colleges and universities may thereby develop a more complete understanding of the organization, policy and activities of the Department of Agriculture, which in turn reflect the type of persons needed. *Second,* the Department of Agriculture may develop a better understanding of the problems confronting colleges and universities in training and placement.

The Department of Agriculture could arrange to send regularly to the colleges and universities current information on the department's program with respect to: (1) organization, policy, and activities of the department; (2) positions to be filled in the department including replacements; (3) educational requirements for such positions; (4) specific information regarding basic training needed; and (5) opportunities for service and permanent careers in USDA.

Colleges and universities may want to make use of information thus provided: (1) in college freshman orientation programs; (2) in college counseling programs; (3) in plans for placement; and (4) in the redirection of emphasis of course content to meet the needs of those students anticipating a career with the Department of Agriculture.

V. *Suggested Procedure for Analysis and Treatment of Wartime Training Needs*

An outline of approach for determining training needs for personnel replacement in time of war and effective methods of meeting these needs is given in the full report "A Plan for Collaboration between Colleges and Universities and the Department of Agriculture with Special Reference to Training Replacements during the War," of which this is an abstract.

It is there set forth that the Department of Agriculture: (1) determine personnel needs by jobs; (2) analyze the job to be done; (3) determine the source of replacements; (4) determine qualifications of replacements; (5) determine differential in training needed by replacements; (6) determine where such training can best be given; (7) determine that part of training which colleges could perform; (8) furnish colleges with detailed information concerning specific training needed.

To illustrate how this formula can be applied to any personnel situation, the cases of the AAA County Administrative Officer (Appendix C) and Assistant Scientific Aid (Appendix D) are explained in detail in the full report.

If it is found that a plan such as the one given is practical and feasible, the colleges and the Department of Agriculture should work out essential administrative details and proceed as soon as possible to develop the best methods and procedures for getting the job done.

The Department of Agriculture can not afford to be hampered by lack of trained personnel in this emergency. It is essential that our allies, our men in the armed forces and our civilian population may continue to eat.

SPECIAL ARTICLES

CAROTENE. I. PRELIMINARY REPORT ON DIPHENYLAMINE AS A STABILIZER FOR CAROTENE

CERTAIN commercial feed preparations for poultry and animals have been fortified with fish liver oils to supply vitamin A needed for improved growth and higher vitality. The present scarcity and increased prices may limit the use of such oils as feed supplements. Carotene, a precursor of vitamin A, is plentiful in green and yellow plant material and may be extracted and used to replace fish liver oils in food and feed preparations.

Carotene, being an unsaturated compound, is very readily oxidized, thereby losing its provitamin A value. The prevention of this oxidation is an important problem in the use of carotene as a vitamin A supplement for feeds.

It has been shown by Fraps and Kemmerer[1] that certain feeds fortified with carotene may lose as much as 70 per cent. of their carotene content in 16 weeks of storage at 28° C. These men also showed that fish liver oils added to feeds lost 79 to 100 per cent. of their vitamin A potency after four weeks' storage at either 7° C. or 28° C. Mitchell and Lease[2] have decreased the loss of carotene in dried powdered sweet potatoes by adding 10 per cent. of crude cottonseed oil. However, when stored at 37° C. the material so treated showed a rapid loss of carotene after 90 days and soon contained less than the untreated material.

A preliminary investigation has been made to determine the stabilizing effect of about 100 substances of antioxidant character on carotene. In these tests it was found that diphenylamine had the greatest stabilizing effect. More extensive tests are being made on these substances, especially diphenylamine.

Diphenylamine has been used as a stabilizer in cellulose nitrate[3] and soap[4] but has not been used in food

[1] G. S. Fraps and A. R. Kemmerer, Texas Agr. Expt. Sta. Bull. 557, 1937.

[2] J. H. Mitchell and E. J. Lease, South Carolina Agr. Expt. Sta. Bull. 333, 1941.

[3] W. W. Bradley, *U. S. N. Inst. Proc.,* 41: 125–9, 1915.

[4] R. E. Divine, U. S. Patent No. 1,542,438, June 16, 1925.

or feed. Its physiological effects are not well known. Reports show that rabbits usually recover from single doses of 0.5 to 1.5 gm per kilogram of body weight[5] and that doses of 3–10 grams given to dogs as an anthelmintic produced no symptoms of intoxication which could be attributed to the effect of the treatment.[6] This is over 1,000 times the amount needed to stabilize the animal's daily need of carotene. Biological tests are being initiated in this laboratory to determine whether small daily doses of diphenylamine have any deleterious effects upon the animal and also to determine whether this compound interferes with the animal's ability to utilize carotene.

