrogen, nitrogen, oxygen, sulfur, and phosphorus (P) is complemented by a selected array of other elements, usually metals or metalloids present in trace quantities that serve critical cellular functions, such as enzyme co-factors (1). There are many cases of these trace elements substituting for one another. A few examples include the substitution of tungsten for molybdenum and cadmium for zinc in some enzyme families (2, 3) and copper for iron as an oxygen-carrier in some arthropods and mollusks (4). In these examples and others, the trace elements that interchange share chemical similarities that facilitate the swap. However, there are no prior reports of substitutions for any of the six major elements essential for life. Here, we present evidence that arsenic can substitute for phosphorus in the biomolecules of a naturally occurring bacterium.

Arsenic (As) is a chemical analog of P, which lies directly below P on the periodic table. Arsenic possesses a similar atomic radius, as well as near identical electronegativity to P (5). The most common form of P in biology is phosphate (PO_4^{3-}), which behaves similarly to arsenate (AsO_4^{3-}) over the range of biologically relevant pH and redox gradients (6). The physicochemical similarity between AsO_4^{3-} and PO_4^{3-} contributes to the biological toxicity of AsO_4^{3-} because metabolic pathways intended for PO_4^{3-} cannot distinguish between the two molecules (7) and AsO_4^{3-} may

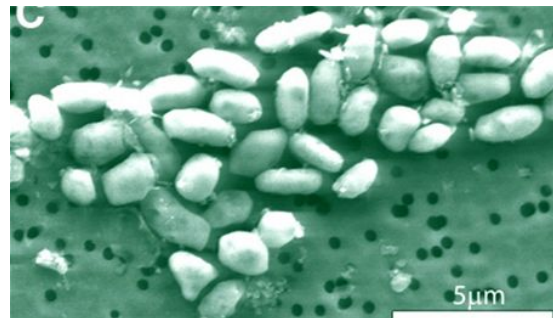
be incorporated into some early steps in the pathways [(6) and references therein]. However, it is thought that downstream metabolic processes are generally not compatible with As-incorporating molecules because of differences in the reactivities of P and As compounds (8). These down-

stream biochemical pathways may require the more chemically stable P-based metabolites; the lifetimes of more easily hydrolyzed As-bearing analogs are thought to be too short. However, given the similarities of As and P—and by analogy with trace element substitutions—we hypothesized that AsO_4^{3-} could specifically substitute for PO_4^{3-} in an organism possessing mechanisms to cope with the inherent instability of AsO_4^{3-} compounds (6). Here, we experimentally tested this hypothesis by using AsO_4^{3-} , combined with no added PO_4^{3-} , to select for and isolate a microbe capable of accomplishing this substitution.

Geomicrobiology of GFAJ-1. Mono Lake, located in eastern California, is a hypersaline and alkaline water body with high dissolved arsenic concentrations [200 μM on average (9)]. We used lake sediments as inocula into an aerobic defined artificial medium at pH 9.8 (10, 11) containing 10 mM glucose, vitamins, and trace metals but no added PO_4^{3-} or any additional complex organic supplements (such as yeast extract or peptone), with a regimen of increasing AsO_4^{3-} additions initially spanning the range from 100 μM to 5 mM. These enrichments were taken through many decimal-dilution transfers, greatly reducing any potential carryover of autochthonous phosphorus

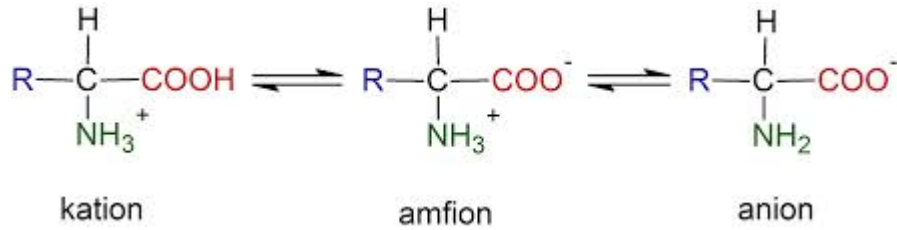


Mono Lake, Kalifornie

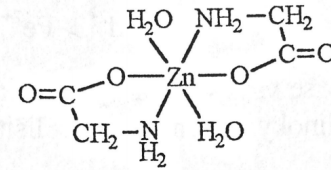
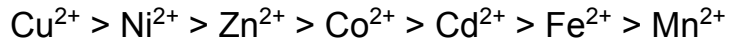


