Vitamins and Vital Elements

Suggesting a Possible Chemical Basis for Vitamin Activity

BY JOHN E. RUTZLER, JR.

THE vitamins are undetermined chemical substances which have been found to be indispensable to the normal functions of all mammalian, and of certain avian bodies. They are known by the effects which they produce. How the effects are produced is still a matter of conjecture.

The etymology of the word vitamin is quite obvious. Certain substances which could be isolated, but not in the pure state, have been found to be vital to the normal functions of the body. Hence, we have the word vital. Further, it was found that carbon, hydrogen, nitrogen, and oxygen were present in some of these substances. From this fact, and from the nomenclature of organic chemistry, the word amine came about. Combining these two, we have vital-amine. From this comes vitamine. But, since the insidious, habit forming alkaloids such as strychnine, morphine, and cocaine, nicotine, cinchonine, and brucine, end in ine, and since the vitamins do not possess any of the characteristics of these drugs, the final e of vitamine has been dropped.

Real Start in 1720

The history of the vitamins, as such, dates back to 1911, when Funk first introduced the name. However, the real beginning came in 1720, when Kremer wrote that medicine and surgery can be of no avail in cases of scurvy. He also suggested that scurvy can be cured by the use of green vegetables and certain fruit juices. Thus, by the inductive method, vent was given to the feeling that there was an important factor in nutrition, theretofore unrecognized.

Fruit Juices Treatment for Scurvy

What of the experimental? A few years later Lind contributed partial experimental verification of Kremer's tenet. Lind was the surgeon on the ship Salisbury. During a certain voyage, he had twelve scurvy patients. There was not sufficient orange and lemon juice for all the sufferers, so to all of the men he gave the best care that circumstances permitted. To two of the patients he gave the juices of oranges and lemons, while to the others he gave different medicaments then advocated for the treatment of scurvy. Those who were given the fruit juices improved rapidly. The others were not affected by the care and feeding given them. Thus, the truth of Kremer's writings was substantiated in some measure.

Budd, in 1847, made further inductions along the same line, but to those pioneers the whole thing was entirely undecipherable.

The British navy introduced a regular ration of lemon juice in 1804. After that scurvy was very rare among Britain's naval force, while a few years prior thousands of cases were reported annually.

In 1885 the Japanese navy took similar steps to control Beri-beri. In this instance barley was sub-

stituted for polished rice, Beri-beri disappearing from Japan's navy very shortly thereafter.

With the advent of Eijkman's work, in 1897, on the disease Beri-beri, the first positive step along the lines of scientific investigation of this problem was taken. He noticed that in certain localities the inhabitants lived, to a great extent, on polished rice. In these places Beri-beri was very common, while in other places where the people used the whole brown rice, the disease was rare. Eijkman then proceeded to extract whole brown rice and polished rice. He fed these extracts to fowls. Those which were fed the brown rice extract did not develop Beri-beri, whereas those fed on the polished rice extract did develop it. He also found that the whole rice extract was a cure for the disease. Eijkman's final conclusion was that Beri-beri is a nutritional disease, due to deficiencies, and not due to any pathogenic bacteria in the body. This man was a pioneer in the experimental study of these mysterious food factors.

Name Vitamin Proposed

The next great step came when Dr. Casimic Funk repeated Eijkman's work and proposed the name vitamin.

Five vitamins have been discovered, to date, namely vitamins A, B, C, D, and E. The best indication of the properties, or effects, of these food factors is embodied in the descriptive adjectives anti-conjunctivitic, anti-neuritic, anti-scorbutic, anti-rachitic, and anti-sterile, respectively.

Vitamin A, the anti-conjunctivitic vitamin, is present in butter fat, cow's milk, egg yolk, and cod liver oil in comparatively large quantities[1]. An interesting fact is that if the cow eats vitamin rich food, her milk is vitamin rich.

Lack of this food factor causes a disease known as conjunctivitis, xerophthalmia. Its manifestations are dryness of the eye ball, excessive redness, and much irritation. Lee says that this is a disease produced by pathogenic bacteria[2]. Xerophthalmia is cured by feeding the patient substances rich in vitamin A.

Heat Destroys Vitamin A

Heat destroys this nutritional factor in the presence of air. In an inert atmosphere, it will withstand high temperatures.

It has been found that the radiant energy of the sun delays the onset of xerophthalmia in rats[3].

Cooking and canning processes do not have any effect on vitamin A[4], whereas ultraviolet light destroys it[5].

This vitamin is soluble in fats. Drummond has shown that the hydrogenation of oils which contain it causes its destruction. Ozone inactivates oils which contain it.

A relationship seems to exist between pigmentation and vitamin A content[6]. For example, very yellow butter fat contains a larger quantity of this food factor than the paler butter fats. Yellow corn likewise has a high vitamin A content. In green vegetables and leaves, where vitamin A is found in high concentrations, there is a yellow pigmentation which is masked by the green color of the plant.

