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The Copper and Iron Content of Some Texas Vegetables

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By

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DEDICATED TO

My Mother and Father

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INTRODUCTION

Considerable interest has been manifested recently in the mineral content of food crops. This is especially true of such elements as calcium, iron, copper and manganese. Not withstanding the importance of minerals in nutrition, the available data on the mineral composition of vegetables are incomplete and unreliable. Davidson and Leclerc (1) have found that there is an appreciable variation in the mineral content of the same vegetable even when raised under the same conditions. Other Authors have reported similar observations, notably, Peterson and Elvehjen (2) who report that different samples of the same vegetable show great variations in their mineral contents.

Until recently research problems of metabolism have been confined largely to the fate in the body of the proteins, fats, and carbohydrates, and little regard has been paid to the roles played in living organisms by the mineral elements that enter into the composition of their tissues and are present in foodstuffs. Most of these elements have been found to have important physiological functions.

Their presence is not merely accidental, as was at one time thought. The inorganic elements (3) exist in the body fluids and oft times as salts (Electrolytes), or in combination with colloids in varying degrees of stability. Electrolytes are essential for the activity of many enzymes, and they also facilitate internal respiration, since oxyhemoglobin is more readily dissociated in the presence of electrolytes. Mineral elements are indispensible for life; and, since they are continually excreted in starvation, they must be supplied in the food.

Warburg (4) has within recent years been paying particular attention to the role of iron in the process of oxidation. He has summarized his work in this field and reported new findings. The recent announcement of Hart(5) signifies that certain types of anemia are benefited by the inclusion of copper in small amounts in the diet. McHargue (6) has concluded that copper has an important function in the metabolism of animals having red blood. Various authors have also reported (7) that the foods which are most potent in the cure of anemia , produced in dogs by bleeding, all contain copper. In striking contrast to the popular view of metals in foods are the laboratory findings of modern dietitians (8) concerning certain metals commonly regarded with suspicion which have been found to be actually essential to animal or plant nutrition, notably copper needed for the assimilation of iron. An excellent review of the place in normal nutrition held by copper, manganese, and iron has been given by Rose (9(. Titus (10) reports that iron with manganese as an impurity would prevent anemia in rats. The above analysis gives us an insight into the type of work which is being carried on with regard to the mineral content of foodstuffs and the relation of minerals to normal nutrition.

Iron And Copper In The Body

Iron (11) is found chiefly in the blood as hemoglobin, but it is also generally distributed throughout the body. In fresh human liver the percentage of iron is about .06 and in fresh muscle.01. Owing to the destruction of red blood cells in the body it is constantly being eliminated, even in starvation. Traces of iron and copper facilitate the oxidation of phosphatides, apparently by acting as catalysts. Iron can be absorbed when ingested in organic or in inorganic form. During pregnancy,(12), the fetus stores up iron in its liver and after birth the young mammal draws on this store during the nursing period. This is important for the young animal because the iron content of milk is very low. In cow's milk it is.00002 %. There are no figures on human milk but it is beleived to be slightly higher. A form of progressive anemia can be induced in animals by diets low in iron. It has recently been shown (8) that the disease as produced in rats cannot be cured by adding pure salts of iron to the diet, but when traces of copper are added, the symptons disappear. These results suggest that copper is necessary for the absorptioh of iron, (11).

Copper (11) takes the place of iron in the blood pigment hemocyanin, of molluscs and Crustacea, and it is about twenty times more abundant in the fish bodies. It is present in the brain substances of infants and adults.

Every element which finds a place in the structure of the cell is essential to life.

No distinction of relative importance can be drawn, since all components of the cell are essential. The mineral elements of the food have three chief functions (13) : (1) They contribute the the supporting framework of the body; (2) They take part in the formation of organic compounds; (3) They circulate in the body fluids in various combinations as inorganic salts, as dissociated ions, and in organic combinations.

The author has attempted to give a brief insight into the importance of iron and copper to the human body and to nutrition as related to the mineral content of foodstuffs. The necessity of a generous supply of vegetables must be particularly emphasized, for they are of the greatest importance in the normal developement and growth of the body and its functions. If we limit the most important sources of iron and copper- the vegetables- we also hinder the development of strong healthy bodies.

DISCUSSION

The importance of iron and copper in the Human body as well as in the human diet has been clearly established.

In keeping with the progress of sciences, the Department of Natural Sciences at Prairie View State Noraml and Industrial College is making a study and comparison of results and facts, established in other sections of the country.

The Author has chosen this subject because of the recent interest manifested in the mineral content of vegetables in other sections, and chiefly because of his interests in analytical chemistry and research. No available data on the mineral contents of Texas vegetables has been published, especially with reference to copper and iron contents.

In the course of the analysis, the author hopes to establish a table, or tables, showing the copper and iron contents of vegetables, and the copper and iron effeciency of vegetables in this section. It is his hope that this information will prove to be reliable, and t-hat it will prove of informational value not only to the members of the Science Department, but to all other individuals interested in Health and Nutrition.

It is the belief of the author taht such imformation, in the course of time, will have a practical value, as well as an increased value in regard to Theory.

Extensive tables of the copper and iron content of vegetables have been prepared by authors in other sections,(16), (17) .

Experimental Part

The vegetables used for these determinations were secured fresh from the College Garden.

All samples were washed in distilled water and dried in an electric oven at a temperature of 90 to 110 degrees. They were than ground up in a flour mill and placed in labelled bottles, stoppered and set aside for future use.

