

Cod Liver Oil and the Vitamin Theory

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THE term vitamin was coined by Casimir Funk¹ as a descriptive name for a substance or substances which he believed were vital to health and which he believed contained nitrogen as an amine. Hence he combined the two words vital amine and coined the "vitamine." The work of Eijkman² on the effect of the presence or absence of rice polishing in the diet of pigeons and the work of Hopkins³ on the effect of the presence or absence of milk as a supplement to his purified ration for rats were precursors to the discovery of vitamin B and vitamin A. These investigations preceded Funk's studies by several years. In the years that followed, investigators in this country and abroad have conducted numerous vitamin investigations until now the literature contains hundreds of scientific papers reporting vitamin studies. As a result some six or seven vitamins have been described. All of these are reported to be essential for regulating or stimulating some special phase of human or animal metabolism. However, five of the vitamins have been more completely studied and are better known than the others. These are vitamin A—antiophthalmic; vitamin B—antineuritic; vitamin C—antiscorbutic; vitamin D—antirachitic; vitamin E—antisterility.

Vitamin A has been variously termed the antiophthalmic and the growth promoting vitamin. It performs both functions. When the vitamin A is inadequate or lacking from the diet, a particular type of eye trouble, characteristic of this dietary deficiency, develops and growth is retarded or stopped altogether. The antiophthalmic and growth promoting functions have been attributed to vitamin A for a relatively long time. More recently, other functions have been ascribed to vitamin A. It is now believed that vitamin A is of particular value for increasing the body's resistance to various types of infections and that a deficiency of vitamin A may cause a disturbance of reproductive functions and a degeneration of nerve tissue.

Vitamin B—antineuritic—must be continually present in the diet if one is to avoid various types of neuritic conditions. Vitamin B is a preventive for or a cure of a special neuritic condition known as "beri-beri" in humans and "polyneuritis" in chickens. During recent years, the substance originally known as vitamin B has been separated into two vitamins designated as vitamin B₁ and vitamin B₂ or as vitamin B and vitamin G.

Vitamin C—antiscorbutic—prevents scurvy or cures it if it is not too far advanced. When vitamin C is inadequate in amount or absent from the diet, scurvy results. Fortunately, however, vitamin C is very widely distributed in common food stuffs.

Vitamin D—antirachitic—is essential for stimulating and regulating mineral metabolism particularly calcium and phosphorus. Since the growth of the skeleton and teeth is in no small measure dependent on the proper metabolism of calcium and phosphorus, it is easy to understand the important role that this vitamin plays in the growth of children and young animals.

Vitamin E—antisterility vitamin—is believed to be essential for normal reproduction. When this vitamin is inadequate or lacking, conception may not take place, more frequently however pregnancy is inaugurated but the foetus dies sometime before normal term. The extent to which the lack of vitamin E may be responsible for premature human birth is a question which merits much careful attention. Also it requires very little imagination to appreciate the economic importance of normal reproduction in the live stock industry.

Vitamins in the Diet

THE relationship between vitamins and other constituents of the adequate diet may be compared to the relationship between the building materials and the workmen employed in building a house or similar structure. In fact,

the building of a house and the building of the human or animal body is quite similar in many respects. When building a house one obviously needs stones, bricks, lumber, cement, hardware, glass, and numerous other building materials. In addition it is necessary to have workmen. Similarly in building the human or animal body it is necessary to have various food constituents such as protein, fats, carbohydrates, and mineral matter and here also workmen or vitamins are needed. With plenty of building materials available and the workmen on a strike, no progress is made. Also with plenty of food constituents and no vitamins at hand, little progress is made in the growth and development of the human body. Efficient building operations require that workmen are specialists in some type of activity. In other words, one does not expect the paperhanger to do a mason's work in laying a cellar wall. Likewise, the various vitamins have their special functions. For instance, vitamin C, which is decidedly efficient for preventing or curing scurvy, is of little value for preventing or curing rickets. From this brief survey and analogy one can readily understand the necessity for care in selecting the diet of young growing children and the necessity for insisting that an adequate supply of vitamins is present to insure normal metabolism of the essential constituents of the dietary.

