SEASONAL VARIATIONS IN BUTTER-FAT VITAMINS AND THEIR RELATION TO SEASONAL MORBIDITY, INCLUDING DENTAL CARIES AND DISTURBED CALCIFICATION

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SEASONAL VARIATIONS IN BUTTER-FAT VITAMINS AND THEIR RELATION TO SEASONAL MORBIDITY, INCLUDING DENTAL CARIES AND DISTURBED CALCIFICATION*

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LIFE'S most precious jewel is health, the quest for which becomes an almost universal struggle with the increase of age, when a breakdown applying to various organs and tissues of the body, as well as to the body as a whole, occurs. The causes are, in general, the same; namely, degeneration due to one of the following conditions: disturbed nutrition, exhaustion or wear, or injury from bacteria and their products.

While specialists assign themselves to the particular needs and problems of various organs and tissues, they are, in the last analysis, largely dealing with the same problems. Prior to the advent of Pasteur's great contributions, the empbasis was placed on diatheses or constitutional tendencies. With the advent of Pasteur's disclosures, that invading organisms were present in many of the epidemic diseases, the emphasis turned from the host to the invader. Within the last decade, there has been a marked tendency to reinstate constitutional conditions, putting the emphasis on both the host and the invading organism, with an increasing emphasis on the characteristic host which makes its tissues available as soil for microscopic invasion by plant and animal forms.

This new point of view has stressed the importance of the soil on which the organisms may grow, and this quality has been found to be due, in part, to individual peculiarities of the host, some of which are characteristic of the family and, therefore, are hereditary for the family group. Some other factors are definitely acquired and are known to be variable. We may speak of these as acquired susceptibilities, and they will apply to disturbances in many, if not all, organs and tissues of the body. It is as a part of the general study of those factors in an acquired susceptibility to degeneration or bacterial invasion that the researches being reported in this communication have been directed.

In my paper read before this society a year ago at Minneapolis,[1] I presented data indicating that a condition of decalcification obtains in many individuals, particularly elderly people, though not controlled by age, in whicb there is a

*Read before the Section on Oral Surgery, Exodontia and Anesthesia at the Seventy-First Annual Session of the Americau Dental Association, Washington, D. C., Oct. 9, 1929.

1. Price, W. A.: New Fundamentals For the Treatment and Prevention of Dental Disease Based on Calcium Utilization and Disturbauce, with Special Consideratiou of Factors Determining When an Infected Tooth Becomes a Liability, J. A. D. A., 16:456 (March) 1929.

tendency to rob the system in order to get the chemicals required for the maintenance of function for the needs of life. I also presented data indicating that certain activators are necessary in order that our bodies may utilize various chemicals which are in foods and which the body needs.

These activators have a rôle which, in some regards, might be compared to that of an ignition system of a gas engine in relation to the utilization of the fuel. The problem has, accordingly, enlarged to include three fundamental factors; namely, inherent characteristics of the individual, contributing overloads and the availability of activators in order that efficient health may be maintained in conjunction with an adequate source of energy food factors.

The purpose of this communication is to present data indicating a seasonal variation in certain of the activators which are related to various food products, particularly calcium and phosphorus, the chief constituents of the bones and teeth, but also required in practically all of the tissues, and also to indicate that these seasonal variations seem to have a distinct relationship to the seasonal variations in health and disease.

SEASONAL TIDES IN MORBIDITY AND MORTALITY

It is strange how prone we are to take that which occurs with regularity as essential. Probably almost everyone knows and expects that there will be more sickness and deaths in the north temperate zones in the winter and spring than in the summer and autumn, and most people assume that it is an essential condition of winter. Doubtless, few have suspected that this cycle has its counterpart in a large number of physical expressions other than disease or degeneration. The death rate of the entire United States varies from about 128 in March per hundred thousand to about eighty-five in September, and, in Cleveland, varies from about 110 in March to about seventy in September. These figures for the United States are for the years from 1920 to 1925 inclusive, and for Cleveland from 1925 to 1928 inclusive. In general, these curves are similar except that, for the entire United States for the six years covered, the peak is in February, a month earlier than in Cleveland. This is shown graphically in Figure 1.

Another source of data is the demand for hospital beds in different months of the year, there being a much greater demand in the late winter and spring than in the summer and autumn. This also is shown graphically in Figure 1. The data for this curve, obtained from the Cleveland Welfare Association, are consolidated from sixteen hospitals of this city for the total days of treatment for medical cases, by months. It will be noted from this, as in the two mortality curves, that the peak of demand is in March for 1928, and that there is marked summer and fall depression and then a rapid rise in December.

Many degenerative processes apparently have a cycle of severity or incidence. This is particularly true of skeletal decalcification, one expression of which is familiar to the dental group; namely, the activity of pyorrhea in the destruction of alveolar bone and the development of dental caries. A survey of my clinical records indicates approximately four times as much dental caries in the winter and spring as in the summer and fall.

Particularly conspicuous among the evidences of decrease of immunity will be found the increased susceptibility to respiratory infections which occur in the

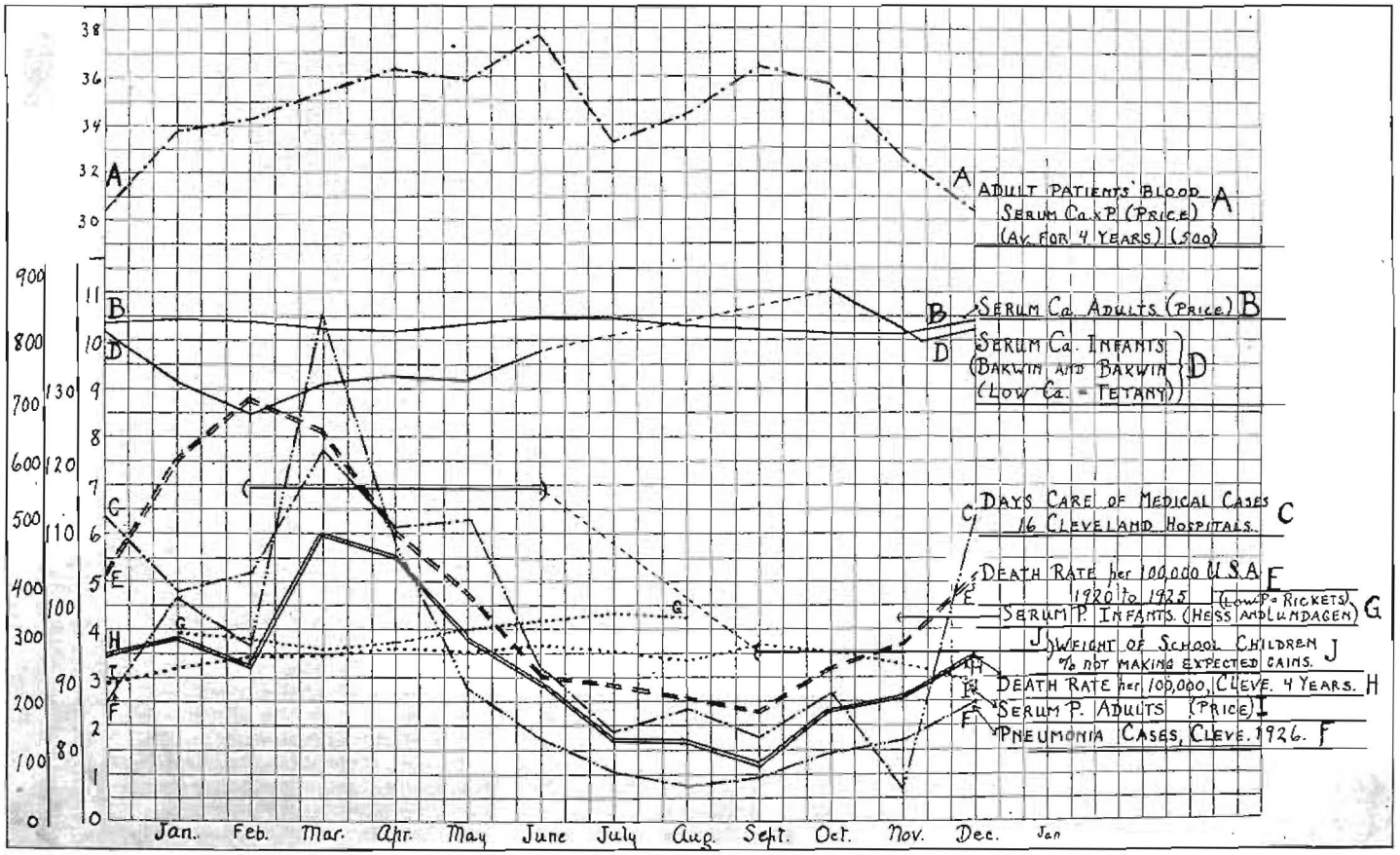


Fig. 1.—Seasonal periodicity in vital factors. Series of ten graphs showing evidence of annual cycles. *A*, composite graph of the product of serum calcium and serum inorganic phosphorus of about 500 patients, covering a period of 4 years. *B*, a similar study for serum calcium. *C*, days care of medical cases in sixteen Cleveland hospitals. *D*, serum calcium of infants, January to June as compared with October to December inclusive. *E*, death rate per hundred thousand in the United States, 1920 to 1925. *F*, pneumonia cases in Cleveland for 1926. *G*, serum phosphorus of infants. *H*, death rate per hundred thousand in Cleveland for four years. *I*, serum inorganic phosphorus of adults for 4 years. *J*, the percentage of school children not making normal expected gains in winter and spring as compared with the fall.

north temperate zone in the winter and spring. The incidence of pneumonia, for example (Fig. 1), in Cleveland in 1926 dropped from 83.8 per hundred thousand of population in March to 5.3 in August. Erysipelas varied from 4.8 in April to 0.6 in August; which indicates a difference in general defense to bacterial invasion from organisms which probably attack the body when it has lost its maximum defensive ability, which we speak of as immunity.

