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Copper Content in Foods of Java Island and Estimation of Daily Copper Intake

Ida Farida Rivai,[1] Shosuke Suzuki,[1] Hiroshi Koyama,[1] Keisuke Hyodo,[2] Nani Djuangsih,[3] and Otto Soemarwoto[3]

[1]Department of Public Health, Gunma University School of Medicine, 39-22 Showa-machi 3, Maebashi 371, Japan; [2]Department of Physical Education, College of General Education, University of Tokyo, 8-1 Komaba 3, Tokyo, Japan and [3]Institute of Ecology, Padjadjaran University, Jl. Sekeloa, Bandung, Indonesia

Copper is an essential nutrient for all animals and human beings, but may exert toxic effect at high concentration. Although deficiency of copper in human beings is very unusual, various symptoms of copper deficiency are known to occur in animals such as anemia, skeletal defects, gray or depigmented hair, hair structure damages, degeneration of the nervous system, cardiovascular lesions and reproductive disorders (Briggs and Calloway 1979).

Copper toxicity in human beings is quite rare and there is a reasonable degree of tolerance for higher levels of food copper than that normally consumed (Briggs and Calloway 1979). Copper can be moderately toxic in man, producing nausea, vomiting, diarrhea and malaise. In severe copper poisoning by oral ingestion, these symptoms are soon followed by deep coma, oliguria, hepatic necrosis and death (Scheinberg 1979). The acute and chronic manifestations of copper poisoning in human beings and animals depend on the mode of contact and mileu in which this contact occurs (Cohen 1979).

The daily copper requirement for man estimated by WHO (1973) is 30 microgram/kg body weight. Provided that intake does not exceed 0.5 mg/kg body weight/day, no deleterious effects should be expected (WHO 1971). Copper concentration in food is generally around 1 mg/kg (Aaseth and Norseth 1986). The richest sources of copper intake are meats, shellfish, nuts, dried legumes and cocoa. Masironi et al. (1977), and Aaseth and Norseth (1986) mention that cereals contain less copper. All natural foods contain copper along with other mineral elements. When soil is extremely low in copper, copper deficiency occurs among animals endemic to the area (O'Dell 1984). Copper in the soil is

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Requests for reprints should be addressed to Ida Farida Rivai at the address indicated above.

essential for understanding soil-plant-animal and soil-foodstuff (water)-human relationships (Thornton 1979).

The purpose of this study was first to determine copper content in soil, foodstuff and feces of villagers, and estimate the daily copper intake of the villagers and a guest. The data obtained may help clarify the relationships of copper content in soil-plant (food)-daily intake-feces in Indonesia. Secondly, the percentage of copper contribution of food groups was calculated to determine the influence of the food patterns of villagers and a guest on daily copper intake. Finally, evaluation was made of daily copper intake of villagers in terms of estimated daily copper requirement by WHO (1973).

MATERIALS AND METHODS

Food sampling was carried out in three rural communities or kampungs in Jawa: Pasirparahu (West Java), Salamungkal (West Java), and Brumbung (Central Java). The samples included raw, processed and cooked foods. Soil and feces samples were also taken from the same sites.

Fresh sample ------ weighed from 10 to 20 gr ------ dried in the sun light ------ weighed again

------ put in a plastic bag ------ weighed in a test tube ------ dried in an oven at 150° C. for 48 hrs.

------ weighed again ------ 1.0 ml of HNO_3 added ------ ashed on hot plate for 48 hrs.

------ made up to a final volume of 1.0 ml of 14 % dilluted HNO_3 ------ Analyzed with flameless atomic absorption spectrophotometer

Figure 1. Pretreatment of sample.