In considering the relationship of cod liver oil and the vitamin theory, attention is directed to the use of cod liver oil as a source of vitamin A and D. Obviously, an individual's dietary requirements for vitamin A and D begin at birth. In general, when considering their dietary needs, infants are classified as bottle-fed or breast-fed. Due probably in no small part to empirical observation it has been generally believed that the breast-fed infant is normally adequately nourished. As a result of this belief, numerous studies have been made of the nutritive value of cow's milk but very little study has been made of human milk. With the advent of the vitamin theory consideration was soon given to providing an adequate supply of vitamins as supplements to the modified milk formula. It became a rule to give infants orange juice to protect them against infantile scurvy and pediatricians regularly prescribed cod liver oil to compensate for the low supply of vitamin A and vitamin D in cow's milk. More recently investigators of the nutritive value of breast milk have shown that the vitamin A content of human milk is quite variable and frequently not adequate for the infants' needs. Kennedy, Palmer and Schultz⁴ have reported that the vitamin A content of human

milk is dependent on the nature of the diet of the mother. From their extensive studies of breast milk Macy and Outhouse⁵ have concluded that "Adjuvants rich in vitamin A, therefore, should be added early to the diet of the breast-fed as well as of the artificially-fed infant. This would not only protect against a widespread series of pathological changes, but would aid particularly in the promotion of optimal well-being."

Results of Vitamin Deficiency

FROM the foregoing the importance of vitamin A as a growth-promoting vitamin can be appreciated. However, vitamin A has other important functions. Numerous investigators have noted that vitamin A deficiency is frequently followed by a lowered body resistance to various types of infections. Werkman⁶ found that rats and rabbits which had been maintained on diets low in vitamin A were less resistant to anthrax bacillus and pneumococcus than animals given an adequate supply of this vitamin. Daniels, Armstrong, and Hutton⁷ noted that laboratory animals which received vitamin A low diets were predisposed towards infections of the nasal and aural passages. Dean⁸ believes that generous vitamin A feeding is indicated for the treatment of paranasal sinusitis in children. Sherman and Burtis⁹ reared groups of albino rats under conditions identical except as regards the vitamin A content of the diet. In translating the results of their studies into human life, the authors conclude that their results indicate "the differences of incidence to infections to be expected of children around ten to twelve years result from differences in the way they were fed before they were three years old."

It has been noted that long continued vitamin A deficiency in adults may occasion a disturbance of the normal functioning of the reproductive organs and in some instances nerve degeneration has also followed vitamin A deficiency. Hence it appears that one should make adequate provision for vitamin A to meet the body's needs at all stages of one's existence. Attention⁵ has been called to the fact "that in the United States one may be dealing with dietaries not wholly devoid of vitamin A and one may not be confronted with the gross pathologic process of xerophthalmia, but rather with borderline conditions such as anorexia, cessation of growth, gastro-intestinal disturbances and susceptibility to infection of the nasal sinus, middle ear and mastoid. In the absence of well defined physical or bacterial causes, such symptoms may be significant of an appreciable deficiency of vitamin A in the diet."

Nearly three centuries ago¹⁰ Glisson identified rickets and for more than a hundred years it has been known that cod liver oil was particularly efficacious for the treatment of rickets. However, it was not until after the advent of the vitamin theory and the recognition of the action and function of vitamin D that a clear understanding developed concerning the role of cod liver oil in the treatment of rickets. Since the mineral portion of bone consists principally of calcium and phosphorus, in order to secure satisfactory bone development, it is essential that the diet should supply sufficient amounts of calcium and phosphorus to provide for bone structure. However, with an adequate amount of calcium and phosphorus present, if vitamin D is inadequate or absent from the diet there is insufficient utilization of calcium and phosphorus for forming normal bones and teeth. This type of malnutrition is known as rickets and afflicts children and young animals. Vitamin D is essential not only during the stages of active growth but during later life. In case of bone repair as following a fracture or after bone surgery, it is essential that an adequate amount of calcium, phosphorus and vitamin D be provided.