That there are cycles in a number of our physical factors has been demonstrated. Seidell and Fenger[2] have shown that the iodin content of thyroid glands of sheep and pigs is about three times as much for the months from June to November as for the months from December to May. Malling-Hansen and others have shown the growth of children to be more rapid in the spring and snmmer than in the winter.

An important contribution to this phase has been furnished to me by the Department of Physical Welfare of the Cleveland Board of Education. They have given me data obtained from the study of two schools in Cleveland where determination was made of the percentage of children making expected gains in weight in each of two periods, September to January, and February to June. These children were divided into grades and averages made for all grades and for each school separately, and then for the two schools combined. These data reveal that only 32 per eent of the children studied in both schools, representing 1,429 pupils, made the expected gain in weight in the spring; whereas, in the fall period, there was a gain of 64 per cent. This is shown graphically in Figure 1, *J*.

2. Seidell, A., and Fenger, F.: Seasonal Variation in the Iodine Content of the Thyroid Gland, J. Biol. Chem., 13:517, 1913.

One of the disturbances showing marked seasonal expression in the north latitude of America is tbe development of rickets in children under 2 years of age. It has been demonstrated that 90 per cent of all children under 2 years of age in the large cities of that zone have some rickets if not treated with sunlight or artificial light, or with vitamin D. This condition has its expression largely in conjunction with the depression of the inorganic phospborus of the blood. This affection usually is cured spontaneously in the summer and early autumn. Hess and Lundagen,[3] writing on artificial radiation, state: "In this connection, it is well also to bear in mind that rickets and tetany are almost nonexistent in the tropics." These authors present data under the title, "A Seasonal Tide of Blood Phosphate in Infants," in which they indicate a level of 4.3 for phosphate in June and July, 1921; 3.95 in December; 3.9 in January; 3.75 in February; 3.58 in March, and rising progressively to 4.22 in June. These figures are shown graphically in Figure 1, *G*.

In a group of somewhat older children, they found the averages to vary in the same direction, but to a smaller extent.

Disturbances in the level of calcium in many animal forms result in tetany if the fall is too great. Bakwin and Bakwin[4] have presented data under the title, "Seasonal Variation in the Calcium Content of Infants' Serum," in which they have studied a large group of infants through several months and have presented the mean for these in chart form. They found, in general, that the calcium tended to be low in February, increasing progressively to June, and was at tbe highest

3. Hess, A. F., and Lundagen, M. A.: A Seasonal Tide of Blood Phosphate in Infants, J. A. M. A., 79:2210 (Dec. 30) 1922.

4. Bakwin, Harry, and Bakwin, Ruth Morris: Am. J. Dis. Child., 34:994 (Dec.) 1927.

point recorded in October, from which point it progressively decreased to February, the range being from 8.4 in February to 10.9 in October. These data are expressed graphically in Figure 1, *D*.

I presented data[5] before the American Association of Medical Milk Commissions, Inc., Montreal, June, 1929, comparing mortality rates for four successive years in Cleveland in order that an observation may be made on the general similarity for different seasons. A curve for this is presented in Figure 1, *H*, showing the death rate per hundred thousand in Cleveland. From this, it will be seen that the high point for mortality is in March, with April nearly as high, but with a progressive monthly decrease through to September, when it rises again through October, November and December. Similarly, I am presenting a graph of the mortality rate, which is shown in Figure 1, *E*, per hundred thousand for the United States for the years 1920 to 1925 inclusive. It is of interest to know that the peak for most of the country comes in February, with the low point again in September, and a rapid increase to December.

Another important phase of this problem has to do with the seasonal cycle of development of degenerative processes in adults. I have presented data in many of my reports indicating a relationship between imbalances in the chemical constituents of the blood and these disturbances. There are many expressions of these affections, some being local in the mouth as a tendency to dental caries, others as a tendency to the development of pyorrhea, often in association with general systemic decalcification of the skeleton, and with expressions of disturbed function of one or several organs of the body. I have also presented data indicating that some of these factors are directly influenced by

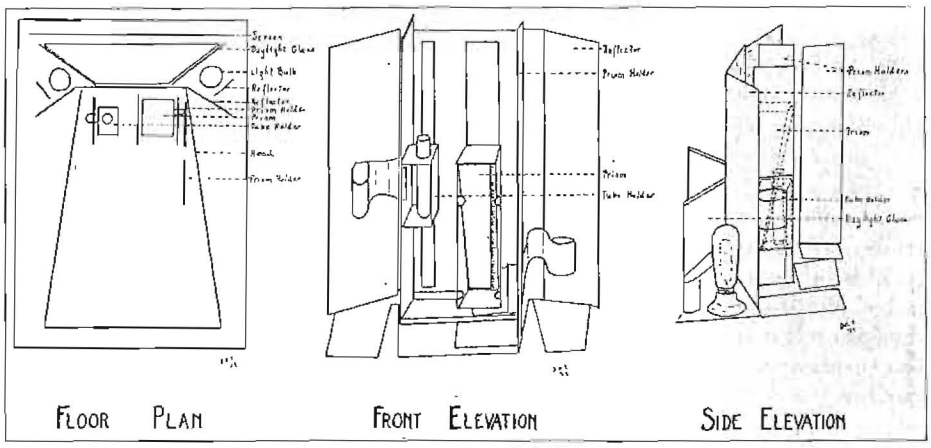


Fig. 2.—Author's instrument for making the vitamin A test, the color tone of which is transient.

5. Price, W. A.: Calcium and Phosphorus Utilization in Health and Disease. I. The Rôle of the Activators for Calcium and Phosphorus Metabolism. II. The Nature and Source of Calcium and Phosphorus Activators. III. Seasonal Variations in Butter-fat Vitamins and Their Relation to Seasonal Morbidity, J. Certified Milk, October-Deeember, 1929.

toxic material from focal infections, particularly infections such as dental in bone, and further that defense against focal infections is directly influenced by these chemical imbalances.

As an aid in my diagnostic procedures, I have included, during the past seven years, a blood chemical study, having now 1,800 sets of blood chemical determinations, many of which have been made at different times for the same individuals while under operation and during treatment. When these data have been projected in chart form, there has been disclosed a cycle. For these graphs, I have used determinations of approximately 140 patients a year for four successive years: 1926, 1927, 1928 and eight months of 1929, having a total of about 500 cases. These curves, represented in Figure 1, *I, B* and *A*, show, respectively, the averages for the inorganic serum phosphorus, the serum calcium and the product of serum calcium and serum phosphorus, the last of which at normal should be approximately 40. It will be seen that a distinct seasonal cycle is expressed, with its maximum depressions in December, January and July, and with the peak in June, September and October.

Similarly, curves might be added for the development of epidemic infections such as colds and influenza. Enough has been shown to indicate a marked annual cycle in morbidity and mortality both, as relates to certain of the infectious diseases, particularly respiratory and nutritional disturbances. These indicate a general maximum of susceptibility for the north latitude for the late winter and early spring months, with the minimum of susceptibility for the summer and early autumn.

A new condition has obtained in recent years in that fewer individuals are dying of epidemic contagious infections and more of degenerative processes through the breaking down of one or more of the organs or groups of tissues of the body. The indications are strong that individuals do not die so much because they get diseases as that they get diseases because they are in the process of dying. The data from researches that I am herewith reporting suggest that the seasonal tides of regeneration and degeneration are directly related to functional causative factors, part of which are found in the seasonal tide of activators in the available foodstuffs.

VITAMINS IN IMMUNITY AND GROWTH

A striking advance in knowledge regarding the factors involved in immunity has been the discovery of the rôle of the vitamins. While vitamin A has a marked influence on growth, perhaps even this is not considered to be so important a discovery as its influence on the defense of the body against infection, particularly infections of the respiratory system. The absence of vitamin A is attended with a decrease in the rate of growth, and the development of a severe disturbance of the eyes, known as xeropthalmia, which may result in the destruction of the function of the eye. But this injury seems to be largely the result of the bacterial infection which develops because of the lack of immunity. All epithelial tissue seems to be influenced directly by the absence of this activator.