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DOI: 10.1126/science.1197258

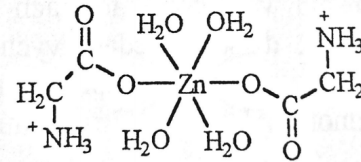
amfoterní charakter AMK:



pokles stability komplexu s AMK:



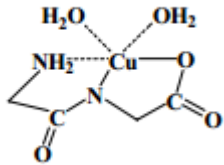
pH 7: diaqua-bis(glycinato)zinečnatý komplex



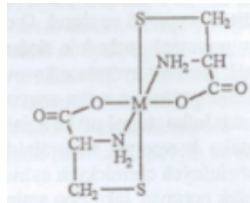
pH 1: tetrahydrát zinečnaté soli glycinu

komplexy kovů s peptidy

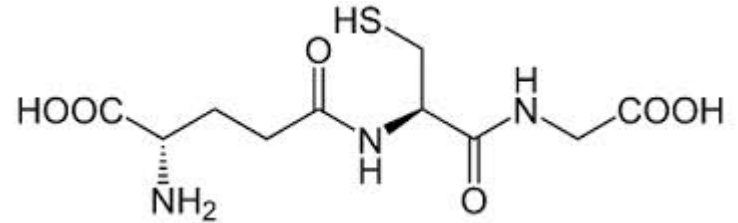
komplex dipeptid-Cu²⁺
Cu(Gly-Gly)₂.H₂O



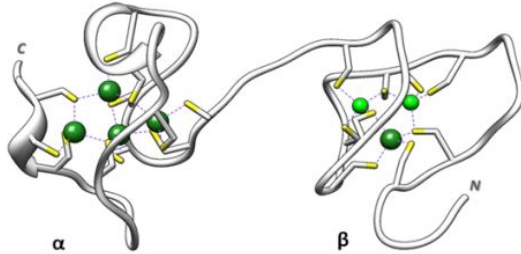
komplex kovu s cysteinem



glutathion (+odvozené fytochelatiny)

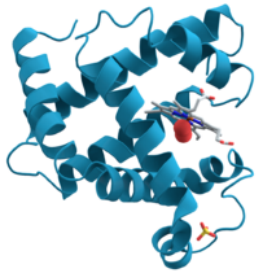


metallothioneiny



metallothionein, domény α a β

komplexy kovů s bílkovinami, metaloproteiny

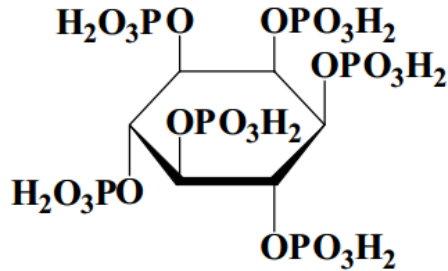


metaloprotein myoglobin
charakteristická vazba kovu

| Prvek | Metaloprotein | Výskyt |
|-----------------|-----------------------|------------------------|
| Ca | kalmodulin | sval |
| | parvalbumin | sval |
| | troponin C | sval |
| Fe | myoglobin | sval |
| | hemoglobin | erythrocyty |
| | cytochromy, katalasy, | všeobecné |
| | peroxidasy | rozšíření |
| | transferrin | krev, játra |
| | ferritin | slezina |
| | laktoferrin | mléko |
| Cu | ferredoxiny | např. špenát |
| | plantakyanin | špenát |
| | ceruloplasmin | krevní plasma |
| | cerebrokuperin | mozek |
| Mo | hemokuperin | krev |
| | xanthinoxidasa | játra |
| Fe (Cu, Zn, Mn) | konalbumin | vaječný bílek |
| Ni | niklplasmin | krevní plasma |
| | ureasa | sója, rýže |
| Mn | pyruvátkarboxylasa | všeobecné rozšíření |

Polyhydroxysloučeniny

- komplexy s kovy tvoří neochotně



kyselina **fytová**

komplexuje kovy, např. Ca, Mg, Fe, Zn
fytin: vápenato-hořečnatý komplex
snižuje jejich dostupnost

