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A NEW WHOLE WHEAT IRRADIATED BISCUIT, CONTAINING VITAMINS AND MINERAL ELEMENTS*

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IN planning a diet it is necessary to have a knowledge not only of caloric requirements and the relative amounts of fats, carbohydrates, and proteins needed but it is also necessary to have a knowledge of the importance of vitamins and mineral elements in metabolism. Before discussing a food product in biscuit form which we have devised we will briefly consider the importance of the vitamins and mineral elements. Deficiencies in these substances are the faults most frequently encountered in our modern diets.

At the present time six separate and distinct vitamins are recognized, and without doubt more will be discovered in the future. The chemical composition of all is as yet unknown. A lack of vitamin A results in deficient growth and the development of xerophthalmia. In addition, this particular deficiency produces a definite alteration in the morphology and function of many of the mucous membranes. Vitamin B has been recently divided into two separate and distinct vitamins; B_1, a lack of which causes peripheral neuritis and poor growth; and B_2 which is necessary for the prevention of pellagra and certain skin conditions. Vitamin B_2 is also necessary for normal growth. Vitamin C prevents scurvy. The antirachitic, or sunshine, vitamin D is necessary for the growth and repair of bone and other tissues. Vitamin E is essential for reproduction, and possibly certain other body changes at the age of puberty.

In addition to producing such definite clinical entities as rickets, tetany, scurvy, and the before mentioned conditions, an inadequate supply of vitamins results in a lowered resistance to infection.[1, 2, 3, 4] We realize that there are many other food factors which influence the resistance of the body cells against disease, such as proteins and mineral elements, but it is evident that a lack of vitamins over a long period may play an important rôle in the development of many of the chronic infective conditions encountered in children and adults.

In regard to degenerative changes it had long been thought that an excess of proteins tends to produce degeneration of the heart, kidneys, and other organs. This idea is now gradually being abandoned, as carefully controlled observations have furnished no evidence in its favour. However degenerative changes do occur in animals fed diets deficient in vitamins, and these changes are sufficient to warrant the belief that an adequate supply of vitamins may be an important factor in the prevention of degenerative changes in human beings. Recent clinical observations lend weight to this belief. Fletcher and Graham[5] have demonstrated the remarkable effect of wheat germ with its high vitamin content in the treatment of chronic arthritis. Boyd, Drain and Nelson[6] have shown the striking results of the administration of a combination of vitamins in the prevention of dental caries and other mouth conditions. Langstroth[7] in a very general paper has advanced some evidence that a lack of vitamins may be associated with arthritis, hypertension, and other degenerative diseases. The importance of focal

* From the Research Laboratories of the Hospital for Sick Children and the Sub-Department of Pædiatrics, University of Toronto, under the direction of Alan Brown, M.B. Presented at the Academy of Medicine, Toronto, January 14, 1930.

infections, however, in the production of degenerative diseases is well known, but, as animal experiments indicate that an inadequate supply of vitamins may be an important factor in the development of these foci of infection, we may conclude that many degenerative diseases may have their origin, either directly or indirectly, in an inadequate supply of vitamins.

It should be remembered that the requirements for vitamins and mineral elements vary greatly, larger amounts being necessary during childhood, and during pregnancy and lactation.

The importance of an adequate supply of the mineral elements, calcium and phosphorus, is universally recognized, particularly for the growth and repair of bone and teeth. Phosphorus is fairly widely distributed, being present in large quantities in meat, eggs, whole grains, milk, and some vegetables. The supply of calcium, however, is more limited, our chief sources being milk and leafy vegetables. McCollum and Simmonds,[8] Sherman and Hawley,[9] and others have shown that the average diet tends to be poor in calcium unless one to two pints of milk are included daily. Although it is obvious that growing children and pregnant or lactating women require large amounts of calcium, it is not so widely recognized that the average adult diet is low in this element unless care is taken to supply it.

Iron is an essential element of the hæmoglobin of the blood and of the chromatin substances within the body cells. Egg yolk has the highest iron content of any food. It is also present in appreciable amounts in liver, lean beef, many fruits and vegetables, and whole grain products. Unfortunately, white flour and finely milled cereals contain very little of this element, as the greater part of the iron is in the discarded germ and bran. Milk contains very little iron. Sherman[10] found that "the typical American dietary does not contain any such surplus of iron as would justify the practice of leaving the supply of this element to chance." It is therefore essential in planning a diet, particularly during infancy and pregnancy, to see that an adequate supply of iron is included.

As recently as one or two years ago it was thought that nine inorganic elements were all that were necessary for life. It can now be said that many others are required. One of the most important of these is copper, minute amounts of which are necessary for the formation of hæmoglobin.