Similarly, an absence of the antipellagric factor, vitamin G (formerly B_2), produces marked changes, both physically and functionally, in the intestinal tract, one of the characteristics of which is marked in the susceptibility of this tract to invasion. Another striking characteristic is the effect of vitamin D, which is usually thought of as being important in the prevention of rickets. This activator

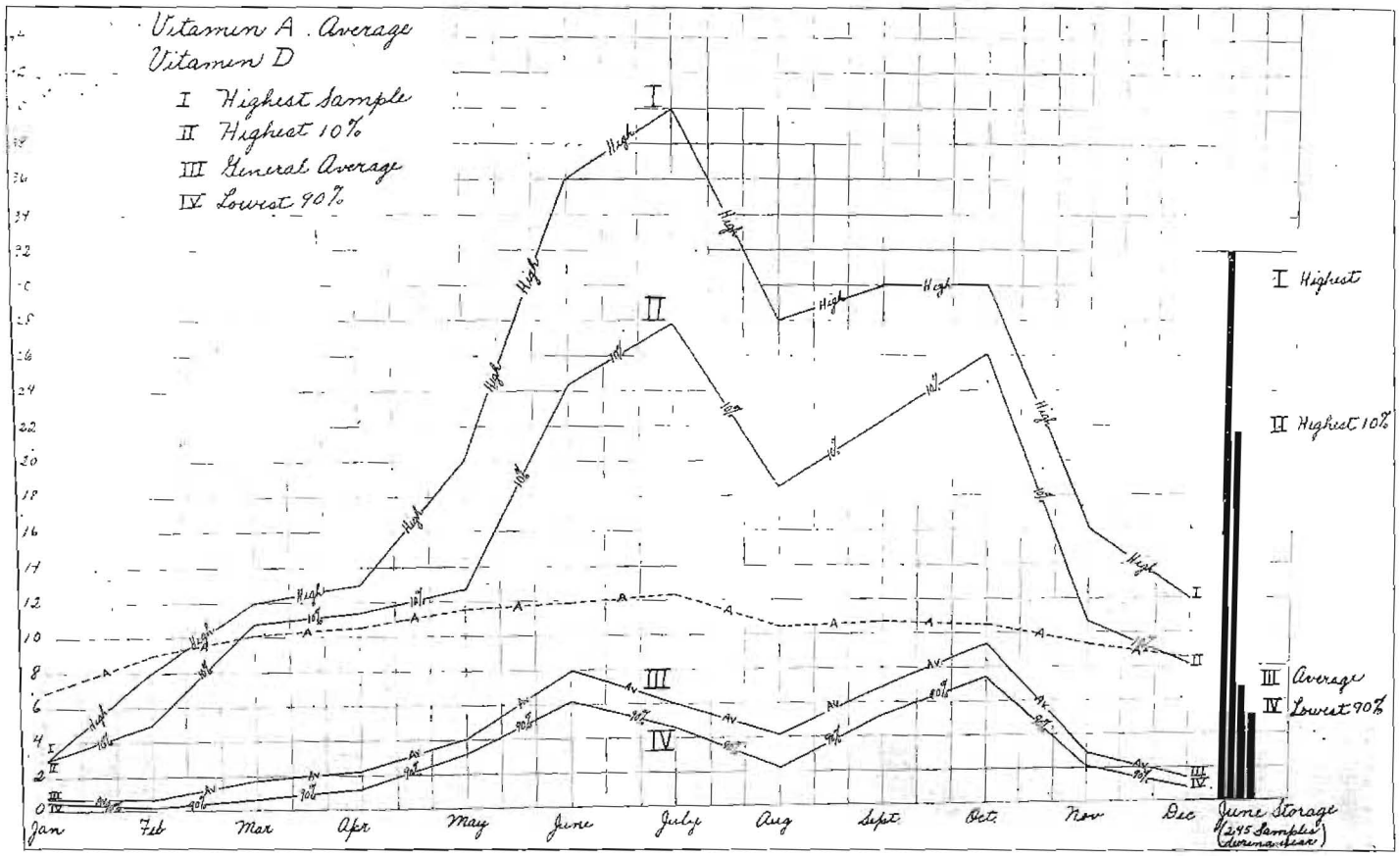


Fig. 3.—Monthly variations in the levels of vitamins A and D in butter from five states during 1928. Vitamin A is shown in the dotted line; vitamin D in the solid line in 4 percentages: (1) highest 1 per cent; (2) highest 10 per cent; (3) general average; (4) lowest 90 per cent. The solid vertical lines at the right indicate the same factors for June storage butters as tested the following winter.

is able to produce marked changes in the hydrogen-ion concentration of the intestinal tract, which largely determines the type of organisms that can proliferate. This vitamin has also been shown to have a marked influence on the metabolism of calcium and phosphorus as well as in their deposition in normal and abnormal calcification processes. The absence of this vitamin, and probably some other activators which are associated in the process, compels the organism to take calcium and phosphorus and probably some other substances from the storage depots of the body for use in the functional processes, in which rôles some of it is lost by excretion. I interpret my research data as indicating that one of the important factors in the degeneration of organs and tissues is associated with this general phenomenon of overdraft on the storage of calcium and phosphorus.

We are all familiar with the commonly recognized problem that in elderly people broken bones do not always readily heal. It has not been appreciated that these bones break largely because they have been weakened from within and further that they do not heal or unite because of the stress produced within the body by the establishing of that condition which produces decalcification. In my studies of these problems of calcification disturbance, I am frequently asked to assist in the management of cases of ununited fracture, and it has been most gratifying to find that in many of these cases, complete union is often brought about quite readily, when a negative calcium balance is changed to a positive. It is also of interest that blood chemical analyses will generally disclose whether or not the broken bone would heal readily.

I have discussed this at some length,[1] showing that as the chemical conditions of the blood improved, there was not only the union in fracture which had existed over a period of nine months in a woman 74 years of age, but also that there was roentgenographic evidence of a marked increase in the cortical layer of the bone in the short period of twelve weeks following treatment by increasing the available activators. This condition occurs in young people as well as old. It much more severely affects people beyond middle life. My data indicate to me that it is an important factor in the development of the essential constitutional phases of the so-called horizontal type of pyorrhea. These individuals are, in a sense, literally burning their furniture, because they cannot take from the food, even though the elements are present in the food, an adequate quantity of calcium and phosphorus for the anabolic and katabolic processes of the body.

We are coming to appreciate that the skeleton is as important as a storage depot for the readily available supply of calcium and phosphorus for the fluctuating demands of routine life as it is as a framework. Many forms of sea life maintain storage depots in their shells, just as a bird's egg provides the calcium for the developing birdling as well as for protection. These depots are necessary because of variation in the available supply of those other products in the foods and because of variation in the supply of the necessary activators for obtaining them from the food. The ignition system is necessary as well as the fuel.

It has been known for some years that the more foods were purified, the shorter would be the period for which they would maintain life. It has also been known that certain vegetable and animal products could not, of themselves, maintain life, but would do so with a minute addition of some other animal product. For example, the laws have required that oleomargarin

