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Copper content of commonly consumed food in Brazil

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Abstract

Little is known of copper content of Brazilian food. In this paper, copper contents of several typical Brazilian foods were determined. The samples were bought in retail stores in cities of the southeast region of Brazil. Atomic absorption spectrophotometry with wet oxidation of the organic material was employed. The highest copper content was found in beef liver (6.06 mg/100 g of fresh product). Lowest copper content was found in milk and in fish fillet, with values below 0.01 mg/100 g of fresh product. Crude beans, Nescau™ and whole wheat had copper contents from 0.44 to 1.04 mg/100 g of fresh food. Other foods, such as fruits, vegetables, grain products, baked products, roots and meat products had copper contents varying from 0.02 to 0.41 mg/100 g.

Keywords: Copper; Brazilian foods; Foods composition

1. Introduction

It is important to know the copper content of food, mainly for nutritional and technological considerations. In biological systems, copper is involved in oxidation–reduction reactions which are important for life (Brody, 1994). Due to its oxidant potential, copper can cause undesirable changes in processed food, related to browning reactions, lipid oxidation and consequently loss in nutritive value (Fennema, 1996).

There is very little research on the copper contents of the foods mostly used in Brazil. Thus, this work was developed with the objective of determining the copper contents of representative samples of the most used foods.

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2. Material and methods

Two hundred and six food samples were collected in retail stores of several cities in the southeast region of Brazil. There were samples of meat and fish products, hen eggs, fruits, grain products, legumes, baked products, leafy and floral vegetables, roots and dairy products, prunes, farinha látea™ and Nescau™. These are foods commonly eaten in Brazil (Anuário Estatístico do Brasil, 1992; Fundação Instituto Brasileiro de Geografia e Estatística, 1977).

Copper content was determined by procedures described in the literature (Matejovic & Durackova, 1994; Novozamsky, Der Lee, & Houba, 1995; Silva, 1990) after preliminary essays for determining recovery rates and also for establishing the best laboratory sample size for each of the foods. In this preliminary study, samples of apple, orange, collard green, rice, bread, beans, meat and milk were utilized. A wet oxidation procedure was carried out on the organic material, for all food products, in triplicate, with a control sample (without addition of copper) and with addition of increasing concentrations of copper to the samples. Recovery rate obtained for the added copper varied from 98% to 102%. From this preliminary study, it was also found that there was a need for a 2 g sample of food such as grain products, legumes, meat, fish products, cheese and eggs. For liquid food, there was a need for 10 ml of sample and 5 g samples for fruits, roots and leafy and floral vegetables.

The procedure for organic material oxidation in each sample required 25 ml of a nitroperchloric mixture in the proportion, three parts of nitric acid and one part of perchloric acid. This mixture was heated from 170 to 190 °C. After complete elimination of the organic material; which could be seen when the sample appeared as a crystalline transparent solution and liberated white vapours, the volumes were made up to 25 ml with deionized water. The readings of the samples for copper content determination were obtained in an atomic absorption apparatus, GBC Scientific Equipment Pty Ltd., model GBC 932AA, set up for 324.7 nm wavelength and air–acetylene flame. The calibration curve was prepared with standard solutions for atomic absorption. Zero reference reading for the calibration curve was prepared for all reagents with the same procedures as for the sample digestion. After each of 10 readings of samples, a new calibration of the equipment was carried out by reading a control sample (zero reference) and the third point sample of the calibration curve. All laboratory glassware was washed by soaking in a 2 N HCl solution for 12 h and then thoroughly rinsed with deionized water. Reagents (PA grade) used in this research were copper standard solution from FIXANAL – Riedel-de-Haën., HCl concentrated from FIXANAL, $HClO_4$ from NUCLEAR and HNO_3 from MERCK.

3. Results and discussion

Average copper contents of animal origin food products are presented in Table 1 and from plant food products are in Table 2. For some foods, the presented values refer to triplicates of one sample. For all other cases, the numbers of samples are shown in parentheses. The highest copper content value was observed in beef liver samples (6.06 mg/100 g of fresh product). Liver is an important organ in animal metabolism. Many toxicant chemicals, including heavy metals, are metabolized or even stored in the liver. The levels of these chemicals in the liver depend on the animal food habits.