It is obvious that the correct method of planning a diet is first to incorporate in it the essential articles of food, and then to add the non-essential foods in order to cover the remaining caloric requirements. The chief essential foods are milk, meat, eggs, vegetables and fruit. In addition to fats and carbohydrates, these foods supply proteins, vitamins, mineral elements, and roughage. With the knowledge that the average diet, such as white flour, finely milled cereals, sugars, etc., contains an excess of the non-protective or vitamin- and mineral-lacking foods, and realizing the necessity of an adequate supply of these elements we have devised a food product in biscuit form which contains these necessary substances in appreciable quantities. Where the ordinary biscuit, zwiebach, rusk, toast or bread are all low in proteins, lacking in vitamins, and deficient in calcium, iron, and other salts, this biscuit contains in appreciable quantities most of the food elements necessary for the growth and repair of body cells and the maintenance of resistance against disease. The biscuit has as its basis whole wheat flour, irradiated wheat germ, milk, bone meal and iron. The whole wheat is in the form of a finely ground flour. The milk is added as a milk powder.

In regard to wheat germ, which constitutes 15 per cent of the biscuit, it is well to mention here the place it occupies in the structure of a grain of wheat. Due to the present day desire for only finely milled products the germ is ordinarily discarded and not used for human consumption. The whole grain consists of three well defined structures, the bran, the endosperm, and the germ. The bran which constitutes about 13.5 per cent of the wheat acts as a protective layer for the rest of the grain. It is comparatively rich in proteins, phosphates and vitamins. The endosperm which furnishes food for the germ during growth and makes up about 85 per cent of the grain is the portion which is utilized in the manufacture of white flour and finely milled cereals. It is very poor in mineral elements and is devoid of vitamins. The germ constitutes only about 1.5 per cent of the grain and is the living part of the seed which grows and develops into the new plant. The germ contains about 8 per cent fat and 30

per cent protein. Its mineral content is about double that of the whole wheat flour and ten times that of white flour. It contains in appreciable quantities vitamins A, B_1, and B_2, and is the most concentrated source known of the reproductive vitamin E.

Before the wheat germ is used in the biscuit it is exposed to the rays from a mercury quartz lamp. As discovered by Steenbock,[11] these rays activate the ergosterol normally present in the germ and thus produce the antirachitic, or sunshine, vitamin D. The whole wheat flour and germ used in our product thus contains all the known vitamins with the exception of the antiscorbutic vitamin C found in fresh orange juice. The vitamin content is further increased by the use of some butter and yeast. Butter supplies vitamin A in large quantities and yeast is a highly concentrated source of both vitamin B_1 and B_2. The yeast is not used as a leavening reagent but as a source of vitamins.

The bone meal is obtained by cooking bones in an autoclave at 267° F. for five hours. This removes all the fat. The bones are then ground and dried in an oven at 220° F. for twelve hours. The final product is an odourless and tasteless white powder. We are using this product in preference to the chemical substance calcium phosphate as there are traces of other mineral elements in the bone meal which may be of importance in the mineral metabolism of the body. The bone meal constitutes about 3 per cent of the biscuit. This means that five to six biscuits have the calcium content of one pint of milk. The iron content is about 5 mgs. iron per 100 grams of biscuit as compared to about double this amount in egg yolk, our most concentrated source of iron in food. The iron is largely obtained from the wheat germ and whole wheat. Examination of the biscuit shows the presence of copper in the concentration of about 1 mg. per 100 grams of biscuit.

In studying the vitamin D content of the biscuit it was found that a considerable amount of the vitamin D present in the irradiated germ before cooking was destroyed when the biscuit

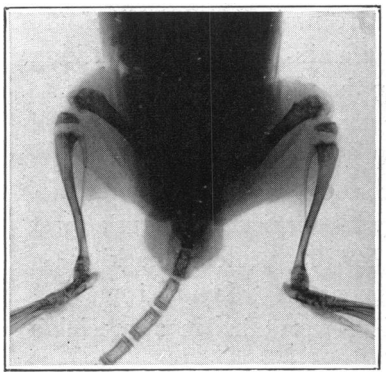

FIG. 1. — Roentgenogram of rat fed on a rachitogenic diet +25 per cent non-irradiated biscuit. Blood phosphorus 1.1 mgm. per 100 c.c., and bone ash 37.2 per cent.

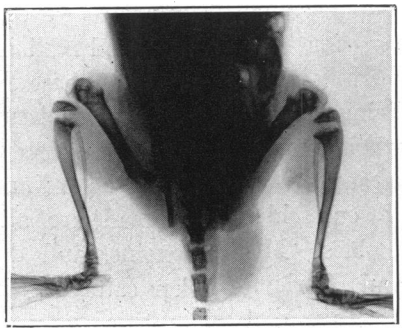

FIG. 2.—Roentgenogram of rat fed on a rachitogenic diet +25 per cent irradiated biscuit cooked at 425° F. Blood phosphorus 2.4 mgm. per 100 c.c. and bone ash 37.8 per cent.