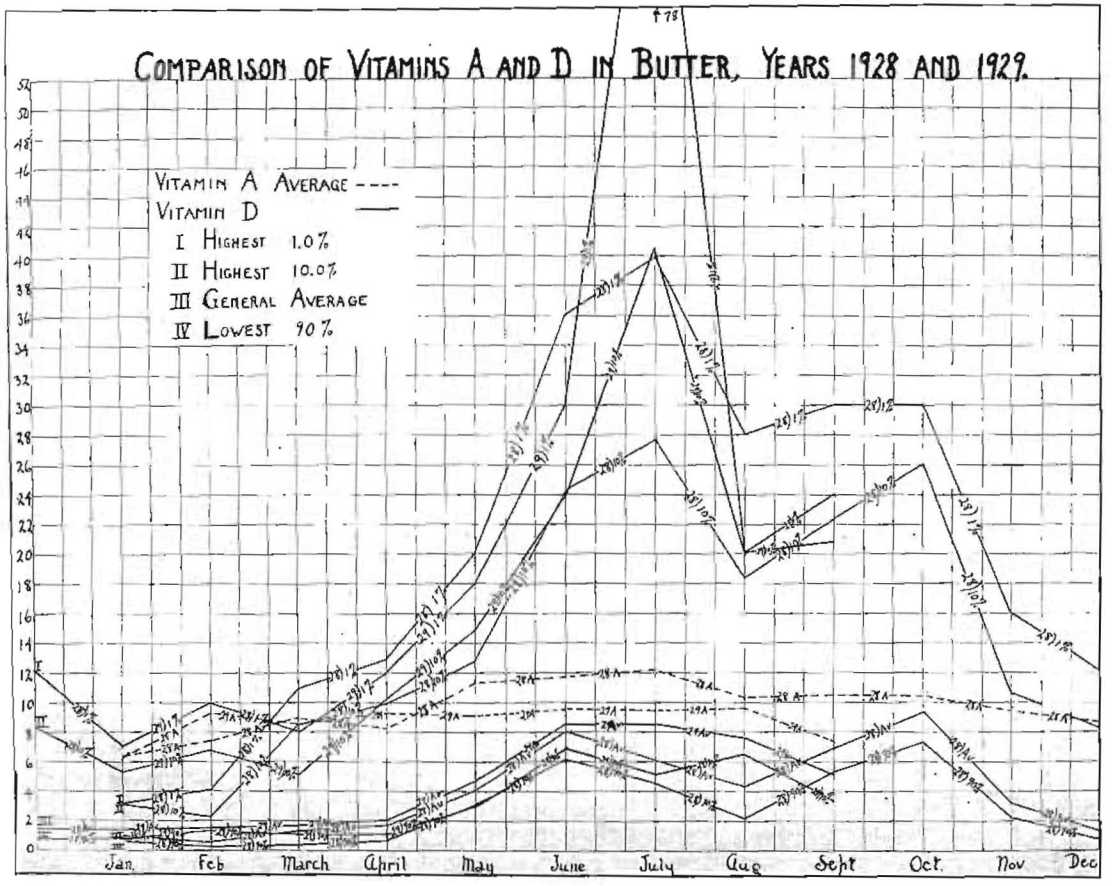


Fig. 4.—Comparison of the levels of vitamins A and D in butter in 1928 and 1929. *I*, the highest 1 per cent; *II*, highest 10 per cent; *III*, general average; *IV*, lowest 90 per cent. (Five state area.)

carry a certain percentage of butter because it was known that alone, under certain conditions, it could not maintain life. With the addition of but 25 per cent of butter, it is life sustaining and will insure growth.

It has not been appreciated to what extent these vitamins were present in the butters used to vitalize the oleomargarin, nor the factors controlling the variation. It is now recognized that human beings cannot, and probably few of the other animal forms can, develop without the presence of an adequate supply of vitamins. Some of these are quite readily provided in the vegetation, particularly vitamins B, C and E, and in some instances A. It is probable that there is greater general stress due to the absence of vitamin D than any other of the known activators because of its scarcity. The civilizations of the world have been built around three principal sources of food; namely, dairy products, sea foods and leafy vegetables. Some communities have had all three, but most communities have depended chiefly on either dairy products or sea foods. A few have had to depend, in considerable part, and usually with great difficulty, on obtaining these vitamins from the sterols of vegetation, particularly of special plants.

American civilization is built largely around the dairy cow as a source of vitamin D and, in a lesser degree, as a source of vitamin A. All mammalian forms are dependent on milk as the principal or sole source of nourishment for the early period of extra-uterine life. In the United States, we maintain, approximately, 25,000,000 dairy cows, or one for every five of the population; approximately eight for every square mile of the habitable country.

The dairy industry constitutes one of the great enterprises of the United States. Approximately forty cents of every dollar that is earned in wages and salaries in the United States goes to buy food; which amounts to about two billion dollars; and probably more is expended for milk and milk products than for any other food. On the basis of its merit and efficiency, this is as it should be and this is probably not so large a sum as it will become with the knowledge and means for increasing the food value of dairy products through an increasing of the vitamins. In my researches on means for preventing dental caries and improving calcification processes, I have been impressed not only with the structure of the teeth, but also with their freedom from dental caries in people who have come from certain communities, as, for example, some places in southern Europe, and we have observed that when these people came to America, this immunity was lost, often within a year or two and that, particularly under stress of overload, they have developed caries. This has been more noticeably true of growing children and in motherhood and during the lactation period. It is particularly significant that, in some districts, women will be relatively immune to dental caries throughout the child-bearing period; while, in certain other districts, their immunity may be adequate or nearly so up to the child-bearing period, and then be lost.

We should have these and similar data in mind when considering the importance of the activators in various foods, especially dairy products. Most people are familiar with the fact that some mothers cannot efficiently rear their own infants on the breast-food that they produce. Probably, few people having no direct contact with the dairy industry have been familiar with the difficulty that is sometimes encountered in raising calves on their own mother's milk, while the milk of some other cow will be entirely effi-

cient. Similarly, it is a matter of common knowledge that infants and growing children do not thrive well on the milk of some cows but do on that of others. By ordinary chemical analyses, these different milks are often found to be comparable; indeed, the milk that is unsatisfactory may have a higher caloric value than the one that is satisfactory. With the development of biologic chemistry, particularly in conjunction with the study of the vitamins, it has come to be quite a common practice to use dairy products as a source of essential food elements, usually, if not generally, with the presumption that milk is milk and butter is butter, and, therefore, one is quite as good as another.

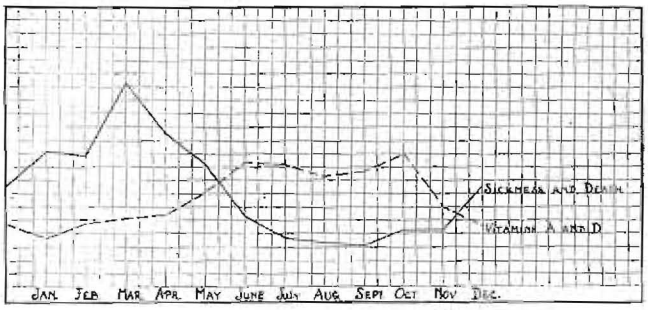


Fig. 5.—Comparison of the graph for the vitamin levels with that for the morbidity levels by months. The latter is the reverse of the former.

An interesting observation was made by McCollum, Simmonds, and Becker, under the title, "Studies on Experimental Rickets; Variation of Vitamin D Content of Butter Fat as a Factor in the Development of Rickets Induced by Diets Suitable for Preparing Rats for the Line Test."[6] They found, in using the same formula in two different periods of the year, where apparently the only difference was the butter fat sample, for the quantity of butter was the same, that there was a marked difference in the effect of the diet. In one series of experiments, these diets produced marked deficiencies in the bone structures in twenty-five days; whereas, they would usually not be ready for the line tests for about from thirty to forty days. In a series of experiments run in the autumn of that year, the same quantities of butter from a different source being used, the bones were almost normal in structure. The authors state: "Since we have chanced to use a sample of butter fat which contained more than the usual amount of vitamin D, we publish this brief account of our experience in order to point out the necessity of keeping the butter fat content of the diet as low as possible, since this may in certain cases be a disturbing factor."

Some important work has been reported by Luce on, "The Influence of Diet and Sunlight upon the Growth-Promoting and Anti-Rachitic Properties of the Milk Afforded by a Cow,"[7] in which she states: "Milk from the same cow has been shown to vary within wide limits, as regards its anti-rachitic and growth-promoting power. A possible contrib-

6. McCollum, E. V.; Simmonds, Nina; Becker, J. E.: J. Biol. Chem., 70:437-438 (Oct.) 1926.

7. Luce, E. M.: Biochem, J., 18:716-739, 1924.

utory cause of the seasonal incidence of rickets in children may be the use of milks whose anti-rachitic value is higher in summer than in winter." She states further: "The anti-rachitic value depends on the diet of the cow, and possibly also on the degree of illumination to which she is exposed. Milk from a pasture fed cow has a definite and high anti-rachitic value; the same animal when stall fed in the dark, yielded a milk much inferior in anti-rachitic properties."

She later reported a continuation of these studies,[8] concluding as follows: "These further observations show that sunlight, of summer intensity in this country (England) has no significant effect in raising the growth-promoting value of cow's milk, when the diet of the cow is deficient in fat-soluble vitamins. The degree of exposure to sunlight appears, however, to have a small effect in determining the anti-rachitic value of the milk given."

Chick and Roscoe reported[9] experiments made in continuation of those by Luce, which in part were as follows:

> The vitamin A content of the milk was found to be dependent on the diet of the cow, being at a maximum when the cow was fed upon fresh green food and least when the cow received a winter feed of cereals and roots.
>
> The degree of exposure of the cow to sunlight had no influence upon the vitamin A value of the milk. When the cow received fresh green fodder in a dark stall the vitamin A content of the milk reached its maximum and no further increase was noted when the cow subsequently went to pasture.
>
> The anti-rachitic value of the milk (vitamin D content), on the other hand, was found to depend principally upon the degree of insolation of the cow. This result was obtained from experiments in which the rickets-preventing power of the milk (1) was estimated from the growth-promoting power of the milk and (2) was measured by its capacity to prevent rickets in rats receiving a low phosphorus rickets-producing diet.
>
> At the same time there was some indication that the diet of the cow, if consisting of fresh green food, was a contributory factor. Our experiments confirmed those of Luce in showing that "pasture-fed" milk possessed the maximum anti-rachitic value while that yielded by the cow when receiving a diet of cereals and roots appeared on the whole inferior in this respect, in spite of exposure to maximum illumination out of doors in summer.

