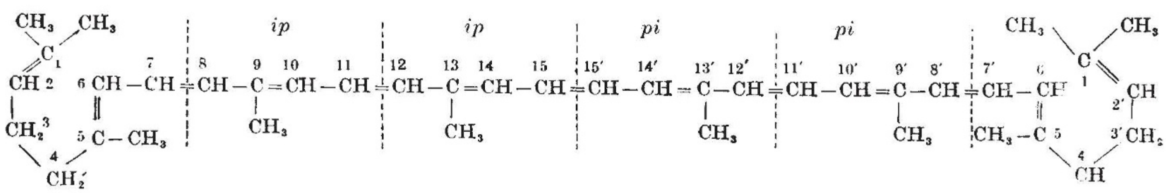
total volume of milk and meat production in respect of which priority of foodstuff supply is given should be restricted to the *essential* needs of the public. A volume of milk, for example, that is ample for the needs of infants, adolescents, invalids, etc., must be assured at all costs; but in view of the serious position in which pig and poultry producers are placed, it is difficult to see why any priority should be given for the production of unlimited supplies of milk for consumption by the adult population.

With the increased arable acreage and intensified utilization of grassland the requirements of the ruminant live stock for imported concentrates should be very substantially reduced, and the pig-man and poultry-man have every right to expect this measure of co-operation from their more favoured fellow farmers.

In the case of the poultry-man, and to a smaller degree the pig-man, there are also other weighty considerations that must be taken into account in the development of national policy. A very large section of the poultry industry is in the hands of 'small' people scattered throughout the country-side, whose living and life-savings are entirely bound up with the maintenance of their small enterprises. The welfare of this smallholder element of the agricultural community has always been regarded as being of great importance to the interests of the State, and any ill-considered reversal of this policy, even in war-time, may have grave sociological consequences. Their problem is for the time being extremely difficult, but must receive serious consideration before we can resign ourselves to the inevitability of human sacrifice on the home food production front.

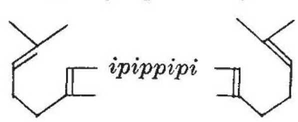
CAROTENE AND ALLIED PIGMENTS*

THE simplest carotenoid is lycopene, $C_{40}H_{56}$; on complete hydrogenation to perhydrolycopene, $C_{40}H_{82}$, thirteen bonds disappear. Quantitative degradation by means of ozone, permanganate and chromic acid as oxidizing agents leads to the formula:



Green leaves and other vegetable products contain α- and β-carotene and 'xanthophyll', a mixture of hydroxylated carotenoids, zeaxanthin and lutein predominating. Their functions in plant physiology are not yet understood, but

The central polyene chain, C_8–$C_{8'}$ inclusive, is made up of four isoprene units arranged in pairs which are united in reverse order at C_{15} and $C_{15'}$, and may be abbreviated as *ipippipi* (*ip* denoting an isoprene unit). Lycopene may thus be written

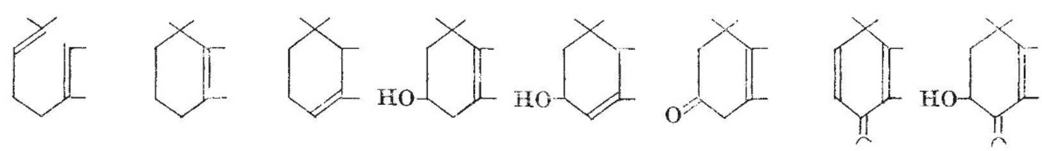


The polyene chain is common to a large number of carotenoids, but the terminal groups may consist of substituted or unsubstituted rings of the α- or β-ionone type as below:

owing to the connexion between carotene and vitamin A, the position concerning the role of carotenoids in the nutrition of animals is much less obscure.

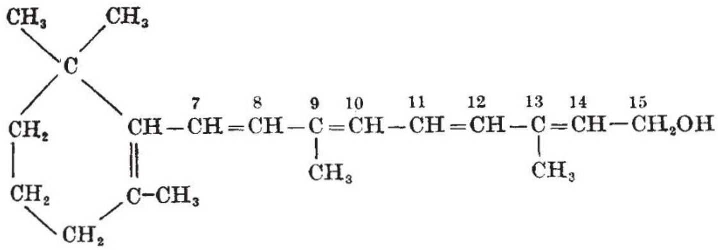
Vitamin A from fish liver oils ($C_{20}H_{29}OH$) possesses a constitution which differs from one half of the symmetrical β-carotene molecule

* Based on papers by Dr. R. A. Morton "On the Constitution and Physiological Significance of Carotene and Allied Pigments", and W. M. Seaber, "On the Commercial Determination of Carotene and Allied Pigments with Special Reference to Dried Grass and other Leafy Materials", read at a joint meeting of the Society of Public Analysts and Other Analytical Chemists and the Food Group of the Society of Chemical Industry on February 7.



a *b* *c* *d* *e* *f* *g* *h*

only by the addition of the elements of water:



The fact that green foodstuffs may cure avitaminosis A just as well as fish liver oils was explained when it was found that pure 'carotene' undergoes fission *in vivo* with formation of vitamin A.