Pretreatment of samples (Fig.1): A fresh sample of 10 to 20 gr was weighed on a balance to three digits. The shallow plastic container of the sample was dried in the sun and weighed again. Dry samples, such as rice, dry bean and dry cassava were put in plastic bags without such drying. The collected dried samples were taken to the laboratory and kept in a refrigerator until the next step. All the dried samples were dried again in an oven for 48 hrs. at 105° C., to give completely dried samples in test tubes. The amount of each sample was accurately weighed by a chemical balance less than a milligram and ashed on a hot plate with 1 ml of concentrated nitric acid until dried. Finally, 1.0 ml of 14 % diluted nitric acid was added and the ash at the bottom was dissolved. The solution was charged in to a flameless

atomic absorption spectrophotometer, Shimazu 650 and Hitachi 180-30, with background correction. To guarantee accuracy of the data, reference materials including rice flour (No. 1568), and dried liver powder (No. 1577) from National Bureau of Standard, U.S.A., were used under the same conditions. Pretreatment and analysis of the feces and soil samples basicaly were essentially the same as those of the fresh food samples (Fig. 1).

The amount of daily copper intake was calculated from the weighed menu survey of 4 households in Pasirparahu for 3 days and from the menu of a guest (Japanese man, 44 yrs., 53 kg) who was served meals by a host family for 9 days in Pasirparahu, 23 days in Salamungkal and 12 days in Brumbung.

RESULTS AND DISCUSSION

The copper content of each food sample is given in the project report (Suzuki et al. 1988). The geometric mean and deviation of copper content in food by nine food groups are shown in Table 1. The data show that copper content in the vegetable groups from three places is higher followed by nut and seed, grain legume, and in cereal groups it is the lowest. Meat group in Pasirparahu is the highest.

Table 1. Copper content in foods by food groups at three sites (ppm dry weight).

Food groups	Pasirparahu			Salamungkal			Brumbung		
	N	Mean	GD*	N	Mean	GD*	N	Mean	GD*
Cereals	17	3.17	4.28	11	1.31	3.03	10	1.95	1.66
Starchy roots	7	3.57	5.09	20	2.61	3.13	4	4.61	9.35
Grain Legumes	6	8.68	2.62	20	10.10	3.50	16	14.15	1.20
Nut and Seeds	3	8.09	1.92	3	14.38	2.27	2	11.87	2.62
Vegetables	24	10.74	2.84	17	13.00	2.27	13	11.02	2.08
Fruits	16	10.90	3.00	5	6.75	2.56	1	5.00	-
Meat and Eggs	3	21.20	2.35	5	2.80	1.66	1	2.30	-
Fishes	5	2.82	1.95	11	3.81	3.56	-	-	-
Miscellaneous	-	-	-	14	10.2	1.77	1	3.20	-

*, Geometric deviation.

The daily copper intake of men was 2.5 mg/day, which was higher than women, 1.7 mg/day (Table 2). Daily copper intake of the National Food Balance Sheet (Department of Nutrition, Indonesia 1967) was in agreement with the data for women, but the data for men showed higher values. Daily copper intake from food generally varied from 1 to 3 mg, corresponding to about 15-45 microgram/kg body weight (Aaseth and Norseth 1986).

The geometric means of copper concentration in feces from Pasirparahu, Salamungkal and Brumbung were 10.60, 9.90 and 17.8

ppm wet weight (Table 3). The average amount of feces excreted per day was estimated as 200 gr for adult villagers, and the daily copper excretion in Pasirparahu, Salamungkal and Brumbung was respectively 2.12, 1.88 and 3.56 gr per person per day on the geometric average. The copper content in feces was accounted for by the dietary copper content not absorbed and by copper excreted in the bile (Scheinberg 1979).

Table 2. Estimation of mean daily copper intake of villagers in Pasirparahu, West Java (mg/day).

Daily Cu intake of:	N	Mean	GD*
Men, for 3 days each	4	2.5	1.25
Women, for 3 days each	4	1.7	1.46
National Food Balance Sheet	-	1.7	-

*, Geometric deviation.

Table 3. Copper content in feces of villagers at three sites, in West Java and Central Java (ppm wet weight).

Site	N	Mean	GD*
Pasirparahu	125	10.60	9.10
Salamungkal	32	9.90	4.32
Brumbung	46	17.8	7.58

*, Geometric deviation.

Table 4 shows, copper concentration in the soil of Salamungkal to be highest or 13.9 ppm, followed by Pasirparahu, 12.2 ppm and in Brumbung to be lowest or 10.5 ppm. These data agree essentially with those data of Suzuki et al. (1980), with the methods of analysis being similar. Copper concentration in the soil from West Java (Pasirparahu and Salamungkal) was higher than that from East Java (Brumbung).