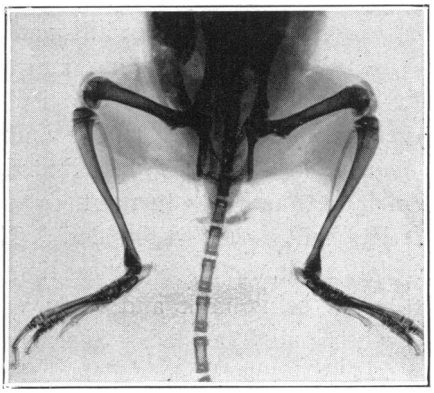

FIG. 3.—Roentgenogram of rat fed on a rachitogenic diet +25 per cent irradiated biscuit cooked at 300° F. Blood phosphorus 3.0 mgm. per 100 c.c. and bone ash 48.7 per cent.

TABLE I

THE ANTIRACHITIC EFFECT OF IRRADIATION OF FOOD AND SUBSEQUENT COOKING AT DIFFERENT TEMPERATURES

	Mgm. P. per 100 c.c. of blood	*Percentage of ash in bones*
Rat on normal diet; age 8 weeks..	6.3	57.0
Rat on Steenbock's rachitogenic diet	1.0	32.5
Rat on rachitogenic diet + 25 per cent of non-irradiated biscuit*	1.1	39.0
Rat on rachitogenic diet + 25 per cent of irradiated biscuit cooked at 425° F.*	2.4	37.8
Rat on rachitogenic diet + 25 per cent of irradiated biscuit cooked at 300° F.*	3.0	48.7
Rat on rachitogenic diet + 25 per cent of irradiated whole wheat and germ in proportions used in the biscuit, uncooked* ..	3.0	46.5
Maximum antirachitic effect possible with rats on rachitogenic diet with the use of ordinary therapeutic measures	4.5 (about)	54.0 (about)

* 76 per cent of the rachitogenic diet consists of yellow corn. The material to be tested was substituted for an equivalent amount of corn.

was baked at 425° F. the temperature ordinarily used in baking biscuits. It is quite possible that if the amount of vitamin D produced by irradiation is markedly increased sufficient amounts for practical purposes may escape destruction at this temperature. After experimenting with different temperatures it was found that very little of the vitamin D was destroyed when the temperature of baking did not exceed 300° F. This is shown by the results in Table I and Figs. 1, 2 and 3. We estimate that the vitamin D content of ten to twelve biscuits is equal to that of one teaspoonful of standard cod liver oil.

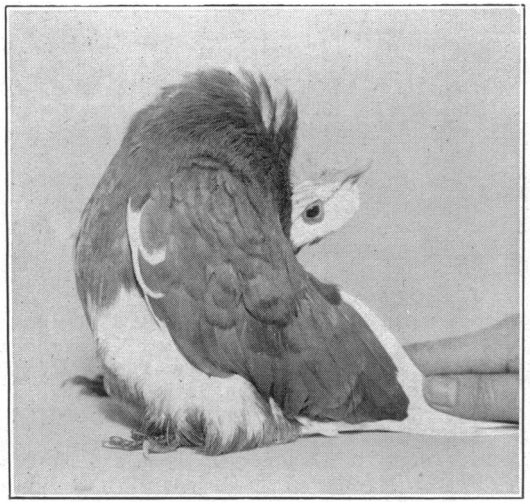

FIG. 4.—Pigeon fed on a diet deficient in vitamins B_1 and B_2. After 4 weeks it developed polyneuritis, or beriberi, and died.

Fig. 4 is that of a pigeon fed on a diet deficient in vitamin B_1 and B_2. After 4 weeks it developed polyneuritis, or beriberi, and died. Fig. 5 is that of another pigeon fed on the same diet, but in addition it received 15 per cent of wheat germ cooked at 300° F. for 20 minutes. After eight weeks on this diet it was apparently normal. Fig. 6 is that of two rats, the smaller one being fed for 4 weeks on a diet deficient in vitamin B_1 and B_2, and the larger rat was fed on the same diet, but in addition received 15 per cent of the cooked wheat germ. This demonstrates that the heat condition under which the biscuits are cooked does not entirely destroy vitamin B_1 and B_2.

It is the custom in the manufacture of biscuits to add certain alkaline salts as leavening agents. This produces an alkaline reaction which readily destroys vitamin B_1 and B_2 during cooking. To overcome this we have produced a biscuit with a reaction just on the acid side of neutrality through the addition of a small amount of cream of tartar. Further observations are underway to determine the exact concentration of each vitamin in the biscuit.