Method for copper determination

For the determination of copper, the method of Elevehjen and Lindon (14) was used.- Principle.- copper salts form with potassium thiocyanate and pyridine, a green precipitate of $Cu(C_5H_5N)_2(CNS)_2$ which can be dissolved in Chloroform and estimated Colorimetrically.

Samples of 4 to 7 grams were weighed into porcelain crucibles, placed in an electric furnace and ashed at a temperature of dull redness until the carbon was completely destroyed. The ash was taken up in 1:1 Hcl and evaporated to dryness on a sandbath to render silica insoluble. The residue was moistened with N Hcl and water, warmed in the sandbath for half an hour, filtered, and the filtrate diluted to a volume of 100 cc.

Iron Determination

For the determination of iron, the method of Elvehjen- Kennedy (15) was used. Principle- The material is oxidized by ignition. The acid solution is made alkaline and boiled to change pyrophosphate to orthophosphate. Thiocyanate is added, the ferric thiocyanate extracted with amyl alcohol and determined colorimetrically.

Samples suitable for the analysis were weighed into porcelain cruciebles and ashed at a temperature of dull redness until all traces of carbon were removed. The ash was dissolved in 1:1 Hcl and digested at near boiling point for 15 minutes or longer. The solution was make alkaline with 40 percent NaoH and boiled for one hour, made acid with concentrated Hcl and diluted to a volume of 100cc. To 2cc of standard iron solution, 10 cc of Hcl Conc. were added and diluted to 100 cc. Ten cc portions of each were measured into stoppered cylinders. To each were added 10 cc. of amyl alcohol and 5 cc of 20 percent potassium thiocynate. The colored layers were compared in the colorimeter.

The solution was evaporated to about 10cc, cooled and transferred to a 100 cc. volumetric flask, made alkaline to phenolphthalain with one- normal NaoH. 1 cc of glacial acetic acid, 1cc of 10 percent KCNs, 10 drops of pyridine, and 5 cc of chloroform, accurately measured, were added, and made up to 100 cc with distilled water. Most of the aqueous layer was removed and the remaining water and chloroform compared with a standard copper solution, treated similarly, in the colorimeter.

Standard Solutions

For a standard copper solution, .3997 grams of $Cuso_4 \cdot Sh_2o$ were dissolved in distilled water and make up to 1 liter. 1 cc equals.10 mg. cu.

The standard iron solutions were prepared by dissolving .7032 gms. of $FeSo_4 \, (NH_4)_2 \, So_4 \cdot 6 \, H_2o$ in distilled water, oxidizing with $KMNO_4$ and diluting to one liter. Ref. (14), (15).

1cc iron standard equals 0.0001 gm. Fe.

A Bausch & Lomb Duboscq type colorimeter was used to make the measurements.

TABLE I

The following table gives the iron content of eleven vegetables, (edible portions) in percent.

Vegatable	Sample I	Sample II	Average
Snap Beans	.0486	.0485	.04855
Turnip Tops	.0797	.0870	.0833
Carrots	.00526	.00548	.00537
Radishes	.00485	.00482	.00483
Cabbage	.00450	.00446	.00455
Beet Bottoms	.00334	.00348	.00337
Turnip Bot'm	.00316	.00309	.00305
Beet Tops	.00290	.00275	.00487
Green Tomat.oes	.00247	.00245	.00246
Mustards	.00178	.00184	.00175
Collards	.00797	.00877	.00837

TABLE II

The following table gives the copper content of eleven vegetables, (edible portions) in percent.

Vegetable	Sample I	Sample II	Average
Carrots	.00057	.66057	.00057
Snap Beans	.00052	.00050	.00051
Mustard	.00060	.00057	.00058
Beet Bottoms	.000464	.000478	.000465
Beet Tops	.00036	.00040	.00038
Radishes	.00026	.00025	.000255
Turnip Tops	.00019	.00014	.000156
Collords	.00015	.00016	.000155
Cabbage	.00013	.00014	.000135
Tomatoes	.00011	.00013	.00012
Turnip Bot'm	.00087	.00072	.000795

Summary And Conclusion

I Two charts showing the copper and iron content of some Texas vegetables have been prepared.

II Texas vegetables are equally as efficient in mineral content as are vegetables grown in other sections.

III The highest percentage of copper is found in turnip bottoms carrots, beans, mustard, beets, radishes, turnips, collards, cabbages, and tomatoes, follow in the order given. ~~with turnip bottoms having the highest percentage.~~

IV Carrots contain the highest percentage of iron. Snap Beans, radishes, cabbages, beet bottoms, turnip bottoms, beet tops, green tomatoes, mustards, collards, and turnip tops following in their respective order, mustard having the least amount of iron.

V Vegetables having high iron content show a decrease in copper, while vegetables low in iron show a similar increase in copper.

VI Vegetables contain a larger percentage of iron than copper.

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BIOGRAPHY

The author was born at Tyler, Texas, July 21, 1917. At the age of twelve, he entered the Emmitt J. Scott High School where he completed his high school work, January 19, 1934.

In February of the same year he entered Prairie View College. Here he was a member of the Varsity Tennis Team and Sports Editor of the student publication, The Panther. He is also a member of Beta Phi Chi Scientific Society, The Grandchildren's Club, and the Delphian Literary Society. He completed his college requirements in the field of chemistry, August 1937.