Passing on to vitamin B and its characteristics, we find that it is the anti-neuritic vitamin. Its lack causes the polyneuritic disorder

[1] Numbers refer to bibliography to be published next month.

called Beri-beri. Beri-beri is an acute disease, characterized by cachexia, and inflammatory changes in the nerves.

Upon feeding animals that have this disease, with foodstuffs rich in vitamin B, they recover. A normal diet sufficient in B content prevents Beri-beri, and aids growth.

Autopsies performed after death due to a deficiency of this vitamin reveal the following facts:

1. Most of the organs have ceased to develop.

2. The stomach, liver, pancreas, and the thyroid glands have wasted away and ceased to develop. This is especially true of the reproductive organs.

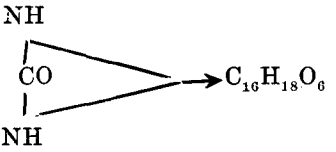
Sources of Vitamin B

Diets rich in yeast and wheat bring back all of these organs to their normal condition and they then function as well as they did originally. Yeast is the richest source of vitamin B, the wheat embryo ranking second. It is also found in most seed embryos, leafy plants, vegetables, and fruit juices.[1]

Vitamin B cannot be stored in the body so well as can the fat soluble vitamins. This vitamin is soluble in water and in alcohol.

Vitamin B is not a colloid, for it can be dialyzed. It is more easily destroyed in alkaline, than in acid or neutral solution. Chamberlain and Vedder, U. S. Army surgeons, have found that this vitamin is not a sugar, a salt, an alkaloid, an organic phosphorus compound, or an amino-acid. They concluded that the substance is an organic base, but not an alkaloid.

Funk, who claimed to have isolated this food factor, thought that it was a pyrimidine base. He went so far as to assign a formula to it, i. e.:



No evidence can be found to support this conclusion.

W. H. Eddy believed that vitamin B might be one of the bioses. In this connection it may be restated that Chamberlain and Vedder found that it was not a sugar. Eddy suggested further that the substance is crystalline, and melts at 223° centigrade.

Vitamin B can be removed from orange juice by shaking with fullers' earth. This is clearly a case of adsorption.

A deficiency of this vitamin affects the nitrogen metabolism of rats. It causes the appearance of creatinuria, accompanied by a slow wasting away of the skeletal muscles.

Uhlman suggests that vitamin B acts as a catalyst in stimulating the endocrine glands.[6]

The Anti-Scorbutic Vitamin

Vitamin C is the anti-scorbutic vitamin. Its presence in our foodstuffs prevents scurvy, and conversely, its absence causes scorbutus.

Scurvy is a skin disease characterized by livid spots, spongy gums, and bleeding from the mucous membranes.

Foodstuffs rich in this food factor are: raw cabbage, white lettuce, orange juice, lemons, citrus fruits, and tomatoes. Cereal grains in the dry state are practically devoid of vitamin C. When the seeds are caused to germinate, vitamin synthesis begins; Vitamin

C then puts in its appearance.

Vitamin C is quite readily destroyed when heated in solution, and also in the presence of oxygen. When air is bubbled through orange juice its vitamin C efficiency is destroyed. Acids protect it and alkalies destroy it. Vitamin C is not colloidal in nature, for it can be dialyzed.

This nutritional factor cannot be stored in the body to the same extent as vitamin A.

Apples canned with their normal oxygen content lose all detectable amounts of vitamin C. The same effect is noticed when the oxygen is replaced by nitrogen. But, when apples are exhausted of their oxygen content, they lose no detectable amount of their vitamin C content.[7]

Ordinary light is unnecessary for the synthesis of this vitamin. Ultraviolet light has been found to be of no aid in its synthesis.[8]

Broken femurs, in guinea pigs, showed no signs of healing in three to four weeks when there was a deficiency of vitamin C. When they were fed a normal amount of the vitamin, the bone was completely consolidated in five to six weeks.

The metabolism of the cholesterol of the suprarenal glands is profoundly disturbed by a deficiency of this nutritional factor.[10]

Vitamin D Anti-Rachitic

Vitamin D is the anti-rachitic vitamin. Like the foregoing three vitamins it is both a preventive and a remedy.

Rickets is a children's disease. It is characterized by the failure of the bones to ossify. The bones become soft and bulky. Calcium, in the form of the oxide, and phosphorus are not taken into the bones when vitamin D is absent. This causes rickets.

It has been found that the mineral matter in rachitic bones falls from the normal 63% all the way down to 25%, in many cases. These figures, of course, do not apply to all cases of rachitis. Cod liver oil, although containing very little mineral matter, completely rectifies this condition. The vitamin investigators wonder at this and ask the question, "How can cod liver oil, which contains so little mineral matter, put so much of it into the bones?" They then proceed to say, in answer to the question, that vitamin D in the oil stimulates the bones so that they utilize the mineral matter in the blood.