While it has been suggested, by the work of McCollum and his associates, that there is a great difference in butters as regards antirachitic factors, and by Luce and later by Chick and Roscoe that diet and exposure play important rôles in the development of vitamins in milk fat, there have not been, to my knowledge, any data available as to the relative value of butters from different sources at different seasons, which has been the reason for my undertaking this task. It is apparent that no comprehensive effort has been made to determine the influence of seasonal factors on the various degenerative processes or their influence on the production of activators in foods on which most animal life is helplessly dependent, but by which a sufficiently informed society might be able to find means for reducing morbidity through use of the products obtained by adapting a knowledge of these forces to its needs.

Since the vitamin content of foods is coming to be recognized as quite as important as the energy-producing factors, and since the calcium and phosphorus activators have proved to be so scarce, I have had the conviction that the vitamins in the butter fat of milk not only have supreme importance for the quantities we may now obtain from that source, but that it might be possible greatly to en-

8. Luce, E. M.: Biochem. J., 18:1279-1288, 1924.

9. Chick, H., and Roscoe, M. H.: Biochem. J., 20:632-649, 1926.

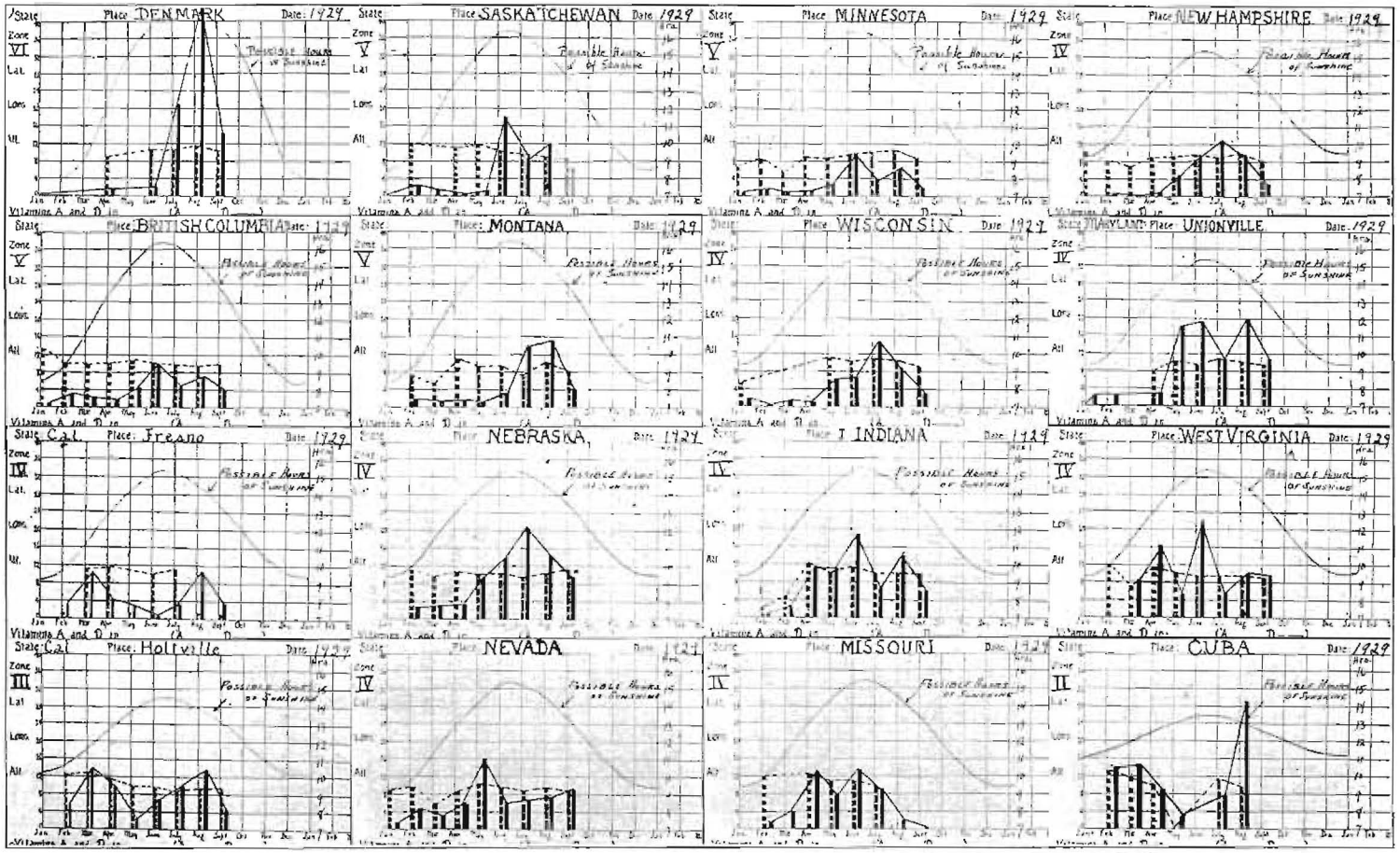


Fig. 6.—Monthly variations in vitamin A and D levels in butter for sixteen states, provinces or countries for 1929, January to September inclusive. Vitamin A is shown in the broken lines, D in the continuous lines. Zone II is latitude 15 to 25; zone III, 25 to 35; zone IV, 35 to 45; zone V, 45 to 55; zone VI, 55 to 65. This is presented as typical of the entire area covered in these studies by analyzing samples, which come on an average of every two or three weeks from more than 400 places.

hance or increase the value of milk by increasing its vitamin content. A search of the literature disclosed practically no dependable data as to the amount of the fat soluble vitamins A and D in milk fat under different conditions, such as seasonal, and the environmental conditions of the animal producing it, including climate and available ration, or the species of the animal.

In order to obtain data on the amount of vitamins in this most nearly universal mammalian food source of vitamins A and D, I have undertaken, during the past five years, to make determinations on a large number of samples of butter and milk, with a view to determining both the chemical eonstituents and the vitamin content and the influence of certain foodstuffs and radiation on the vitamin content.

In a paper read before the International Dental Congress in 1926 at Philadelphia,[10] I presented considerable data dealing with the chemical content of the blood and the milk of cows, with and without special treatment, and also with the effect on chickens of the milk produced under different conditions. These early studies were dependent entirely on the feeding of the products to animals for the purpose of evaluating the level of the vitamins. With the advent of colorimetric methods for the determination of vitamins A and D, these have also been utilized. Among these methods is the antimony trichlorid method of Carr and Price[11] and the hydriodic acid method of Yoder.[12] Comparisons have been made by several persons as to the relative merits of these methods, and they have been found, in general, to check within 10 per cent, and with some workers, the results have been much closer tban this.

In a study of the value of the animal assay method, McCollum and Adams[13] have published a lengthy investigation in which they have come to the conclusion that this method is not an accurate means of assaying vitamin D in cod-liver oil. A part of their conclusion is as follows:

1. The data obtained in this investigatioo do not bear out the anticipated possibility of determining the anti-rachitic potency of cod liver oils by following changes in bone composition.

2. Blood analyses calculated to give the ion product values $[Ca_{++}]^3 \times [PO_4^{\equiv}]^2$ indicate whether test animals show active rickets or healing.

3. Indications such as given by results of blood analyses can be correlated with line test (i. e. histological) observations in practically all cases. The line test picture as evidenced by the majority of a group of ten or fifteen animals should be indicative of the potency of a given oil.

4. Cod liver oils do vary with respect to their content of antirachitic vitamin.

CONCLUSIONS

t. Application of the ahove method to assay of cod liver oil gives data which can be interpreted to indicate only relative potency of oils. Absolute comparison to the point of establishiog so many arbitrary units of antiracbitic factor per given weight of oil is not justified on the basis of data of the type obtained.

2. A given procedure is no more accurate than the least accurate of the factors involved; io particular, biological behavior, valuable as it is in indicating the general trend of results, is not subject to mathematical accuracy. It is the writers' opinion, therefore, that no biological assay with respect to the vitamin content of given substances will yield more than relative values.

