8-1938

A Redetermination of the Copper and Iron Content of Some Texas Vegetables

Maurice Harold Shavers
Prairie View State Normal and Industrial College

A REDETERMINATION OF THE COPPER AND IRON CONTENT OF SOME TEXAS VEGETABLES

By

Maurice Harold Shavers

A Thesis in Chemistry Submitted as Partial Fulfillment of the Requirements

for the

Degree of Bachelor of Science

in the

Division of Arts and Sciences

of the

Prairie View State Normal and Industrial College
Prairie View, Texas

August, 1938

Dedicated To

My Darling Mother
Addie Mae Shavers

A C K N O W L E D G M E N T

Grateful acknowledgment is made to Mr. W. A. Lynk, Jr., Prairie View State College, Prairie View, Texas for his helpful suggestions during the experiment and also for his assistance in criticizing the written work. The author also wishes to express graditude to Mr. R. P. Perry for his assistance in the beginning of this experiment.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

Although special interest has not been placed on mineral contents of vegetables in former years, they have been found to play an important role in nutrition and health maintenance in more recent years. Elvehjen (16) has reported that iron used in the body for maintenance and nutrition is obtained from food stuff, vegetables being the chief source. Bronson (18) and Sherman (3) found that fresh vegetables and fruits were often regarded as a food of low nutritive value because of their high water content and low portions of proteins and fats, but that it was largely these properties which made them important as sources of mineral foods. Peterson and Elvehjen (2) reported that green leafy vegetables are the best sources of iron in the diet. They report the results of about one hundred fifty determinations of iron in common food in which the highest percentage of iron was found in leafy vegetables. They also found a direct relation between iron content and the presence of chlorophyll. Further still, they point out that orange juice contains only 0.00028 percent iron while the orange pulp contains 0.00066 percent iron; the iron remains largely with the pulp on pressing. A similar relation exists between the juice and pulp of tomatoes. McHargue (15) reports that copper is also a normal constituent of plants. It is present in lettuce, cabbage, the germ of white and yellow corn, the germ of wheat, wheat bran etc. McHargue (15) also observes and reports that there is no form of plant or animal life in which copper cannot be found in minute amounts when ever sought for by the right methods. Bronson (18) reports that copper occurs in greatest concentration in plant life in young and tender green leaves and shoots and in the germs of the seed. Russell Stage Institution of Pathology, in 1933, ran an analysis of iron content of foods used in Belleuae Hospital, New York City, New York. They found that some of the foods served in this hospital vary remarkedly in iron content from those of the standard table of Sherman ('32), Rose ('29), Luchsenring and Flor ('32) and Levine and his co-workers ('32). They also found that there is a greater varation in foods of higher iron content than in those of lower iron content. Davidson and Peclerc (1) found that there is appreciable varation in the mineral content of the same vegetable when grown under different conditions. They also found that each vegetable studied has its own range of varation.

Some work has also been done in this laboratory regarding iron and soils. A soil analysis of Waller County was made by Johnson, in which he concluded that Waller County soil was low in nitrogen, low in phosphoric acid and calcium and slightly acidic. With reference to iron, Jones made a study on calcium, iron, protein, nitrogen and sulphur content in some Texas vegetables. He concluded that considerable varation was found in different samples of the same vegetable; each sample had its own range of varation; and that analytical data showed that mineral content of vegetables should be studied with the object of determining range of varation rather than a fixed value.

CHAPTER II
DISCUSSION

The role that iron and copper play in the body has been found to be of much significance to both human and other living organisms. Iron is distributed generally throughout the body (9). It is found chiefly in the blood as hemoglobin (9). It is also found in fresh liver and fresh muscles of human beings.

Copper, although not as abundant as iron in the human body, does possess a special and important place in the human body (4). Copper is found chiefly among the mineral salts of the body. It is also found in combination with iron in the blood vessels (5).

Investigations show that copper and iron are essential for normal nutritions and health (3), synthysis of hemoglobin (4), synthysis of chromatin substances of the cells, formation of organic compounds (15), and formation of the mineral salts of the body (3). As mineral salts of the body, these elements have three chief functions: they contribute to the supporting frame work of the body (1); they take part in the formation of organic compounds(2); and they act as body regulators (3).

Iron is very closely connected with the fundamental processes of nutrition. It is an essential element (3) both of the oxygen - carrying hemoglobin of the blood and of chromtin substances which appear to control the most important and vital activity within the cells. Recent work (3) indicates also that small amounts of iron in other forms (and possibly copper) may play an important part catalyzing the oxydation-reducting reactions through which the protential energy of the oxidizable food stuffs are made Kinetic for the support of the work of the active tissues of the body.

A recent investigation by Hart and his co-workers (4), has proved that it is not only essential to have a sufficient amount of iron in the body, but like wise to have all the other elements and substances which the body requires to enable it to assimilate iron and transform it into such substances as hemoglobin.

Copper was proved to be one of the elements acting in this capacity.