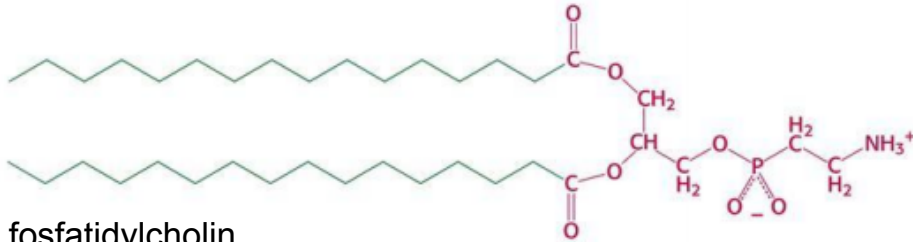
stabilita při pH 7:

$\text{Cu} > \text{Zn} > \text{Ni} > \text{Co} > \text{Mn} > \text{Fe} > \text{Ca}$

→ [GMO rostliny](#) se sníženým obsahem fytové

nepolární **lipidy** - minimální interakce

polární fosfolipidy → soli



fosfatidylcholin

organokovové sloučeniny

Hg, As, Sb, Se, Pb, Cd, Sn, ...

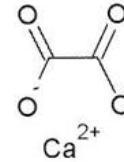
významné: methylrtuť MeHg^+ , tetramethylolovo $\text{Pb}(\text{CH}_3)_4$

organické kyseliny

tvoří soli

šřavelan vápenatý

nerozp.



citronová kys.

1/ vyvázání Fe z fytové v cereáliích,

2/ $\text{Fe}^{3+} + \text{kys. citronová} \rightarrow \text{Fe}^{2+}$

(prooxidační působení)

Popel

= podíl potravin nespalitelný
při předepsané teplotě

vážkové stanovení popela:

v žíhací misce (Pt, keramika) 550 °C,
do konst. hmotnosti (až několik hodin)

možný přídavek: AlCl_3 (snížení ztrát těkáním)

**Písek**

= popel nerozpustný v 10 % HCl

vážkové stanovení písku:

popel v smíchán s 10 % HCl,
filtrace, znovu žíhání 550 °C

typický obsah popela:

| | |
|----------------|-----------|
| obiloviny | 0.6–2.5 % |
| mléčné výrobky | 0.7–2.1 % |
| ovoce | 0.3–1.8 % |
| maso | 0.9–2.5 % |

mineralizace (rozklad)

způsob pro kvantitativní zachování stanovované látky

a/ mineralizace suchou cestou

- zpopelnění
- rozpuštění popela v 10 % HCl
- zbytek znovu zpopelněn, promyt 10 % HCl
- roztoky filtrátů smíchány → mineralizát

b/ mineralizace mokrou cestou

- mnoho způsobů pomocí různých minerálních kyselin: HNO_3 , HCl, H_2SO_4 , peroxid
- možno podpořit:
zvýšená teplota, tlak, ultrazvuk, mikrovlnný rozklad
- probíhá až do vyčerení roztoku → mineralizát



Norma připouští rozklad pomocí
směsí $\text{HNO}_3 + \text{H}_2\text{SO}_4$
 $\text{HNO}_3 + \text{H}_2\text{SO}_4 + \text{H}_2\text{O}_2$
 $\text{HNO}_3 + \text{H}_2\text{SO}_4 + \text{HClO}_4$

výbojka:

dutokatodová výbojka
ze stejného prvku který se

plamen:

vzduch-C₂H₂ (acetylen): 2100 °C
N₂O-acetylen: 2700 °C

hořák:

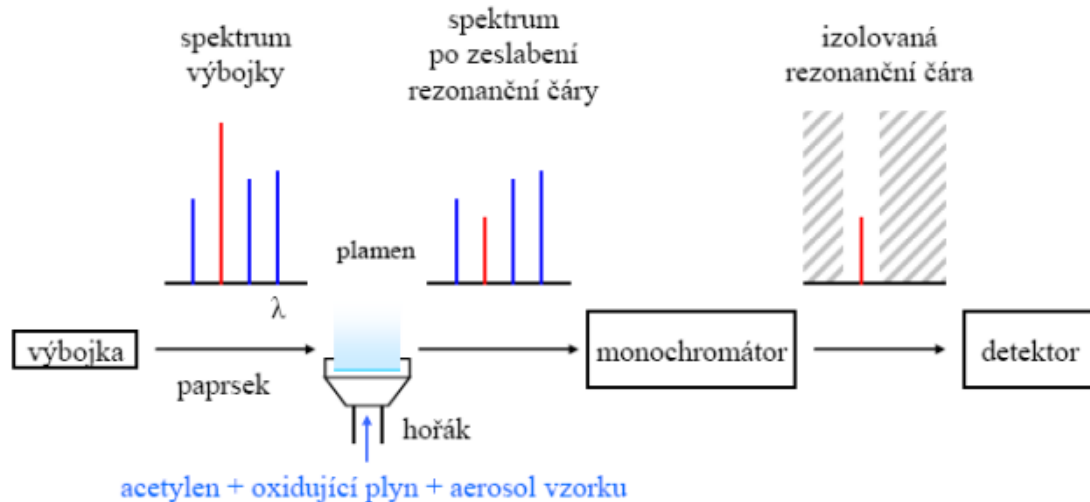
přívod zmlženého roztoku vzorku
→ atomizace
10 cm optická délka

