CHROMIUM - METABOLISM AND BIOCHEMICAL INTERACTIONS IN ANIMALS AND HUMANS

by

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B.S., Michigan State University, 1965

A MASTER'S REPORT

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Foods and Nutrition

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1975

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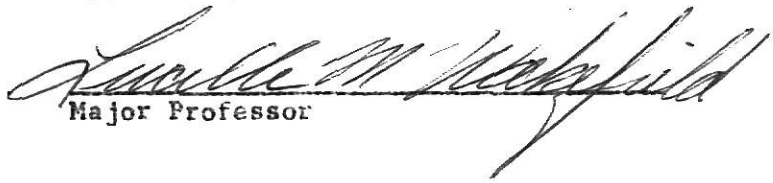

Major Professor

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INTRODUCTION

Research during the past twenty years has demonstrated the essential role of chromium for animals and humans. Progress has been most rapid since chromium was identified as the active component in the "glucose tolerance factor" in 1959. Chromium in this biologically active form is necessary for normal glucose, protein and lipid metabolism through its relationship to insulin. Nanogram quantities of chromium are required for the optimal effect of insulin in every insulin-dependent system that has been investigated. It appears that chromium initiates the formation of disulfide linkages between the intra-chain disulfide of insulin and sulfhydryl groups of the cell or mitochondrial membrane by participating in a ternary complex.

Chromium deficiency in laboratory animals is characterized by impaired glucose tolerance. Chromium deficient rats incorporate less of certain amino acids into body tissue, have higher circulating cholesterol levels and an increased incidence of aortic plaques.

Tissue levels of chromium are lower in persons in the United States than in other areas of the world; levels also decline markedly with age. Chromium levles are lower in the food supply of the United States and are further lowered by the refining of sugar and milling of flour. A nutritional deficiency of chromium is therefore likely in the United States.

Therapeutic trials of chromium supplementation have indicated that a deficiency may exist in impaired glucose tolerance of the middle-aged and elderly, diabetes mellitus and protein-calorie malnutrition, all of which are characterized, in part, by impaired glucose tolerance. There is also indirect evidence of chromium malnutrition in gestational diabetes and atherosclerosis.

Chromium research is hampered by difficulties in analysis of the extremely low concentrations in which it occurs in biological materials. Various methods of analysis have been used with widely different results. Reports of chromium levels in foods or tissues can therefore be compared only within a study and cannot be considered as absolute.

REVIEW OF LITERATURE

Inorganic Chemistry

Chromium, with an atomic number of 25 and a mass of 52.1 daltons, belongs to the first series of transition elements. It is surrounded on the periodic table by three elements with known biological function: vanadium, manganese and molybdenum. Chromium can occur in every one of the oxidation states from -2 to +6, but only 0, +2, +3 and +6 are common. Cr^{o} is inert and not thought to have a biological role. The divalent forms are unstable unless protected from oxidation and are unlikely to occur in biological systems.

The hexavalent form is almost always linked with oxygen and is a strong oxidizing agent. The important ions of Cr^{+6} are chromates, CrO_4^{-2}, and dichromates, $Cr_2O_7^{-2}$, both of which are easily reduced to Cr^{+3} in acidic solution according to the following formula:

$$Cr_2O_7^{-2} + 14\ H^{+} + 6\ e \longrightarrow 2\ Cr^{+3} + 7\ H_2O$$

The trivalent is the most stable oxidation state and has a strong tendency to form coordination compounds, complexes and chelates. The rate of ligand exchange is very slow. Trivalent chromium has a coordination number of six, with the direction of the ligands pointing to the corners of an octahedron. Some of the more common ligands are water, ammonia, urea, ethylenediamide, anions like halides, sulfate and anions of many organic acids. Free chromic ion does not exist in aqueous solution, it is always coordinated, either with water or other ligands in the solution (1).