We would like to emphasize that no attempt should be made to supply all the vitamin requirements with this biscuit. Cod liver oil should still be administered to infants and children, to supply vitamins A and D. The diet should still be constructed around the essential articles of food, namely, milk, eggs, meat,

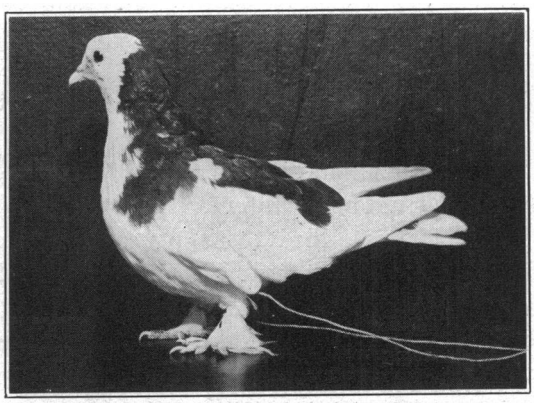

FIG. 5—Pigeon fed on a diet deficient in vitamins B_1 and B_2 with 15 per cent of wheat germ added. The wheat germ was cooked at 300° F. for 20 minutes. After eight weeks on this diet the bird was apparently normal.

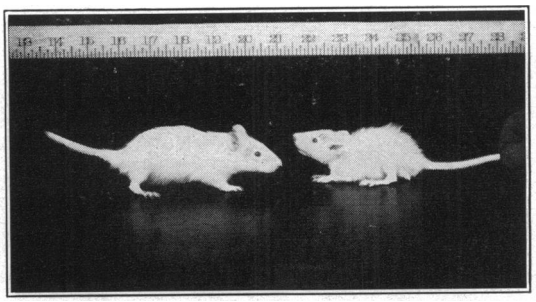

FIG. 6.—Two rats fed on a diet deficient in vitamins B_1 and B_2. The larger rat received in addition 15 per cent wheat germ cooked at 300° F. for 20 minutes.

vegetables and fruit. But when the biscuit is used in place of the ordinary biscuit, rusk, zwiebach, toast or bread, in addition to simply supplying calories, a food will be given which will assist in the repair and growth of body cells and the maintenance of resistance against disease.

With the realization that our work is only partly completed unless this biscuit is manufactured under the conditions outlined and made available to the public, we have arranged with the McCormick Manufacturing Company to produce this biscuit under our supervision.

It will shortly be available under the trade name of McCormick's Sun Wheat Biscuit.*

SUMMARY

A biscuit has been devised containing whole wheat, wheat germ, milk, butter, yeast, bone meal, iron and copper.

The wheat germ contains a large amount of vitamin E and appreciable amounts of vitamin A, B_1 and B_2. In addition it has been exposed to the rays of a mercury quartz lamp which activates the ergosterol present and thus produces the antirachitic vitamin D. Vitamin A is present in large amounts in the butter, and yeast is a concentrated source of vitamins B_1 and B_2.

The biscuit is baked under conditions which conserve the vitamin content.

Bone meal is added to supply calcium and phosphorus. Five to six biscuits contain the same amount of calcium as one pint of milk, the most important food source of this element.

The iron content is approximately one-half the concentration found in egg yolk, our highest source of iron in food. A trace of copper is also present.

The biscuit should be regarded as belonging to the essential or protective class of foods, and may be used to replace the ordinary biscuit, rusk, zwiebach, toast, or bread which are non-protective foods.

* The patents for the manufacture of this biscuit are held by the Research Laboratories, and all royalties accruing will be devoted to medical research.

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SURGICAL MEASURES IN THE TREATMENT OF PULMONARY TUBERCULOSIS*

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THE treatment of pulmonary tuberculosis by artificial pneumothorax was barely established on this continent when the surgeon entered the field to help make good its failures. To Dr. E. W. Archibald, as a pioneer in introducing thoracoplastic methods to America, and to Dr. John Alexander, for his illuminating survey of a vast literature, thereby hastening their adoption, a great debt of gratitude is owing from both physicians and patients. I had the good fortune to have Dr. Archibald accessible, although at long range, and I am grateful to him for the successful results obtained in the earlier days when patients were persuaded with some difficulty to undergo what seemed an appalling operation, uncertain in outcome. I am also indebted to Dr. N. S. Shenstone for undertaking more recently some very unpromising material with the hope of palliation, and for doing the series of phrenicotomies.

Something may be gained by the analysis of this small amount of material in regard to the indications for the operations and to the factors of resistance, and by a re-appraisal of the points upon which selection was based.

During the twelve years since 1916, compression of the lung by artificial pneumothorax has been attempted in 141 patients, that is in 22 per cent of all tuberculous patients under treatment, or in 28 per cent of the moderately- and far-advanced cases.

Satisfactory compression was impossible in 63 patients (45 per cent of the cases attempted),

* Read at the forty-fourth annual meeting of the Association of American Physicians, at Atlantic City, May 7, 1929.