The only carotenoids which act as precursors or provitamins A are those which possess intact one half of the β-carotene molecule. They include those shown in the accompanying table, echinonene and a few derivatives prepared *in vitro* from natural provitamins. There is no evidence that animals can synthesize either provitamins A or vitamin A *de novo*, or that the conversion of carotene to vitamin A is reversible.

Substance	Constitution	Occurrence
Lycopene	*a-ipippipi-a*	Ripe tomatoes
* α-Carotene	*b* ,, *c*	Red palm oil, mountain ash berries
* β-Carotene	*b* ,, *b*	Carrots, leaves, etc.
* γ-Carotene	*b* ,, *a*	Leaves of lily-of-the-valley
* Kryptoxanthin	*b* ,, *d*	Yellow maize
Zeaxanthin	*d* ,, *d*	Maize, egg yolk, leaves
Lutein	*d* ,, *e*	Grass, green leaves
* Myxoanthin	*b* ,, *g*	Algæ, especially blue-green algæ
* Aphanin	*b* ,, *f*	
Rubixanthin	*d* ,, *a*	
Astaxanthin	*h* ,, *h*	Crustacea

* Provitamins A.

The animal body contains only small quantities of carotenoids, and is not equipped to assimilate large doses. Carotene utilization is optimal when minimal doses are fed in oil solution, and the transport of carotene through the intestinal wall is conditional on normal fat absorption. The site of the conversion of carotene to vitamin A is generally held to be the liver; certainly the liver is the main storage depot for the vitamin. In most species there is a normal level of concentration of vitamin A—and of carotenoid—in the blood. Carotenoids are also found in the pigmented layer of the eye and in yellow bone marrow.

Milk contains both vitamin A and carotenoids (largely β-carotene) and for a given species the total vitamin A activity of normal milk tends to be fairly constant, but in domesticated animals there are interesting variations with breed. Thus Holstein and Ayrshire cows yield milk with little carotene but more vitamin A, whereas Guernseys give a cream more deeply coloured by carotene but less rich in vitamin A. The new-born possess very low liver reserves of vitamin A, and it is significant that colostrum may possess vitamin A activity one hundred times that of normal milk. Human colostrum is two or three times as potent as early milk, which in turn is five or ten times as rich as the later milk.

The earliest sign of shortage of vitamin A or provitamin A is defective low-intensity vision. Visual purple, the photosensitive substance of the rods, may be obtained from retinas; it is a conjugated protein from which vitamin A can be separated. Faulty dark adaptation is due to delayed regeneration of visual purple, and in the majority of subjects can be remedied by supplementing the diet with vitamin A or carotene. In order to prevent night blindness in cattle, sheep, pigs, rats and horses, Guilbert finds that either some 25–30 μgm./kgm. body weight (1 μgm. = 10^{-6} gm.) of β-carotene or 6–8 μgm./kgm. of vitamin A is needed daily.

Outspoken vitamin A deficiency is characterized by widespread atrophy of epithelial structures and often by xerophthalmia, but retardation of growth (weight) is the criterion most readily amenable to quantitative interpretation.

The diet of the majority of town dwellers shows inadequate vitamin A activity, especially during the winter months. It is also certain that most winter milk from stall-fed cattle is inferior to summer milk. Artificially dried grass is superior to hay both in respect of protein and provitamin A content, and its value as a feeding stuff has been established in many well-controlled experiments. The addition of vitamins A and D to margarine is a valuable way of alleviating vitamin deficiency, but the problem of utilizing the available resources to the best advantage and of increasing the supply to meet the known needs has not been solved. That it is necessary and possible to do so cannot be doubted, nor that the cost of effective action would be a small fraction of the cost of inaction.