McCullum¹¹ and Peterson¹² have reported that it is essential in the treatment of non-union fractures to give careful attention to the vitamin content of the diet. In their studies, these authors obtained excellent results by supplementing the diet with calcium carbonate and cod liver oil. The results obtained were very significant—"Out of twenty patients with fractures of long standing who were treated according to this plan, eighteen secured satisfactory unions. The remaining two cases were handicapped by complications arising from infections." From time to time it has been noted clinically that breast-fed infants develop rickets. Accordingly, it is now recognized that human milk is a doubtful source of the antirachitic vitamin. As a consequence, it has become a quite general routine practice for pediatricians to prescribe cod liver oil as a source of vitamin D to supplement the dietary of both breast and artificially-fed infants.

Nature of Vitamin D

DURING the past five years, considerable research work has been directed towards determining the nature of vitamin D and it has been found that a number of edible oils acquire antirachitic activity when irradiated under controlled conditions with ultraviolet lights of certain wave lengths. The earlier studies seemed to indicate that the cholesterol present in fats was responsible for the development of anti-

rachitic potency in irradiated fats. The effectiveness of sunshine in preventing or curing rickets was explained as resulting from the irradiation of the cholesterol in the human fat in the skin by the natural ultra-violet light in the sunshine. This explanation, however, was short-lived for soon the brilliant researches of Hess¹³, Rosenheim¹⁴, Steenbock¹⁵, Webster¹⁶, and Windaus¹⁷ showed that minute amounts of ergosterol were associated with cholesterol as it was distributed in natural products. These investigators also showed that it was the ergosterol that became active when treated with ultraviolet light. They found that ergosterol, when prepared in the pure form, was a white crystalline substance, which if treated with ultraviolet light under proper conditions acquired antirachitic properties. When the irradiated ergosterol was fed to rachitic albino rats it was found to possess heretofore unheard-of calcifying value. As soon as the significance of these discoveries was appreciated, attempts were made to produce this material on a commercial scale. As a consequence, there has recently appeared on the market various preparations under the name of "Viosterol" designed to be used in the prophylactic or curative treatment of rickets in the place of cod liver oil. However, a careful comparison of viosterol and cod liver oil shows that while both may be used as antirachitic agents their functions and values are quite different.

The irradiated ergosterol preparations are extremely potent calcifying agents. Accordingly, in the treatment of rickets it is possible to administer therapeutic amounts of irradiated ergosterol by drops even when the irradiated ergosterol has been many times diluted with corn or other vegetable oils. Thus if one wishes to secure rapid calcification, the irradiated ergosterol preparations are extremely valuable products. But here the therapeutic value ends for irradiated ergosterol possesses no vitamin A value. Thus if one wishes to secure the beneficial action of vitamin A for increasing the body's resistance to infections and for insuring normal functioning of the body in other respects irradiated ergosterol is not indicated. On the other hand, as pointed out above, cod liver oil contains both vitamin A and vitamin D. Since its calcifying value is lower than that of irradiated ergosterol, viosterol, larger amounts are required to perform the same results. Thus cod liver oil is administered by the teaspoonful and viosterol by drops, but the necessity for larger amounts may in some instances be a blessing in disguise for there is little likelihood of an overdose of cod liver oil and evidence is at hand to show that the inges-

tion of too much irradiated ergosterol produces undesirable and sometimes disastrous results.

The condition for which the antirachitic factor is most definitely indicated is in the prevention or cure of rickets. It is generally agreed that the amount of the antirachitic factor required for the cure of rickets is very greatly in excess of the amount required for prophylactic use; thus it would at first appear that irradiated ergosterol was par excellence the substance to be used for this condition. However, it has been recognized for a long time that individuals afflicted with rickets were particularly susceptible to various types of infections. Hence it appears that in the treatment of rickets provision should be made for vitamin A as well as vitamin D. In this connection reference may be made to the investigations of Daniels⁷ and coworkers who noted that the laboratory animals which they maintained on low calcium rations but to which they gave an adequate supply of vitamin A, failed to develop infections of the nasal and aural passages and this led them to conclude "that the well known low resistance in rickets is the result of a deficiency in the fat-soluble A vitamin or some substance associated with it and not to calcium deficiency."