Copper concentrations in the soil of these three sites were ten times those of Houston, Texas, according to a similar method of analysis by Suzuki (1982). But the data in this study were between the values for copper in the soil from other countries as quoted by Thornton (1979), ranging from 4 to 37 ppm for Tertiary and from 6 to 60 ppm for Jurassic in England. Although copper concentration in the soil of Salamungkal (13.9 ppm) was higher than that in Brumbung (10.5 ppm), copper content in food (cereal) of Salamungkal (1.31 ppm) was lower than in Brumbung (1.95 ppm). Essentially the same situation was found for Pasirparahu (10.6 ppm) and Salamungkal (9.9 ppm), where copper content was lower than that in Brumbung (17.8 ppm). The present data indicate there to be no clear relationships of copper content in soil-food- daily intake-feces.

Table 4. The relationships of copper content in soil-food (cereals)-daily intake-feces of villagers and a guest at the three sites in Java Island.

Source of copper content:	Pasirparahu	Salamungkal	Brumbung
Soil (ppm dry wt.)	12.2	13.9	10.5
Cereals (ppm dry wt.)	3.17	1.31	1.95
Daily intake of a guest (mg/day)	1.9	1.4	1.2
Feces of villager (ppm wet wt.)	10.6	9.9	17.8

The percentage of food group contribution to daily copper intake at the three sites (Table 5), shows the cereal group to be the largest contributor to daily copper intake, followed by vegetables, nut and seed and then by the grain legume group. Although cereals contain less copper, it was found from the food patterns of villagers that almost 50 % the source of their daily copper intake was from the cereal group. Abdoellah (1985) also suggests that the foodstuff most frequently eaten in Salamungkal is rice (cereal). Data on men and women in Pasirparahu showed that there was no copper intake from the meat and egg group. Meat is a very rare dietary food for the villagers, but it was not for the guest. Possibly the guest obtained copper from a greater variety of foods than the villagers. This may explain differences in food patterns between villagers and the guest as due to those in daily intake. The food patterns at Pasirparahu were in agreement with the data for food group contribution according to the National Food Balance Sheet put out by the Department of Nutrition, Indonesia (1967).

Table 5. Percentage food group contribution to daily copper intake at the three sites.

Food group	Nat.Food Balance Sheet	Pasirparahu			Salamungkal	Brumbung
		Men	Women	Guest	Guest	Guest
Cereals	52 %	52 %	57 %	23 %	28 %	30 %
Starchy Roots	12	4	3	10	9	3
Grain Legumes	9	15	14	34	23	18
Nuts and Seeds	15	3	4	3	2	4
Vegetables	1	20	15	9	11.5	17
Fruits	4	2	3	9	7.5	1
Meats and Eggs	1	-	-	4	10	25
Fishes	2	3	3	3	5	1
Beverages	2	1	1	4	3.5	1
Others	1	-	-	1	-	-

Table 6. Comparison of daily copper intake in Pasirparahu with daily copper requirements by WHO (1973).

	Men	Women
Daily copper intake in Pasirparahu	2.5 mg/day	1.7 mg/day
Daily copper requirement*	1.6 mg/day	1.2 mg/day

*, 30 microgram/kg body weight, multiplied by mean body weight of men (54 kg) and women (42kg).

Table 6 shows the daily copper intake of villager to be higher than the Daily Intake Requirement by WHO (1973), calculated with mean body weight being 54 kg for men and 42 kg for women. The upper limit of copper intake suggested by WHO (1971) is 0.5 mg/kg body weight/day. When this is multiplied by the average body weight of men and women villagers, the limits are 27 mg/day for men and 21 mg/day for women. The data of this study clearly indicate the daily copper intake of villagers to be much less than these values. Thus, there is no copper deficiency and no copper toxicity in the present daily intake of villagers.

This study gives some indication there is no clear relationship of copper content in soil-food-daily intake-feces in Java Island. Although the cereal group contains a lesser amount of copper, it is a major source for the intake of this element for Indonesian villagers. Possibly, the daily copper intake of Indonesian villagers is adequate and safe.

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