monochromátor:

odraz na mřížce
vymezení měřené vlnové délky

detektor:

vzduch-C₂H₂ (acetylen): 2100 °C
N₂O-acetylen: 2700 °C





| Prvek | Plamen | λ (nm) | Charakteristická koncentrace ($\mu\text{g/ml}$) | Optimální pracovní rozsah ($\mu\text{g/ml}$) |
|-------|---|-------------------|---|--|
| Na | vzduch- C_2H_2 | 589,0 | 0,004 | 0,05-0,7 |
| Mg | vzduch- C_2H_2 | 285,2 | 0,003 | 0,05-0,4 |
| Al | $\text{N}_2\text{O}-\text{C}_2\text{H}_2$ | 309,3 | 0,6 | 5-100 |
| Fe | vzduch- C_2H_2 | 248,3 | 0,05 | 0,2-8 |
| Cu | vzduch- C_2H_2 | 324,7 | 0,025 | 0,1-5 |
| Zn | vzduch- C_2H_2 | 213,9 | 0,008 | 0,1-1,4 |
| Pb | vzduch- C_2H_2 | 217,0 | 0,08 | 2-20 |

Na, K, Cl

Funkce

Na+K: osmotický tlak, acidobazická rovnováha, aktivace enzymů

K: svalová a nervová aktivita

Cl: osmotický tlak, trávení

obsah draslíku /100g (CZFCDB.cz)

| Název potraviny | Hodnota |
|--|---------|
| Hřib smrkový, sušený | 2969 mg |
| Sója extrudovaná, Sojavita | 2353 mg |
| Koření, paprika | 2344 mg |
| Prášek kakaový | 1955 mg |
| Mouka sójová, odtučněná | 1870 mg |
| Sója | 1607 mg |
| Mléko sušené, odstředěné | 1570 mg |
| Koření, majoránka, sušená | 1546 mg |
| Mléko sušené, nízkotučné | 1504 mg |
| Melasa | 1464 mg |

obsah sodíku /100g (CZFCDB.cz)

| Název potraviny | Hodnota |
|---|----------|
| Sůl jedlá | 38850 mg |
| Omáčka sójová | 5900 mg |
| Sýr, Akawi, 40 % t. v s. | 2638 mg |
| Olivy zelené, marinované | 2400 mg |
| Sýr, Jadel, 40 % t. v s. | 2296 mg |
| Sýr, Olomoucké tvarůžky | 1918 mg |
| Sýr, Niva, 50 % t. v s. | 1833 mg |
| Sýr, balkánský, 50 % t. v s. | 1764 mg |
| Maso vepřové, krkovice bez kosti, uzená, syrová | 1380 mg |



Ca
+
Mg

obsah **vápníku** /100g (CZFCDB.cz)

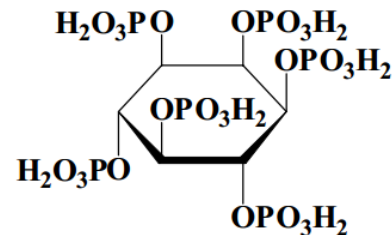
| Název potraviny | Hodnota |
|--|---------|
| Koření, tymián, sušený | 1890 mg |
| Koření, skořice, mletá | 1437 mg |
| Mléko sušené, odstředěné | 1421 mg |
| Koření, majoránka, sušená | 1388 mg |
| Mléko sušené, nízkotučné | 1361 mg |
| Mák | 1357 mg |
| Mléko sušené, polotučné | 1226 mg |
| Mléko sušené, plnotučné | 1073 mg |
| Sýr, Tylžský, 50 % t. v s. | 970 mg |
| Sýr, Eidam, 30 % t. v s. | 952 mg |
| Sýr, Eidam uzený, 40 % t. v s. | 874 mg |
| Sýr, Eidam, 50 %, t. v s. | 773 mg |
| Sýr, tavený, nízkoenenergetický, Lipno, 30 % t. v s. | 750 mg |
| Koření, hřebíček | 730 mg |
| Koření, kmín | 689 mg |
| Sýr, Romadur, 40 % t. v s. | 683 mg |
| Koření nové | 660 mg |
| Sýr ovčí, Brynza | 644 mg |

obsah **hořčíku** /100g (CZFCDB.cz)