It has been shown that, in the absence of vitamin D, the body cannot use its own rich deposits of calcium, and the calcium piles up in the system.

Curative Effects of Light

Hess came to the conclusion that ultraviolet light possesses a curative effect in rachitis like that of vitamin D. Steenbock went further and showed, experimentally, that foods which allow rickets to develop, act in just the opposite way after treatment with ultraviolet light. He has shown that irradiation with ultraviolet rays causes inactive vegetable oils to acquire anti-rachitic potency. The anti-rachitic factor has been found to multiply eight times when foodstuffs containing it are exposed to ultraviolet light.

Further, sawdust which has been irradiated with this short-wavelength light has been found to acquire anti-rachitic properties.

N-butyl nitrite, when heated with cod liver oil, rich in vitamin

D, destroys its anti-rachitic potency[12].

Cholesterol seems to be linked closely to vitamin D. If we saponify cod liver oil with sodium hydroxide, and remove the soap that is formed, it will be found that the cholesterol, which is left behind, contains almost the entire vitamin content of the oil. Many other widely differing experiments support this view.

Cod liver oil varies in vitamin D content with the diet of the cod and the treatment of the oil.

Passing to consideration of vitamin E, we find that it is the anti-sterility vitamin. H. M. Evans first clearly established its existence. He separated it from vitamin B, and named it vitamin X. Later it became known as E.

Sources and Effects

This vitamin is found in lettuce, meat, wheat germ, oats, and alfalfa.

Sterility is induced by a deficiency of this accessory food factor. In cases where it has been so induced, the feeding of vitamin E returns the individual to normal reproductive powers.

Vitamin E is soluble in many fats and so-called fat solvents such as chloroform and benzene. It is not destroyed by heat, and it can be distilled at 233° Centigrade. Hydrogenation does not destroy this vitamin.

It has been found that the irradiation of foodstuffs, or of the individual, with ultra-violet light does not compensate for vitamin E deficiency.

The suggestion, found under the discussion of vitamin B, concerning its stimulating power for the endocrine glands, probably does not apply to that vitamin. Since that work was done, the fifth vitamin has been isolated. Since this fertility factor was intimately mixed with B, it therefore seems necessary to assume that the stimulation noted was due, not to vitamin B, but to vitamin E.

Characteristics Common to Vitamins

There are some characteristics common to all of the vitamins. All of the vitamins are growth promoting. An excess intake of them does absolutely no harm. Furthermore, they are not habit forming like certain drugs and alkaloids. Careful studies have brought vitamin investigators to the conclusion that plants are the only organisms that can manufacture them, but that animals can store them. Germinating seeds contain vitamins by virtue of synthesis, while dry seeds do not contain them. It also seems that seeds that germinate in the light are more productive of these nutritional necessities, than are those that germinate in the dark. It is believed that vitamin synthesis is related to the green coloring, or chlorophyll part of the plant. And, quantitatively, the greater the green surface, the greater the vitamin producing power of the plant.

A good definition of vitamins is given by Madame Randoin[14]. It is in accord with the lack of definiteness which enshrouds the subject. She says, "Vitamins are defined as substances, still indeterminate chemically and physically, which the animal organism cannot synthesize, and which possess properties recognized in certain fractions of the unknown part of the diet, which are indispensable for the accomplishment of vital phenomena

in the adult, or during the course of the development of the animal, and whose absence produces characteristic pathological nutritional changes."

Some of the data given in this brief survey of the vitamins is quite contradictory. This is due to the fact that the vitamin investigators are not yet sure on all matters pertaining to the subject.

(To be continued)

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Oil Firms Consolidate

AT the recent annual stockholders' meeting of the Chickasha Cotton Oil Co. the acquisition of the Anadarko, Mangum and Hollis cotton oil companies was approved. The directorate of the Chickasha firm was increased from ten to eleven in order to elect the general manager of the Anadarko company to the board. It is expected that earnings of the Chickasha plants now will be better than $5.50 a share.

Glidden Moves Offices

The New York office of the Glidden Food Products Company, now at 82 Wall Street, will be located at 209 14th Street, Long Island City, after October 1. The Glidden Company of Cleveland purchased the new location recently as a permanent home for its New York offices and warehouses and for its Purit department, which markets the product of the Purit Company of Amsterdam, Holland.

Lauro Writes Paper

M. F. Lauro recently wrote a paper on the subject of separation and identification of various fatty acids by the determination of solubilities of their metallic soaps in various solvents. The paper was prepared by Mr. Lauro as a thesis for his M. S. degree at the Brooklyn Polytechnic Institute, New York.

This paper will be published in full or abstract in OIL & FAT INDUSTRIES in an early issue.