Some other foods with considerable levels of copper were beans, Nescau™, whole wheat and some fruits. Foods with higher levels of copper are those high in protein, such as beans for example. In bean samples, copper content varied from 0.08 to 0.85 mg/100 g of crude product. In samples of fruits, vegetables, processed grain and root products, copper levels varied from 0.02 to 0.31 mg/100 g.

As could be expected, there were variations in copper levels in the same type of food coming from different regions and also from different varieties. Other researchers

Table 1
Copper contents of edible portion of some foods of animal origin in Brazil

Food[a]	Copper (mg/100 g of food)		
	Mean value	Range[b]	CV (%)[c]
Beef			
Chã de dentro	0.06		
Contra filé frito temperado	0.05		
Contra filé (2)	0.09	0.07–0.10	22.2
Liver	6.06		
Filé mignon	0.15		
Patinho	0.07		
Chicken			
Thigh	0.07		
Liver	0.35		
Breast	0.04		
Sobre coax	0.05		
Pork meat			
Sirloin (2)	0.09	0.07–0.12	38.5
Pork ham (3)	0.08	0.06–0.09	20.3
Ham	0.09		
Smoked sausage	0.10		
Fresh sausage	0.08		
Hot dog sausage	0.14		
Fish			
Tuna fish	0.06		
Shark cut	0.03		
Red shrimp	0.08		
Merluza, file	0.01		
Sardinha em óleo (3)	0.15	0.13–0.18	22.2
Sardinha molho de tomate	0.14		
Eggs			
Egg white (3)	0.03	0.02–0.03	19.0
Egg yolk (3)	0.15	0.14–0.16	5.3
Ovo de codorna inteiro	0.07		
Whole egg (2)	0.07	0.06–0.08	19.4
Dairy products			
Yogurt	0.01		
Skim milk sterilized (2)	0.01	0.01–0.01	11.5
Whole UHT milk (4)	0.01	0.01–0.01	7.5
Whole pasteurized milk (2)	0.01	0.00–0.01	50.3
Minas frescal cheese	0.05		
Tilsit type cheese	0.04		
Cream cheese	0.02		

Raw samples or cooked are as specified.
[a] Numbers of food samples analyzed are in parentheses. When not specified, only one sample was analyzed.
[b] Range of copper content observed in sample of the same food.
[c] Coefficient of variability of copper content in food samples analyzed.

Table 2
Copper contents of edible portion of some foods of plant origin in Brazil

Food[a]	Copper (mg/100 g of food)		
	Mean value	Range[b]	CV (%)[c]
Vegetables			
Green squash (2)	0.07	0.05–0.08	37.0
Lettuce (3)	0.04	0.04–0.06	21.5
Chicory	0.06		
Egg plant	0.10		
Broccolis	0.06		
Onions (3)	0.08	0.04–0.12	55.5
Green onion	0.06		
Chayote	0.08		
Cauliflower (3)	0.04	0.03–0.05	19.8
Collard green (4)	0.04	0.02–0.06	45.1
Spinach	0.06		
Japanese squash	0.16		
Palm heart, canned	0.14		
Cucumber (2)	0.04	0.03–0.05	32.7
Green pepper (2)	0.09	0.07–0.10	24.9
Okra	0.10		
Radish	0.02		
Cabbage	0.03		
Sparsely	0.08		
Taro leaves (3)	0.20	0.15–0.23	21.5
Tomato (2)	0.06	0.04–0.09	62.1
Roots and tubers			
Batata barôa (2)	0.06	0.05–0.08	36.1
Sweet potato (2)	0.14	0.13–0.14	3.2
Potato (5)	0.11	0.07–0.15	27.7
Beets (2)	0.11	0.07–0.16	59.0
Carrots (6)	0.07	0.05–0.11	33.8
Yam (3)	0.17	0.14–0.21	21.0
Beans			
Canned pea (3)	0.21	0.19–0.24	12.1
Black beans (4)	0.85	0.73–1.04	15.8
Red beans (3)	0.79	0.69–0.85	10.6
Butter beans	0.44		
"Carioquinha" bean	0.76		
"Rajado claro" bean	0.72		
Boiled red beans (3)	0.36	0.25–0.48	31.0
Kidney beans (2)	0.08	0.08–0.08	0.5
Fruits			
Avocado (2)	0.20	0.12–0.28	57.4
Pineapple	0.13		
Prunes	0.17		
Banana	0.09		
Gold banana	0.12		
Banana prata(3)	0.08	0.05–0.12	47.9
Kaki	0.03		
Red guava (3)	0.12	0.09–0.17	39.2
Kiwi	0.31		
Orange (6)	0.03	0.02–0.05	33.5
Argentinean apple (2)	0.02	0.02–0.02	3.7
Brazilian apple (4)	0.04	0.04–0.05	16.5
Papaya	0.08		
Mango (3)	0.15	0.14–0.16	7.9
Yellow passion fruit	0.12		
Water melon	0.03		
Melon	0.10		
Peach	0.11		
Grape (3)	0.05	0.03–0.09	57.8
Grain products			
Rice raw (5)	0.18	0.13–0.28	33.3
Rice cooked w/salt	0.03		
Rice (3)	0.19	0.16–0.22	14.0
Gross corn meal	0.06		
Manioc meal (2)	0.13	0.11–0.16	25.3
Wheat meal, common (2)	0.23	0.23–0.24	2.3
Whole wheat meal	0.54		
Corn meal (6)	0.10	0.08–0.12	16.2
Whole corn meal	0.19		
Farinha lactea	0.24		
Crude sweet corn	0.05		
Canned sweet corn	0.05		
Cream-cracker (2)	0.21	0.20–0.22	6.9
Biscoito de maisena	0.14		
Bread (2)	0.16	0.13–0.19	26.7
Milk bread (sweet)	0.14		
Raw macaroni (7)	0.18		37.4
Boiled macaroni	0.03		