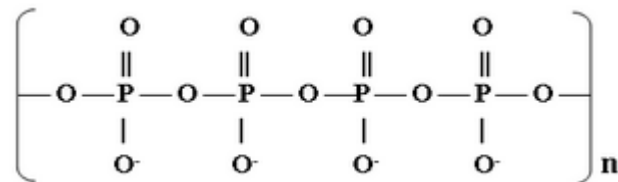
| Název potraviny | Hodnota |
|--|---------|
| Semena tykvová, sušená | 535 mg |
| Otruby pšeničné | 480 mg |
| Prášek kakaový | 409 mg |
| Mák | 395 mg |
| Semena slunečnicová | 367 mg |
| Semena sezamová | 352 mg |
| Koření, majoránka, sušená | 333 mg |
| Mouka sójová, odtučněná | 300 mg |
| Sója extrudovaná, Sojavita | 276 mg |
| Ořechy kešu | 268 mg |
| Mouka sójová, plnotučná | 267 mg |
| Sůl jedlá | 265 mg |
| Koření, hřebíček | 260 mg |
| Koření, kmín | 258 mg |
| Mandle | 258 mg |
| Melasa | 242 mg |
| Droždí sušené | 230 mg |

fosfor

| Potravina | Obsah P (mg.kg-1) |
|-----------------|-------------------|
| banány | 230 - 310 |
| brambory | 320 - 580 |
| cibule | 300 - 480 |
| čaj černý | 6300 |
| čočka | 2400 |
| čokoláda mléčná | 2200 - 3000 |
| fazole | 3700 - 4300 |
| hlávkový salát | 300 - 390 |
| hrách | 3000 - 4300 |
| hrášek | 1000 - 1500 |
| chléb celozrnný | 1800 - 2000 |
| jablka | 100 - 130 |
| jahody | 230 - 350 |
| játra vepřová | 3600 - 4800 |
| jogurt | 1100 - 1200 |
| káva pražená | 1600 |
| maso hovězí | 1200 - 2000 |
| maso kuřecí | 1200 - 2500 |
| maso vepřové | 1300 - 2200 |



kyselina fytová



polyfosfát (aditivum)

ideální poměr Ca:P v dietě:
1 : 1 až 1 : 1.5

fosfor

E 338: kyselina fosforečná,
E 339 – 343: fosforečnany,
E 450 – 452: polyfosforečnany



| | PODÍL MASA | KVALITA MASA | ADITIVA | ZAKOUPENO | ZEMĚ PŮVODU | CENA (ZA 100 G) | ZNÁMKA |
|---------------------|---------------|-----------------|---------|--------------|----------------|--------------------------|--------|
| Gran Mare | 65 % | v kuse | ne | Penny Market | Německo | 8,87 Kč | 1* |
| Ocean Trader | 65 % | v kuse | ne | Lidl | Německo | 12,20 Kč | 1 |
| Clever | 57 % | mleté | ano | Billa | Polsko | 8,76 Kč | 3 |
| Euro Shopper | 22 % | mleté | ano | Albert | Estonsko | 4,36 Kč | 3 |
| Fish Fingers | 22 % | mleté | ano | Globus | --- | 7,48 Kč | 3- |
| Nowaco | 22 % | --- | ano | Globus | Estonsko | 7,96 Kč | 4 |
| Vita Star | 35 % | pyré | ano | Kaufland | Polsko | 4,36 Kč | 4 |

rybí prsty - obsah fosforečnanů (jako “aditiva”)

síra

DDD nestanovena
(jen pro sírné AMK)

nedostupné formy:
elementární a anorganická síra

na obsah **bohaté** (mg/kg):

| | |
|-----------|-----------|
| maso | 1 – 3 000 |
| obiloviny | 1 000 |
| luštěniny | 400 |
| vejce | 400 |



:Beauty Tip:

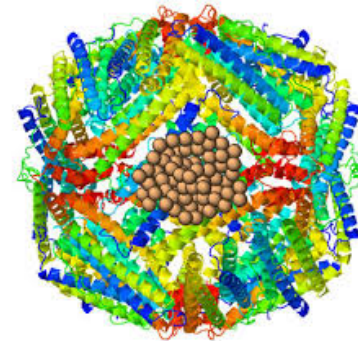
Any food that
smells like
Sulfur is good
for your skin

erika doolan
NUTRITION IRELAND

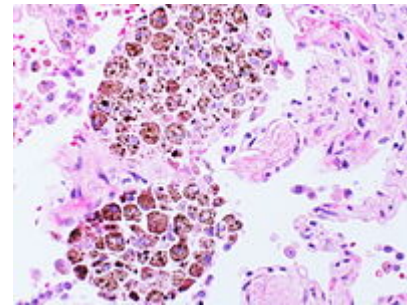
Fe

Tab: distribuce železa v těle

| Sloučenina | Množství v g | Obsah Fe v g | % celkového množství Fe |
|-------------|-----------------|-----------------|----------------------------|
| hemoglobin | 900 | 3,0 | 60-70 |
| myoglobin | 40 | 0,13 | 3-5 |
| ferritin | 2-4 | 0,4-0,8 | 7-15 |
| transferrin | 10 | 0,004 | 0,1 |
| katalasa | 5 | 0,004 | 0,1 |
| cytochrom c | 0,8 | 0,004 | 0,1 |



ferritin



homosiderin

Fe

| | | | |
|----------------------|----|-----------|-----|
| hovězí maso | 25 | kapusta | 10 |
| vepřové maso | 20 | mrkev | 7 |
| hovězí játra | 71 | rajčata | 5 |
| vejce | 21 | špenát | 70 |
| sýr ementál | 9 | hřiby | 10 |
| mouka pšeničná hrubá | 21 | jablka | 3,5 |
| mouka žitná | 48 | broskve | 13 |
| rýže loupaná | 28 | pomeranče | 5 |
| kukuřice, zrna | 24 | jahody | 9 |
| ovesné vločky | 36 | maliny | 10 |
| brambory | 17 | borůvky | 7 |
| fazole | 60 | hrozny | 5 |
| hrách | 50 | ořechy | 21 |

ARTICHOKEs



EGG YOLK



SCALLOPS



RED MEAT



DARK GREENS



OYSTERS



DRIED FRUIT



LEGUMES



zinek

**poměr
fytát/zinek**

využitelnost zinku

<5

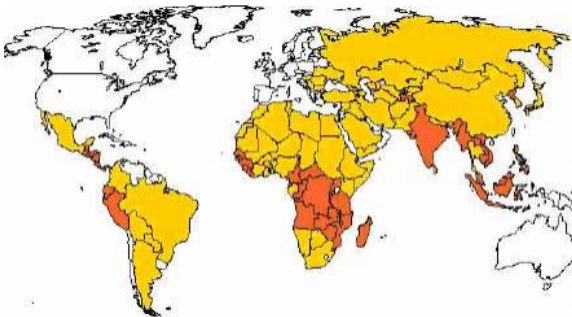
vysoká: až 55 %

5–15

střední: až 35 %

>15

nízká: pod 15 %



nedostatek zinku ve světě

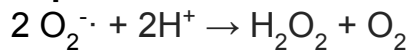
| Potravina | Obsah zinku mg/100 g | Využitelný zinek mg/100 g |
|-----------------|-------------------------|---------------------------------|
| játra, ledviny | 4,2 – 6,1 | 2,1 – 3,1 |
| maso červené | 2,9 – 4,7 | 1,4 – 2,4 |
| drůbež | 1,8 – 3,0 | 0,9 – 1,5 |
| mořské produkty | 0,5 – 5,2 | 0,2 – 2,6 |
| vejce | 1,1 – 1,4 | 0,6 – 0,7 |
| mléčné produkty | 0,4 – 3,1 | 0,2 – 1,6 |
| semena, ořechy | 2,9 – 7,8 | 0,3 – 0,8 |
| luštěniny | 1,0 – 2,0 | 0,1 – 0,2 |
| chléb | 0,9 | 0,4 |

měď

v organismu:

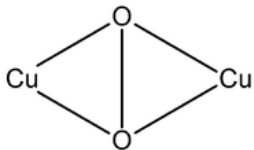
játra:

superoxiddismutáza



bezobratlí:

(oxy)**hemokyanin**



+ další **kuproenzymy**,
ceruloplasmin, ..

většina potravin < 10 mg/kg

játra 36

brambory 11

luštěniny 10

houby 10





mangan

kofaktor enzymů:

- superoxiddismutasa
- pyruvátkarboxylása
- arginása

maso, játra < 3 mg/kg

lesní ovoce až 50

obiloviny až 50

čajové lístky 300 až 1 000

některá koření stovky mg/kg



| potravina | obsah Ni |
|------------------|--------------|
| většina potravin | < 0.1 mg/kg |
| luštěniny | 3 – 10 mg/kg |
| ořechy | 9 mg/kg |
| čokoláda | 0.3 mg/kg |
| celozrnný chléb | 0.2 mg/kg |

High nickel release from 1- and 2-euro coins

The amount of nickel is regulated in European products that come into direct and prolonged contact with human skin^[1] because this metal may cause contact allergy, particularly hand eczema^[2-4]. Here we show that 1- and 2-euro coins induce positive skin-test reactions in sensitized individuals and release 240–320-fold more nickel than is allowed under the European Union Nickel Directive. A factor contributing to this high release of nickel is corrosion due to the bimetallic structure of these coins, which generates a galvanic potential of 30–40 mV in human sweat.

We performed skin tests with 1- and 2-euro coins in seven patients known to have nickel-contact allergy. After 48 and 72 h with these coins fixed by transparent tape onto their skin, all seven patients showed a strong reaction, with erythema, infiltration and formation of vesicles; they showed no reaction to 1% zinc chloride in Vaseline or to 1% copper sulphate in water.

In a quantitative nickel-release test (the European Standard EN 1811; ref. [5]), the 50-cent coin did not release a measurable amount of nickel, as expected. However, we found that the 1- and 2-euro coins released more nickel than pure nickel itself (Fig. 1).

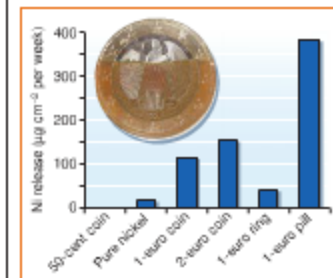
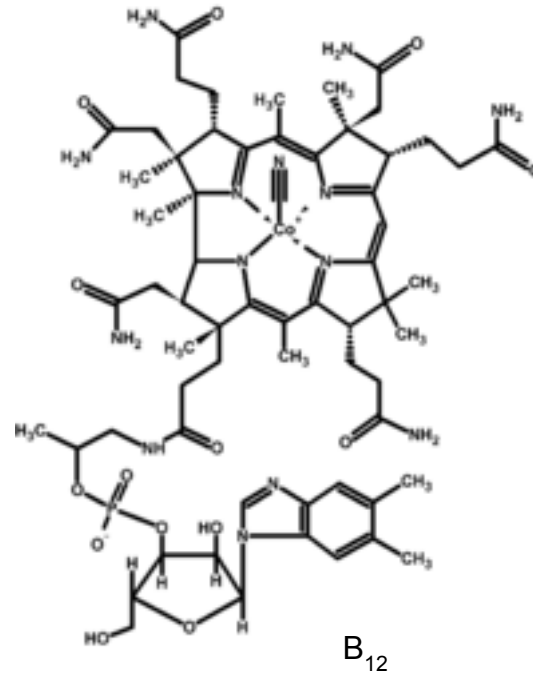


Figure 1 Release of nickel from euro coinage compared with that from pure nickel in artificial sweat, as measured by the EN

kobalt

| potravina | obsah Co |
|------------------|-------------------|
| většina potravin | < 0.1 mg/kg |
| luštěniny | 0.01 - 0.1 mg/kg |
| játra | 0.02 - 0.02 mg/kg |
| čokoláda | 0.3 mg/kg |
| ořechy | 0.01 - 0.3 mg/kg |



molybden

v krvi a moči: molybdát: MoO_4^{2-}

sýry 10 $\mu\text{g}/\text{kg}$

játra 200 $\mu\text{g}/\text{kg}$

luštěniny 200 $\mu\text{g}/\text{kg}$

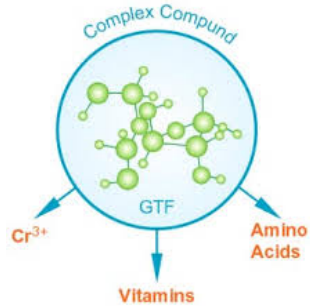
ořechy 40 $\mu\text{g}/\text{kg}$



Arménie je významným vývozcem molybdenu, což se promítá také v expozici obyvatelstva Mo