3. The dosages ordinarily indicated, and the time period usually involved in the utiliza-

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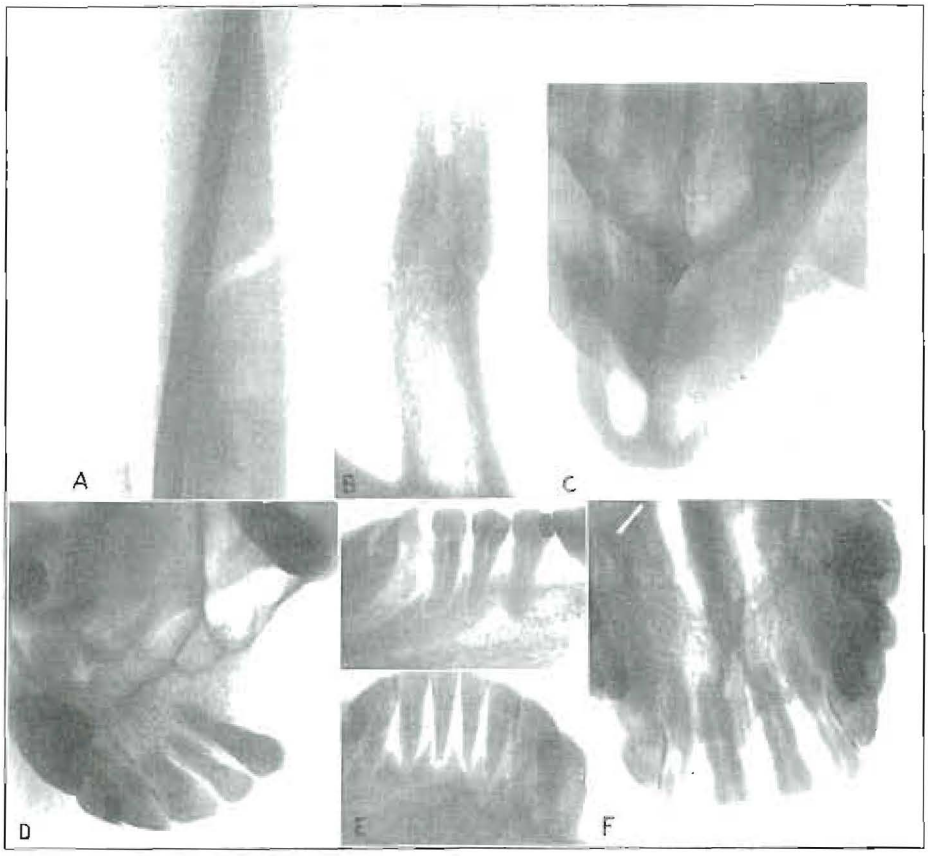


Fig. 7.—A series of decalcification disturbances (patients all showing negative calcium balance). *A*, ununited fracture after twelve weeks; no callous formation. *B*, same three weeks after starting treatment, showing excellent callous formation. *C*, marked alveolar decalcification, showing slight difference between density of hard and soft tissues. *D*, decalcification with enlargement of maxillary sinus and loss of alveolar ridge, with marked thinning of floor of sinus. *E*, above, reduced density with loss of trabeculae in mandible; below, loss of supporting alveolar process, both due to systemic decalcification. *F*, loosening and movement of upper teeth from pressure of lower, due to systemic decalcification (patient, aged 22).

tion of cod liver oil for prevention or cure of human rickets, admit of a sufficient factor of safety that it is probable that any of the better grades of oil upon the market afford protection.

In these studies, I have used both methods and have found great value in the colorimetric method for evaluating vitamins A and D in butter fat. Since the blue produced by the use of antimony trichlorid for the vitamin A test is very transient in some instances, the matter of making comparisons with standard colors constitutes a real problem. I have reduced this problem by devising a colorimeter that allows readings to be made quickly. This instrument (Fig. 2) is relatively simple in construction.

The plan for this research has been as follows: I obtained, during 1927, samples of butter from a few states and made tests using both animal and colorimeter procedures. During 1928, I extended this work to include a better representation of the five states. Butters were obtained from the same sources, when possible, throughout the entire twelve months of the year, from January to December inclusive, at fortnightly periods. Analyses were made of vitamins A and D in approximately 1,300 samples of butter during that year. Some of these butters were obtained directly from the creameries; others were purchased from wholesale distributors of dairy products, from the same source each time. The units that I have used will later be expressed in terms of other adopted units. The result of that study will be seen in Figure 3, "Vitamins A and D in butters by months, 1928." In this chart, several factors are represented. The determinations are shown from January to December for both A and D. There is only one graph for vitamin A, which is the broken line extending across the sheet, curving upward with the approach of summer and downward during the autumn and winter, with a depression in each April and August. Vitamin D is shown in four quantities for each month; (1) the highest 1 per cent; (2) the highest 10 per cent; (3) the general average; (4) the lowest 90 per cent.

Clearly, the majority of people would have to depend on the 90 per cent quality; and, in these experiments, practically none knew whether they were using the poorest or the best butter with regard to these vitamins. It is particularly tragic to note how low vitamin D was found to be in 90 per cent of the butters throughout January, February, March and April and the following December. Beginning in April, a sharp rise occurred in all the vitamin D measurements, a peak being reached in June, at which time vitamin D was more abundant, many times over, than during the winter and early spring months. July and August showed a progressive decline, and September and October, a progressive increase; with a rapid decline in November, reaching a low level in December.

During this period, determinations had also been made as to the vitmain content of a storage butter that was being sold as cooking butter, since the law of this city, as in many others, requires that storage products shall be so labeled, and they are, therefore, always regarded with prejudice. During this period, it was found that some samples of the storage June butter of the year before, 1927, were very high in vitamin content, others medium and others moderately low. These studies of the storage June butters are shown at the extreme right of Figure 3, and it is of particular interest to note that, when divided into the same four groups on the basis of vitamin D, namely, highest 1 per cent, highest 10 per cent, general average and lowest 90 per cent, these factors checked relatively closely with the readings obtained for the fresh June butter which was made in June, 1928, which suggests, if it does not indicate, that the storage of the butter had not diminished the vitamin content.

This is a matter of importance, and one which I will discuss further later. These data seem so clear-cut that they are evidently significant.

In order to increase the value of the data obtained by checking the prohability that they indicated conditions that are related to seasonal changes, rather than groups of influences which were generally local and incidental to the climate over a particular season, I purposely did not

publish these data until I might add to their value by obtaining a curve for another year, not only for the same districts, namely, five states, but also for a much larger field, in order that latitude, as well as available sunshine, might be studied in relation to local contributing factors such as altitude, soil, precipitation and clouds.

We will all recognize that the characteristics of the climate of 1928 and 1929 for all parts of the year varied through a wide range as compared to each other. The remarkable paralleling of these two series of determinations is shown in Figure 4, in which it will be seen that the average amount of vitamin D provided in the butter of these five states, month by month, for 1929, is at a little higher level throughout the entire period, but is as nearly parallel as the tracks of an automobile up to June. It is not depressed in July, as in last year, but is lower in August than in July. We will readily recognize, in the climates of the two years, that July of 1929 was quite unlike July of 1928. I shall discuss this later.

It is also of interest to note the depression in vitamin A for March of this year and also that vitamin A did not increase through June and July of this year as it did in 1928. When we realize how many hundreds of determinations were made and also appreciate the significance of smooth curves, we cannot escape the conviction that we are dealing here with fundamental facts of almost incalculable import, for, in general, we are reproducing cycles which correspond with the cycles of morbidity which exist in human beings and in other animal forms. Immediately, we get the suggestion: Why not conserve the high vitamin product of June and October, or of such intervening months as may prove to be high, to tide over the periods of stress?

The similarity of the vitamin levels of these two years is more strikingly shown by comparison of the curves for all four percentages of vitamin D, namely, highest 1 per cent, highest 10 per cent, general average and lowest 90 per cent. The outstanding feature is that, in all grades, the averages run a little higher in 1929 than in 1928.

We will not readily appreciate the difference in food values of the high and the low samples of butter until we have an opportunity to see the difference in their effect on life. As foods have been, in the past, largely evaluated on their ability to produce energy or their caloric value, they would be relatively equal, but as a means of sustaining life, they are vastly different. I have already presented data bearing on these facts.[14]

A striking illustration of the conditions in the vitalization factors of different grades of butter on the basis of these chemical tests will be seen in the following:

An observation was made to determine the results of putting different groups of chickens under similar stress conditions and allowing them to eat all they wished of the special feed carrying vitamins A and D, as a means of maintaining life when on the deficient diet, McCollum's 3143, which is low in phosphorus but adequate in calcium. Some children do not have all they want of such as is available. These chicks did. The difference in the various groups consisted only in the quality of the butter as determined solely by chemical analyses of vitamins A and D. Twenty-five chicks were placed in

14. Price, W. A.: Calcium Metabolism Studies on the Nature and Rôle of the Activators; Researches on Fundamentals for the Prevention of Dental Disease, J. A. D. A., 16:265 (Feb.) 1929; Dominion Dent. J., October-November, 1929; Footnote 5.

each group, and each group had its own electrically heated brooder. All conditions were similar, with ample feeding trays of the same size, two automatic drinking fountains of the same size in each pen, sufficient room to permit running around and silica sand for scratching. Each group had two dishes of the same size filled every day with the kind of butter from which that group was to obtain vitamins A and D, except the limited vitamin A contained in the basic food. In one week, in group 1, receiving butters high in A and high in D, none were dead. In group 2 receiving butters high in A and low in D, 16 per cent had died, and in group 3, receiving butters low in A and low in D, 28 per cent had died. In nineteen days, the deaths were as follows: group 1, 24 per cent; group 2, 53 per cent and group 3, 72 per cent.