Raw samples or cooked are as specified.
[a] Numbers of food samples analyzed are in parentheses. When not specified, only one sample was analyzed.
[b] Range of copper content among samples of the same food type.
[c] Coefficient of variability of copper content among samples of the same food type.

have observed differences in mineral contents of foods due to plant variety and soil characteristics. Besides these factors, the use of copper-based fungicides can also contribute to these variations. This can explain the finding of high copper levels in some fruits (Reilly, 1991), for example kiwi 0.31 mg/100 g of fresh fruit.

In foods of plant origin, a high copper level may even be toxic, because of the high variation. The coefficient of variability can be above 50%. For example, in six samples of orange, copper levels varied from 0.02 to 0.05 mg/100 g. The recommended dietary allowance (RDA) of copper for adults is 0.9 mg/day and the tolerable upper intake level (UL) is 10 mg/day. Thus, these values of 0.02–0.05 mg/100 g represent only 2.22–5.55% of RDA and less than 0.2–0.5% of UL. Food composition tables used in Brazil usually do not present data on copper content (Fundação Instituto Brasileiro de Geografia e Estatística, 1981) or in some cases include only a few types of foods (Franco, 2001). Beef, rice, broccoli, pea and egg yolk were the only food samples analyzed in this research whose data for copper level are listed in Franco (2001) food composition table, one of the most used in Brazil. According to Franco (2001), the copper level in beef is 0.65 mg/100 g, in rice 0.58 mg/100 g, in broccoli 0.84 mg/100 g and in pea and egg yolk 0.57 mg/100 g. These values are 2–10 times higher than those found in our research. In the USDA Handbook No. 8, by Shils, Olson, and Shike (1994), copper contents of some foods are listed as follows: grilled beef sirloin 0.164 mg/100 g, tuna fish 0.071 mg/100 g, chicken thigh 0.050 mg/100 g, chicken breast 0.080 mg/100 g, broccoli 0.043 mg/100 g, parboiled rice 0.094 mg/100 g, canned peas 0.082 mg/100 g and whole egg 0.014 mg/100 g.

Introduction of new food varieties and the use of soil fertilizers and agrochemicals in crop production, among other factors, lead to changes in food composition (Malavolta, Vitti, & Oliveira, 1997; Reilly, 1991). For this reason, and also due to developments in analytical techniques involving more accurate and precise methods of analysis, it is necessary to periodically re-evaluate food composition.

4. Conclusion

Higher copper levels were detected in foods that are also higher in proteins, such as beans. Copper content of raw bean samples were 0.44–1.04 mg/100 g. In samples of fruits, vegetables, grain products, roots and tuber, the copper content varied from 0.02 to 0.31 mg/100 g of fresh product. The highest copper content was detected in one sample of beef liver (6.06 mg/100 g fresh weight).

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