Elvehjen (13) has shown that the most common form of organic iron, hematin is of little value in blood even when combined with copper. He believes this is an indication that all iron compounds must be broken down into the inorganic salts before the body can use them. Others (3) point out that food rich in iron contains also its essentials of copper, which indicates their value for the up building of hemoglobin. The studies concerned with this are still to be more substantiated.

Since it has been shown that vegetables play an important part as a source of copper and iron; since the copper and iron content of vegetables has been established by Preston and Elvehjen (2) of the northern section of the United States; while one attempt has been made in this laboratory, but resulted in a failure to obtain apparently correct results; and for the reason that copper and iron play such important roles in the body as body builders and in various other capacities, the author felt that a redetermination of the iron and copper content of some Texas vegetables would prove both interesting and profitable.

CHAPTER III

EXPERIMENTAL PART

All vegetables used in this analysis were obtained from the college garden.

All vegetables were washed with ordinary hydrant water until free of all adhering soil, after which they were re-washed with distilled water and dried in an electric oven at a temerature of about 110° C. until all traces of moisture were gone. They were then ground in a flour mill and placed in labelled bottles, stoppered and set aside until needed.

The Procedure for Copper

The method of Elvehjen and Linden (14) was employed for this determination. Principle envolved - copper salts react with potassium thiocyanate and pyridine to form a green precipitate of $Cu(C_5H_5N)_2(CNS)_2$ which can be dissolved in chloroform and determined with the colorimeter.

Samples of from 2 - 5 grams were weighed on analytical balances, placed in porcelain crucibles transfered to an electric furnace where they remained from 8 - 10 hours to ash at a temperature of dull redness to destroy all traces of carbon. The ash was taken from the furnace, cooled and dissolved with 1 :1 HCl solution, and evaporated on a hot plate from 8 - 10 hours to render silica insoluble. The residue was moistened with HCl solution and water, warmed on a hot plate for half an hour, filtered and the filtrate diluted to a volume of 100 cc, evaporated on a hot plate down to a volume of 10 cc, cooled and transferred to a 100 cc volumetric flask. The solution was then made alkaline to phenolphthalein with normal sodium hydroxide solution after which was added 5 cc. of 10 percent KCNS, 10 drops of pyridine and 5 cc of chloroform respectively. The solution was throughly mixed by shaking and allowed to stand for about 1 - 2 minutes. Most of the aqueous layer was removed and the remaining water and chloroform compared with a standard copper solution treated similiarly in the colorimeter.

Standard Copper Solution

For a standard copper solution, 0.3997 grams of $CuSO_4 \cdot 5H_2O$ were dissolved in distilled water and made up to one liter.

1 cc equals 0.10 Mg Cu.

A Bausch and Lomb Duboscq type colorimeter was employed for the determination.

The Procedure for Iron

The Elvehjen - Kennedy method was employed for this determination. Principle envolved - the material is oxidized by ignition. The acid solution is made alkaline and boiled to change pyrophosphates to orthophosphates. Thiocyanate is added, the ferric thiocyanate extracted with amyl alcohol and determined in the colorimeter.

Samples of from 0.3 - 2 grams were weighed on analytical balances, placed in porcelain crucibles, transferred to an electric furnace where they remained from 8 - 10 hours to ash at a temperature of dull redness to destroy all trace of carbon. The ash was then taken from the furnace, cooled and dissolved with 1 : 1 Hcl solution. The solution was then heated on the hot plate for about 15 minutes to make sure of digestion. The solution was made alkaline with 40 percent NaOH and boiled for one hour, made acidic with conc. Hcl solution and diluted to a volume of 50 cc. To 4 cc of standard iron solution 5 cc of conc. Hcl solution were added and diluted to 50 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 potasium thiocyanate. Most of the aqeous layer was removed and the remainder compared in the colorimeter.

Standard Iron Solution

The standard iron solution was prepared by dissolving 0.7032 gram of $FeSO_4(NH_4)_2SO_4.6H_2O$ in distilled water, oxidizing with $KMNO_4$ and diluting to one liter. (12), (13).

1 cc iron standard equals 0.10 MgFe.

A bausch and Lomb Dubascq type colorimeter was used to make the determination.

CHAPTER IV

TABLES SHOWING RESULTS

TABLE I

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

VEGETABLES	SAMPLE I	SAMPLE II	AVERAGE
Beet Bottoms	0.0022	0.0023	0.00225
Bell Peppers	0.0027	0.0026	0.00265
Carrots	0.0075	0.0076	0.00755
Onions	0.0085	0.0083	0.00840
Squash	0.0082	0.0083	0.00825
Mustard	0.0061	0.0062	0.00615
Cabbage	0.0042	0.0044	0.00430
Cucumber	0.0086	0.0088	0.00870
Kale	0.0041	0.0043	0.00420
Green Tomatoes	0.0079	0.0078	0.00785
Lettuce	0.0051	0.0051	0.00510
Radish Bottoms	0.0061	0.0062	0.00615
Lima Beans	0.0034	0.0036	0.00350
Corn	0.0111	0.0111	0.01110
Irish Potatoes	0.0044	0.0046	0.00450