Perhaps the value of cod liver oil in the treatment of rickets and some other diseases is not wholly due to its generous supply of vitamin A and vitamin D but may be due in part to the ratio of vitamin A to vitamin D which exists in cod liver oil. As early as 1923, Hopkins¹⁸ suggested that a balance of the vitamins in the diet might be an important factor

in the maintenance of normal health. Recently Hoyle¹⁹ has suggested that "a degree of deficiency of vitamin A or excess of vitamin D, either of which acting separately might be quite inadequate to induce calculi formation, when acting together might well do so. Such a condition would illustrate clearly the significance of 'vitamin balance' in the case of the fat-soluble accessory factors." When the advent of viosterol, with its excessive antirachitic potency, there appears to be need for more conclusive evidence as to whether the upsetting of the ratio of vitamin A to vitamin D by the administration of relatively large amounts of the antirachitic factor is without significance or whether as suggested by Hoyle¹⁹ the administration of large amounts of the antirachitic factor in conjunction with a low or perhaps deficient supply of vitamin A may be the cause of unexpected and disastrous results.

However, regardless of the outcome of questions of this character there now seems to be a satisfactory theory to account for the efficacy that cod liver oil has enjoyed for generations. With the development of the vitamin theory and the accumulation of data concerning the role and function of vitamin A and vitamin D we have an explanation for the peculiar value that cod liver oil has had in the treatment of certain diseases and nutritional disorders. Hence we find the close relation that exists between the high therapeutic value that cod liver oil has enjoyed for ages and the vitamin theory which has developed with the last two decades.

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The quantity of decolorizing carbon shipped from the Netherlands to the United States during the first six months of 1929 aggregated 747,672 pounds, valued at \$48,410 as compared with 394,352 pounds, valued at \$30,440 during the corresponding period of 1928.

A. E. Starkie, sales manager of soap making oils and fats for Glidden Food Products Co., for the past eight years, joined the Acme Oil Corp., 800 N. Clark St., Chicago, in the same capacity, as directing vice-president, on Jan. 1.

Sharples Separator Co., West Chester, Pa., is now distributing an eight-page folder describing the Sharples Super-Centrifugals for use in oil purification and reclamation. The Sharples machines are used in a number of industries to remove particles of foreign matter, impurities and moisture from oils.

American Can Co. and Thermokept Corporation are cooperating with English interests in the formation of the British Can Co., which has acquired the business of Ernest Taylor, Ltd., of Liverpool, H. W. Phelps, president of the American Can Co., and Harry Craver, vice-president, will be directors of the new company and other American members of the board include Robert M. McMullen, chairman of the Thermokept Corporation, and George K. Morrow, chairman of the United Cigar Stores Corporation and Gold Dust Corporation.

Excess stocks of olive oil in Spain were responsible for a recent conference of Spanish olive oil producers in Madrid. They propose the following measures to relieve the situation: Compilation of statistical data to show world production and prices, confining of propaganda to organize producers, advertising among medical authorities as to the hygienic and alimentary properties of olive oil, and prohibition of manufacture of oils from imported nuts and seeds.

Considerable interest is being exhibited throughout the world in the forthcoming German "Great Exhibition of Chemical Apparatus,ACHEMA VI" organized by the Deutsche Gesellschaft für chemisches Apparwesen E.V., which is to be held at Frankfort a/Main from June 10 to 22, 1930. The sponsors of the exhibition expect visitors representing the chemical industries of the major countries of Europe, America and Asia.

The National Tung Oil Company, a new \$1,000,000 corporation with headquarters in Chicago, is reported to have purchased 10,000 acres at Bond, near Wiggins, Mississippi, upon which tung trees will be planted this year.

The area sown to rapeseed and mustard seed in India for 1929-30 is reported to be 3,372,000 acres, compared with 3,073,000 acres reported at the same time last year. The final report for last season, however was 6,823,000 acres.