This raises the point of the relative efficiency of carotene and vitamin A. The accepted unit of vitamin A activity is that exerted by 0·6 μgm. of pure β-carotene, so that the pure substance has a potency of $1{\cdot}66 \times 10^6$ I.U./gm. (by definition). Vitamin A, according to the best available data, has a potency near $3{\cdot}0$–$3{\cdot}3 \times 10^6$ I.U./gm., whereas all provitamins other than β-carotene have an activity near $0{\cdot}83 \times 10^6$ I.U./gm. These figures apply to rats receiving minimal doses.

There is urgent need for more research on the relative efficiencies of provitamins and vitamin A at the level needed to convert a marginal diet into an optimal diet.

The commonly accepted view that the equation

$$\underset{\beta\text{-carotene}}{C_{40}H_{56}} \xrightarrow{2H_2O} 2C_{20}H_{29}OH$$

corresponds with a process occurring *in vivo* would lead to $1{\cdot}56 \times 10^6$ I.U./gm. for pure vitamin A. This is not in accord with experience ; it rests upon the assumption that fission occurs exclusively at C15—15′ double bond, and its only advantage is that it agrees with the superiority of β-carotene over other provitamins. Unsymmetrical fission is more plausible and an equation

$$\underset{\beta\text{-carotene}}{C_{40}H_{56}} \rightarrow C_{20}H_{29}OH + \text{decomposition products}$$

is in closer harmony with the observed potency of vitamin A.

Vitamin A is estimated spectroscopically by utilizing the absorption maximum at 325 mμ. There is at present no reason to justify changing the accepted conversion factor, namely :

$$E^{1\%}_{1\text{cm.}}\ 325\ \text{m}\mu,\ 1 = 1{,}600\ \text{I.U./gm.}$$

The estimation of carotene in dried grass and similar materials involves extraction of the pigments, preparation of non-saponifiable extracts and a phase separation (that is, partition between petrol ether and 90 per cent methyl alcohol). The provitamins appear in the hydrocarbon solvent and the xanthophyllic compounds are eliminated in the aqueous methyl alcohol. Chromatographic adsorption permits a finer separation of individual carotenoids, specially prepared alumina, lime, calcium carbonate, magnesia and soda ash being good absorbents for particular purposes. The carotene, freed from 'xanthophylls', is evaluated spectroscopically or colorimetrically.

Dried grass and similar products are now important sources of provitamin A for animal feeding. The following method of analysis has been thoroughly tested and found to be satisfactory by the Grass Driers' Association :

0·25 gm. dried grass is ground thoroughly with sharp silver sand (5 gm.) and the mixture is treated with a mixture of acetone (15 ml.) and petrol ether (45 ml.) in a continuous drip extractor for at least 1 hour. The cooled extract is transferred to a separating funnel using a little petrol for washing in, and 30 per cent methyl alcoholic potash (5 ml.) is added. Vigorous shaking for two to five minutes is followed by addition of water (200 ml.). Carotene remains in the petrol, and after washing with water (200 ml.) the 'xanthophylls' are removed by shaking the petrol ether three times with 90 per cent methyl alcohol. The petrol layer is retained and made up to known volume. A solution of potassium dichromate (0·025 per cent) is colorimetrically equivalent to a solution of β-carotene containing 0·158 mgm. per 100 ml. petrol ether.

The estimation of carotene is complicated by the presence in the petrol ether fraction of a variable amount of an *X*-substance, which may be eliminated by filtering through a short column of alumina after adding 3 per cent of acetone. A yellow impurity is adsorbed but the carotene is carried through. Dr. Kon has confirmed the observation that the percentage of this contaminant increases in dried grass on storage.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

COLUMBUS MEETING

By Dr. F. R. Moulton, Permanent Secretary of the American Association

In many respects the American Association for the Advancement of Science is similar to the British Association, which served as a model for its organization and early development. It is the great democratic scientific organization of America (using the word in the geographical, not the national, sense), including in its interests all of science and its applications and relations to society. During a period of rapid increase in specialization and the organization of special scientific societies, it has served as an integrating agency. The breadth of its scope and the number of its members, now exceeding 20,000, make its voice more and more the voice of science in America.

In certain respects, however, the American Association differs from the British Association. Perhaps the least important is that it holds two meetings each year, the annual meeting during the Christmas holiday week (this year December 27—January 2, inclusive) and another meeting in the summer, usually the latter part of June. In addition, because of the large area of America, it has two geographical divisions, the Pacific Division and the Southwestern Division, each of which holds one meeting each year. A greater difference between the two associations is in the nature of their programmes. Before stating this difference, I wish to point out that many special scientific societies and organizations, at present 174 of them, are affiliated with the American Association, meet