TABLE II

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

VEGETABLES	SAMPLE I	SAMPLE II	AVERAGE
Beet Bottoms	0.0697	0.0695	0.06960
Bell Peppers	0.0407	0.0408	0.04075
Carrots	0.0326	0.0327	0.03265
Onions	0.0345	0.0347	0.03460
Squash	0.0246	0.0248	0.02470
Mustard	0.0628	0.0626	0.06270
Cabbage	0.0276	0.0274	0.02750
Cucumber	0.0652	0.0653	0.06525
Kale	0.0544	0.0547	0.05455
Green Tomatoes	0.0775	0.0777	0.07760
Lettuce	0.0885	0.0882	0.08835
Radish	0.1074	0.1077	0.10755
Lima Beans	0.0234	0.0231	0.02325
Corn	0.0243	0.0245	0.02440
Irish Potatoes	0.0219	0.0217	0.02180

CHAPTER V

C O N C L U S I O N

Findings of this experiment as compared with findings made by Peterson and Elvehjen (2) are similiar for some vegetables while there is a wide variation in other vegetables. Findings of this experiment are similiar to those made by Titus (8) with respect to the relative amounts of iron and copper. Texas vegetables have been found to be equally as valuable as sources of iron and copper content as vegetables grown in other sections of the country.

The procedure employed in this experiment, although not completely accurate and free from all faults, can be recommended for accuracy with as much confidence as any other available.

CHAPTER VI

SUMMARY

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 of the country.

III. The higher percentages of copper are found in corn, onions, squash, carrots, cucumbers and green tomatoes.

IV. The higher percentages of iron are found in lettuce, green tomatoes, beet bottoms, radish bottoms, cucumbers and mustard.

V. Vegetables contain a larger percentage of iron than copper.

B I B L I O G R A P H Y

1. Jichiel Davidson and J. A. Leclerc
J. Nutrition, 55 Vol. II, 1936
Study on the varation of mineral
content of vegetables.

2. Peterson and Elvehjen
J. Biol. Chem. 78, 215 - 22 June, 1938
Iron Content of Plant and Animal foods.

3. Henry C. Sherman, Macmillan Co. New York, 1932
Chemistry of Food and Nutrition
Iron and Copper in the body.

4. Hart, Stienback, Waddell, Elvehjen
J. Biol. Chem. 77, 792 - 812, 1938
Copper as a supplement to iron for
hemoglobin building in the rat.

5. McHargue, Healy, Hill
J. Biol. Chem. 78, 637 - 641. August, 1928
Relation of Copper to hemoglobin content
of rat blood; preliminary report.

6. Eden, Sperry, Robscheit, Robbins, Whipple
J. Biol. Chem. 79, 577 - 586, Oct., 1928
Blood regeneration in severe anemia;
Influence of Certain Copper salts upon
hemoglobin output.

7. Rose, Macmillan Co., New York, 1928.
J. Nutrition 1, 541 - 556, July, 1929
What place have aluminum, copper and
manganese in normal nutrition.

8. Titus,
J. Biol. Chem. 80, 565 - 570. Dec., 1928
Manganese, Iron, Copper Complex.

9. Maclead,
Physiological and Biochemistry, Sixth edition
1930, pp. 831 - 832.
Mineral Requirements in the Human Body.

10. Harding,
Physiological Rev. 5, 279 - 302, 1925
Metabolism in Pregnancy.

11. McLester,
Nutrition and Diet
Mineral salts in the diet, 109-110.

12. Elvehjen and lindon,
J. Biol. Chem., 81, 435, 1929.
Razzo, Am. Chem. Appl., 16, 2, 1936
Inovge and Flinn, J. Tab. Chem. med. 16, 29,
1934.

13. Elvehjen and Kennedy,
J. Biol. Chem. 74, 385, 1927
Elvehjen,
J. Biol. Chem. 86, 463 - 1930.

14. Linden, Elvehjen and Peterson,
J. Biol. Chem. 82, 465, 1929
Table of copper contents of foods.

15. McHargue, Am. G Physiol., 72, 583, 1928
Warburg - Kreb, Biochem. Z 178, 255, 1927
Elevhjen, Stienback and Hart,
J. Biol. Chem. 83, 21, 1929.

16. Elvehjen,
J. Am. Med. Asso. 98, 1048, 1932
Organic Iron in hemoglobin formation.

17. Graves, Macmillan Co., New York, 1932.
Foods in Health and Diseases.

18. Bronson, John Wiley and Son Inc., 1930
Nutrition and Food Chemistry, 1930.

B I O G R A P H Y

The author was born October 3, 1915, at Gatesville, Texas. His elementary school work was done in South Side Ward School of Longview, Texas. His high school work was done at Longview Colored High School of the same town. He entered Prairie View College as a Freshman in the year 1934 - 1935, and took up courses leading toward a major in Chemistry and a minor in Education.