Cr³⁺ v organismu

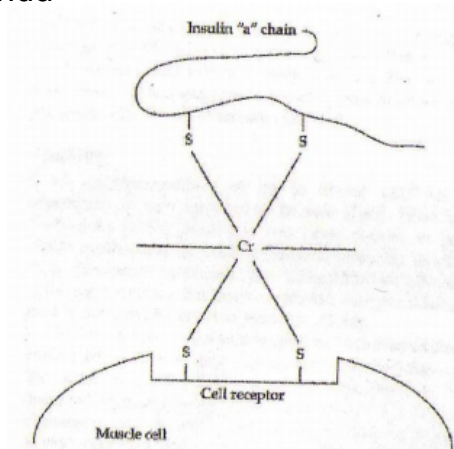
- metabolismus sacharidů



(glukosotoleranční faktor)

- metabolismus lipidů

- struktura NK (RNA)



| Potravina | Obsah chromu (µg/kg) |
|-----------------|----------------------|
| Mušle | 1300 |
| Para ořechy | 1000 |
| Celozrnná mouka | 210 |
| Rajčata | 200 |
| Houby | 170 |
| Brokolice | 160 |
| Brambory | 30 |
| Hovězí maso | 30 |
| Pivo | 30 |

Selen

Funkce selenu v organismu:

- faktor 3 (1957)
- glutathionperoxidasa (1973)
- metabolismus jodu
- spermatogeneze
- ochrana před TK



| země | příjem selenu $\mu\text{g}/\text{den}$ |
|----------------------------------|--|
| Švédsko - vegani | 10 |
| Švédsko - běžná strava | 40 ± 4 |
| Finsko - před suplementací | 26 |
| Finsko - suplementace | 56 |
| Slovensko | 27 ± 8 |
| Itálie | 41 |
| USA | 80 ± 37 |
| Kanada | 98 - 224 |
| Čína - oblasti s hojným výskytem | 1338 |

Selen

| potravina | ppm Se |
|-----------------|----------|
| mořské produkty | 0.4–1.5 |
| maso | 0.1–0.4 |
| cereálie | 0.1–0.8 |
| houby | 0.03–1.4 |
| ovo-zeľ | <0.1 |



Effect of Selenium and Vitamin E on Risk of Prostate Cancer and Other Cancers

The Selenium and Vitamin E Cancer Prevention Trial (SELECT)

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 M. Scott Lucia, MD
 Ian M. Thompson, MD
 Leslie C. Ford, MD

Context Secondary analyses of 2 randomized controlled trials and supportive epidemiologic and preclinical data indicated the potential of selenium and vitamin E for preventing prostate cancer.

Objective To determine whether selenium, vitamin E, or both could prevent prostate cancer and other diseases with little or no toxicity in relatively healthy men.

Design, Setting, and Participants A randomized, placebo-controlled trial (Sele-

Conclusion Selenium or vitamin E, alone or in combination at the doses and formulations used, did not prevent prostate cancer in this population of relatively healthy men.

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suspicious for prostate cancer.

Interventions Oral selenium (200 µg/d from L-selenomethionine) and matched vitamin E placebo, vitamin E (400 IU/d of all *rac*- α -tocopheryl acetate) and matched selenium placebo, selenium + vitamin E, or placebo + placebo for a planned follow-up of minimum of 7 years and a maximum of 12 years.

Main Outcome Measures Prostate cancer and prespecified secondary outcomes, including lung, colorectal, and overall primary cancer.

Results As of October 23, 2008, median overall follow-up was 5.46 years (range, 4.17-7.33 years). Hazard ratios (99% confidence intervals [CIs]) for prostate cancer were 1.13 (99% CI, 0.95-1.35; n=473) for vitamin E, 1.04 (99% CI, 0.87-1.24; n=432) for selenium, and 1.05 (99% CI, 0.88-1.25; n=437) for selenium + vitamin E vs 1.00 (n=416) for placebo. There were no significant differences (all $P>.15$) in any other prespecified cancer end points. There were statistically nonsignificant increased risks of prostate cancer in the vitamin E group ($P=.06$) and type 2 diabetes mellitus in the selenium group (relative risk, 1.07; 99% CI, 0.94-1.22; $P=.16$) but not in the selenium + vitamin E group.

Conclusion Selenium or vitamin E, alone or in combination at the doses and formulations used, did not prevent prostate cancer in this population of relatively healthy men.

Trial Registration clinicaltrials.gov identifier: NCT00006392