These butters were the pooled and graded products of various samples left over after our vitamin tests were made. They came, therefore, from a number of places, since each tube contained only about 5 c.c. when received, of which 1 c.c. was salt and water, or buttermilk. About 2 c.c. was to be used for making the tests, which left, on an average, about 2 c.c. excess for each sample. When we realize that these butters represent the dairy product of various sections of the country, we anticipate at once what a handicap individuals must receive who are compelled to use the lower grades of butter.

COMPARISON OF VITALIZING AND DEVITALIZING FORCES

Since life is a balance between a building up and tearing down of forces, with degeneration the ultimate result of the predominance of the tearing down forces, it becomes important not only to reduce the destructive forces, but also to augment, wherever possible, the constructive forces. I have undertaken to make a study of this aspect by reducing to a composite curve for the various months of the year the relative intensity of the various expressions of degeneration as shown in Figure 1, for morbidity, mortality, medical hospitalization, etc., and similarly I have made a composite curve for vitamins A and D for the years 1928 and 1929 to date as found in milk fat. These new curves are shown in Figure 5. Since these curves represent thousands of determinations, they are not dominated by incidental changes in a particular month in one factor or in one location. The curve for degenerative processes contains a national factor in the deaths by months for the United States for six years; whereas, the vitamin curve includes only A and D in milk fat and these only for five states in much the same latitudes. With the rapid fall in vitamins in November and December, individuals must draw on their reserves or storage vitamins and chemicals controlled by vitamins. This seems to tide them through the month to January, but the reserve is exhausted by February, so that many of them have broken sufficiently, either by loss of immunity or advance of degenerative processes, that they find themselves in need of hospital care. Many, if not most of these, have realized a reduction in their factor of safety through a feeling of loss of energy so that, by the end of March, large numbers have become bedridden or sufficiently indisposed to need hospitalization. With a marked increase in disturbances during February, March and April, the provitamins are steadily decreasing in the food products, for we probably may assume, though we do not have data to demonstrate it, that what is occurring in vitamins A and D owing to the absence of the vitalization factors of freshly grow-

ing vegetation for the cows, is also occurring with the vitamins from similar causes, since they too are largely the product of plant life, though some are stored in animals eating the plants and, in a small extent, syuthesized by some animals when on a plant ration.

Concurrent with this sharp rise of the vitamins in April, May and June, there is a sharp fall in morbidity, and with the return of these vitalizing factors by July and August, morbidity has been greatly reduced. With the coming of the hot weather, there is a secondary depression of the vitamins more or less severe, according to the local conditions. Again, individuals are thrown somewhat on their reserves, which they soon diminish or exhaust, and, by September, they are losing their defense; which is expressed in this curve in an increase in hospitalization during October. Fortunately, there is an increase in the available activators or vitamins in October, which reaches a higher level even than the June peak, and the morbidity line straightens out. This October rise in vitamins is short, the peak being reached at varying times in different parts of the country according to local conditions. Consequently, there is a rapid fall of the vitamin levels through November and December, but again we see the fall in morbidity, the rise occurring sharply during December and January.

Probably, one of the principal reasons why progress in the reduction of the degenerative diseases has been so slow has been that the cause has been searched for by studying the effects. With the rapidly accumulating newer knowledge regarding the activating substances, some of which are recognized and identified as vitamins, a new approach has become possible through a study of the causative factors and an intensive study of the vitalizing factors. This puts more and more emphasis on studying the individual with regard to his varying capacity to maintain immunity or to maintain organ and tissue function because of the presence in his system of forces which he must continually replenish from the often scant sources, since they are apparently ultimately the product of radiation energy in conjunction with plant and animal life, chiefly the former.

There are two conditions which are so important that they should, if possible, have much more extended consideration as a part of this message. The one has to do with the difference in the vitamin levels of different districts, on the basis of latitude, for the study of the effect of the approach of spring, and of longitude, for a study of geographic, environmental and climatic conditions in conjunction with latitude. The other is the desirability of presenting here concrete and clinical evidence that activators should be used as reinforcements for the available diet for reducing morbidity and degeneration, not only general, but also for this group particularly in the dental and oral field. I can present, at this time, only one illustration of each. I have unpublished data on both of these subjects, and this information will appear with a general discussion of this entire problem as early as is feasible after the completion of this year's curves for the vitamins.

In Figure 6 will be seen reproductions of the 1929 vitamins A and D curves by months for sixteen states, provinces and countries. In part, these are arranged according to latitude, that is zone II includes latitude 15 to 25; zone III, 25 to 35; zone IV, 35 to 45; zone V, 45 to 55; zone VI, 55 to 65. I have not included South American countries, Alaska or Honolulu, but only a few of the states, provinces and countries. On these charts

will be seen the curve showing the possible hours of sunshine, and it will be interesting, and no doubt a surprise to many, to see how much flatter the curve of hours of possible sunshine is in zone II than in zone VI; in other words, the daily hours of sunshine in the summer time are much greater as we go north in the northern hemisphere and the winter hours of sunshine are similarly greater as we go toward the equator. This is true also in the southern hemisphere, except that the seasons are reversed. It is particularly interesting to note that people who can afford to change their residence to points south in the winter and spring move northward progressively in midsummer as an essential health measure. The idea expressed in practically all of the literature has been that this movement has been primarily to obtain direct contact with the sun in the winter and spring and to escape the heat in midsummer. I wish to submit for consideration the evidence that one of the helpful facts and, indeed it may readily be the most important fact to be considered, has been the improvement of health through obtaining a higher level of vitamins in the available foods.

Immediately, we have the suggestion that greater effort should be made to provide foods of high vitamin content out of season as well as in season for each particular geographic location. All that will be required in most instances is the storage of at least part of the product at the time that the vitamins are high for use at the time when they are low in that district.

With regard to the matter of preventing degeneration and inducing regeneration, we are dealing with so many phases of life that it is exceedingly difficult to select one illustration which would represent even one phase, so I shall limit the general illustration of this phase to a composite one. One of the problems that intimately concern the members of this section has to do with bone regeneration following surgical procedures and trauma. *A* and *B* of Figure 7 show a fracture before and after the administration of carefully selected activators. At *A*, a young man, aged 28, had been twelve weeks under treatment for the healing of a fracture but without union. He had received large doses of cod-liver oil and liberal exposure to ultraviolet light from a mercury quartz lamp. The result (*A*) was complete absence not only of union, but also of formation of callus. *B* shows the condition four or five weeks after the patient was placed on activators, as determined on the basis of frequent blood chemical analyses. There is splendid callus formation. The activators used were a preparation made from a concentration of the vitamins of butter and a high vitamin cod-liver oil suitably activated, taken internally, and a specially activated cod-liver oil of high vitamin content, rubbed on the body. The total quantity of cod-liver oil taken internally was much less than at the preceding treatment. This phase deals directly with the rate of repair following surgical procedures, reduction of complications, such as hemorrhage and local infection, primarily due to increase of immunity to infection and improvement of clotting power of the blood.

One of the most difficult problems that present themselves to the general practitioner and also to the oral surgeon and diagnostician is the decision as to the program that is indicated for those patients with loosening teeth, with or without gingival infection and, if without, usually with gingival tissue still attached to the teeth, a condition which would usually be classified as pyorrhea. Suppurative infec-

tion may or may not be present, and the condition may advance in spite of persistent treatment and thorough home care. Such a case as I have in mind will be seen at *D,* Figure 7, in which roentgenograms of the tooth are shown, with its supporting structures. The maxillary sinus is separated from the mouth by a thin alveolar plate and, in the lower arch, it can readily be seen that the trabeculae have been largely removed by the process of decalcification from within. If these teeth are removed and dentures are placed, without a change in the systemic condition, progressive absorption will prevent the continued seating of restorations, with recurring perplexities to the prosthodontist. This patient's primary trouble is that her calcium balance is negative, and from day to day, it is necessary to take calcium and phosphorus from the storage depots of her skeleton because she does not get a sufficiency from her food. The product of serum calcium and serum phosphorus is 24.8 instead of 40; colesterol, 100 c.c., whole blood, is down to 60 instead of 150, and the cell volume is at 35 instead of 45. None of these conditions would be changed by any operation that would be done in the mouth, and the mouth condition can be largely corrected by proper systemic treatment through the administration of proper activators.

A similar case is shown in *C,* Figure 7. This patient was sent for special study because she had required five new plates in eight years. The maxillary bones cast little more shadow than the soft tissues of the nose. The recurring loosening of her denture ceased after she was placed on treatment for buidling up the hard tissues.

While these cases generally occur in people over 40 years of age, they often develop much earlier. In *F,* Figure 7, is shown a section of the upper arch of a woman, aged 22. These teeth are loosening from internal decalcification to such an extent that they are spreading out of the normal relationship and distorting the arch owing to the pressure of the opposing teeth, and all this notwithstanding excellent professional and home care. The serum calcium of this patient is approximately 20 per cent below normal. She urgently needs an increase in the amount of activators. These teeth tightened remarkably in sixty days.

If space permitted, I would also present data relating to the opposite phase of this problem, excessive calcification. In general, a number of the degenerative processes which we have thought to be disease processes are really symptoms of nutritional disturbance. Rachitic disturbances, attended with the rapid growth of childhood, when due primarily to a low phosphorus diet, readily cease when suitable activators are provided, either by rubbing them on the surfaces of the body or by changing substances already in the body into suitable activators by means of radiant energy. The convulsions in tetany of childhood and some phases of osteomalacia are due primarily to lowered calcium, and, frequently, show normal phosphorus levels, and the restoration of the calcium level with proper diet and proper activators completely remove the disturbances. Similarly, we have only to be reminded of the new point of view regarding infections of the mucous membranes of the body, particularly of the respiratory tract, and the important rôle of vitamin A in restoring immunity and for lessening or relieving some forms of neuritis not due to the absence of the antineuritic vitamin B_1. Likewise, dental caries will be found to be directly related to the absence of proper activators, which

is attended with the production of negative calcium balance.

The problems of adults are largely related to degenerative processes. It is my belief that we have been looking in the injured tissue for the cause rather than recognizing it as the effect, and I would quote from William Weston, who has expressed the view that caries and rickets, taken together, "constitute the greatest challenge to civilization of all problems with which we are called upon to deal." "We have about reached the conclusion," he says, "that their evils are the foremost enemies of the Nordic race in the temperate zone." I would add to this the large group of affections which, in adults, are associated with decalcification and which are not like the affections of childhood, for the bone has reached its growth. These studies are disclosing several of the contributing factors for normal development of the activators in foods.

SUMMARY AND CONCLUSIONS

Data from several sources which relate morbidity and mortality to monthly or seasonal variations have been here consolidated in a single graph. Data on the monthly variations in vitamins A and D in milk fat through a period of nearly two years for several communities, are here reduced to a single graph showing monthly values. These two composite graphs have been correlated and evidence has been presented regarding an important relation between the generative vitamin levels and the presence or absence of degeneration. Some of the physical expressions of decalcification have been indicated and the importance of a new point of view in the study and interpretation of degenerative processes is emphasized. These data indicate the need for a change of emphasis from consideration of the degenerative processes, whether of the oral cavity or other parts of the body as being primarily disease entities, to the consideration of their being largely the symptoms and effects of the absence from the body of activators (with or without a shortage of mineral constituents in the food), which are essential for the utilization of food elements. These degenerations are seasonal primarily because of the rise and fall, at different seasons, of the level of the activators in the foods, some of which are vitamins.

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DISCUSSION

F. R. Talley, Petersburg, Va.: I wish to make this plea that men in general practice give most serious consideration to this particular thing that Dr. Price has called our attention to, because it underlies the very foundation and the very success of the future generations. If you will study the conditions of the world over, as Dr. Price has pointed them out to you, you will find that people living on dairy products are generally well developed both in bony structure and the dental organs. Take those people of the Arabian desert who live on butter, sour milk, cheese and things of that kind and the green things that they find growing wild in their country, and you will find some of the finest specimens of humanity in the world, people of fine frame and fine teeth, and otherwise fine. Bring the same men to America, to our country today, and let them live under our conditions, and it will not be long before we find their teeth decaying, with probably arthritis and other ailments developing because of the fact that they cannot or do not get in our ordinary process of living the things that they need to keep up their body vitality and supply all of their tissues with the minerals necessary to their well-being. We are living today too much in tin cans. It is so easy to buy food and carry it home in the can. Then, we must recognize the fact that many of us when we were children, had the family cow, or the neighbor had one, and we got our dairy products from this source, raw milk and good, rich butter, and when conditions were not so crowded, the cow got the proper pasture and we had a sufficiency of vitamins A and D to supply the things we needed. But as we

have grown in population and have come to live in urban centers, it has become necessary to protect the health of our people, particularly against typhoid and tuberculosis, and so we resort to pasteurization of our milk, which, if I am properly informed, destroys vitamin C to a large extent. It is not the heat that destroys it, as I understand, but the oxidation of this vitamin. Then what do we do? Our children are getting a milk deficient in vitamins A and C, which stimulate the thyroid to better activity, thus promoting calcium metabolism, and today our children are not getting the proper amount of mineral salts ro maintain bodily health, and the people themselves, not knowing these conditions, do not then add to their diet those green vegetables, lettuce, cabbage, oranges, grape fruit, carrots, all of which we could take raw and so make up for this loss of vitamin C in milk and butter. Therefore, I find among the younger generation a larger percentage of dental decay than we have noticed for a long time, and not until the general practitioner of dentistry realizes that this is partly his problem and that it is his moral obligation to acquaint himself with the physiologic factors that enter into the growth and maintenance of the child, is dentistry going to serve its purpose in serving its patrons. We must study this thing ourselves. Dr. Price has shown us the way as have many other men who are making these investigations, but there is a lack of interest shown by men in general practice. We are not willing to take the time to study this, and that is why physicians have not a higher respect for the dentist today. Let us lend our minds and hearts to the promotion of greater things in dentistry, physiologically, which are necessary to the maintenance of the health of our patients. These physiologic conditions must come first, and then mechanical restorations. The placing of fillings and things of that kind are secondary to the patient's good health.

Roy S. Hopkinson, Milwaukee, Wis.: Too frequently, we are inclined to say that we cannot make blood chemistry experiments and we have no one in our city that can do it. Two years ago, I was called in consultation regarding a multiple fracture of a mandible on one side. In other words, there was a fracture at the angle of the jaw and one anterior to the cuspid. We took care of this case in the usual way by the interdental wires, and in three weeks, constantly observing this case every day, I noticed that the lower bicuspid on the right side was apparently loose. Either the wire had slipped or the tooth had moved. Cutting these wires, I picked the tooth out by taking hold of a 25 gage wire. The patient was immediately sent to the x-ray room and, to my surprise, the mandible on that side showed definite evidence of a well-developed osteomyelitic condition. Three weeks later, we took another picture, and there was almost complete disintegration of the entire bony structure from the anterior fracture to the angle of the jaw, and each time that we took a picture, the case seemed hopeless. In the intervening time, the patient developed a general septicemia, with a high temperature and delirium a part of the time. The septic condition in the jaw was developing so rapidly that it seemed we would never be able to stop the infective process. Rubber drains were inserted and adequate drainage was established. Saline irrigation was used every hour, and I never saw a group of nurses more conscientious in taking care of this patient; yet we could not stop the process. Finally, the surgeon working with me said, "If there is anything you want to do on this case, I am perfectly willing to have you do it." I instituted the treatment that Dr. Price has given you today, giving this man calcium and phosphorus and an activator, and we exposed his entire body to ultraviolet light every day. Some day, I hope to report this case and show you a beautifully regenerated jaw. The fractures were reduced, and I might say that it will be interesting to Dr. Price to know that the jaw was so full of punctures with rubber drains that all our appliances were removed; that we had a marked displacement of the fractured segments due to the contortion of the muscles from the septic condition, and yet in a little over three months, we removed sequestrum, the regeneration of bone continued and the fractures were reduced without any wires or any appliances on at all. I have the hospital record to prove the statements that I am now making.

A. T. Rasmussen, La Crosse, Wis.: For the benefit of those who are inclined to consider this subject an academic one only, I wish to emphasize the fact that it is an exceedingly practical one. I am on record a number of times as saying that we must

think of certain periodontal diseases as calcium and phosphorus deficieucy diseases. Having followed this line of thought and instituted treatment accordingly, I have been able to show clinical results that have been eminently worth while. The worst cases of periodontal diseases with which we have to deal are not those exhibiting a free flow of pus. I am not very much concerned about getting rid of pus! I do not seem to have much trouble with that; bnt those cases in which there is a progressive and persistent destruction of the alveolar processes, in spite of the fact that no local irritation or infection is apparent, are the ones that baffle most of us, I believe. It matters little what you call these diseases. They are deficiency diseases, and must be treated as such, if results are to be attained. In such cases, I bave been able to show some clinical results that have pleased me immensely, and have confirmed my diagnosis of the case as one of calcium and phosphorus deficiency. Extreme susceptibility to dental caries has been changed to a relative immunity, or, should I say, a lessened susceptibility, under similar treatment. The study of mineral metabolism of the system is an exceedingly interesting one. I believe it holds the key to the solution of some of our problems that up to this time have baffled the scientific world.