The mixtures used in our experiments were made by adding carotene,[7] white mineral oil and stabilizer to oil-free rice bran. The mixtures were formed into pellets to reduce the surface exposed directly to air. The mineral oil was used to fill pore space and thereby cut down the diffusion of air into the pellets. Solutions of carotene in edible oils and in organic solvents to which stabilizers have been added are also under investigation.

It is known from published data that mineral oil interferes with the utilization of carotene, even when ingested in small amounts.[8] Nevertheless, mineral oil was used in order to avoid the interference of peroxide and acid formed in edible oils by oxidation so that the direct effect of antioxidants on carotene could be observed. Antioxidants and conditions found to be effective for stabilizing carotene in mineral oil will also be applied to carotene in edible oils. Preliminary tests using edible oil show a similar preservation of carotene by antioxidants.

Some of the pellets were analyzed directly after preparation. Other pellets were stored in darkness at 37° C., but freely exposed to air, for 30 days before analysis. The analysis was made by dissolving the carotene from a weighed pellet with petroleum ether, b.p. 30°–60° C. The carotene dissolved in a very few minutes and the solution was then passed through a column of dicalcium phosphate[9] covered with anhydrous sodium sulfate. The resulting clear solution was diluted to a suitable volume and its light transmission was measured with an Evelyn photoelectric colorimeter using a 420 mμ filter. The carotene concentration was determined by comparing the reading with a previously constructed transmission-concentration curve. Subsequent tests have shown that mineral oil interferes to a certain extent with the removal of oxidized products of carotene by the dicalcium phosphate, and for this reason the values reported in Table I are a little high.

The addition of diphenylamine to the mixtures caused a marked increase in the per cent. of carotene retained after storage (Table I). Two samples containing diphenylamine (Nos. 8 and 10) retained 96 and 97 per cent. of the original carotene after 30 days of storage, whereas similar samples without diphenylamine (Nos. 7 and 9) retained only 58 and 68 per cent., respectively, of their original carotene after similar storage.

TABLE I

THE STABILITY OF CAROTENE ADDED TO MIXTURES OF RICE BRAN AND MINERAL OIL

Sample No.	Ratio of white mineral oil to rice bran*	Antioxidant used†	Carotene before storage	Carotene after 30 days storage at 37° C.	Per cent. carotene retained
			Mg/gm	Mg/gm	%
1	None	None	0.63	0.06	10
2	1:10	None	0.64	0.17	27
3	1:10	Diphenylamine	0.68	0.53	78
4	1:5	None	0.60	0.31	52
5	1:5	Diphenylamine	0.64	0.57	88
6	1:5	Hydroquinone	0.64	0.50	78
7	1:4	None	0.66	0.38	58
8	1:4	Diphenylamine	0.67	0.65	96
9	1:2.5	None	0.66	0.45	68
10	1:2.5	Diphenylamine	0.66	0.64	97

* The rice bran used in these experiments was extracted with petroleum ether until free of oil.
† In all cases 5 mg of antioxidant were incorporated in each gram of mixture.

Hydroquinone, which has been recommended as a stabilizing agent for carotene in synthetic solvents,[10] was also used in these experiments. A comparison of results for samples 4, 5 and 6 (Table I) shows that the pellets containing diphenylamine retained 88 per cent. of the carotene after storage, the pellets containing hydroquinone retained 78 per cent. and those containing no antioxidant retained only 52 per cent. Similar results have been obtained in many other tests, not reported here.

There was a marked difference in the retention of carotene when various ratios of white mineral oil to rice bran were used in the mixtures. It may be noted, however, that an oil-bran ratio of 1:4 is as satisfactory as a ratio of 1:2.5 in the retention of carotene when diphenylamine is present. In the absence of diphenylamine, however, this same increase in oil content of the preparation does show an increase of carotene retention (see Nos. 7 and 9, Table 1).

It must be known from adequate tests that a sub-

[5] P. Lande, P. Derville and R. Colloft, *Comp. Rend. Soc. Biol.*, 117: 363–5, 1934.

[6] James E. Guthrie, *Proc. Helminthol. Soc. Washington*, December 7, 1940, pp. 84–5.

[7] Carotene is used herein to denote a mixture of approximately 90 parts beta- to 10 parts alpha-carotene.

[8] R. Adams Dutcher, Philip L. Harris, Eva R. Hartzler and N. B. Guerrant, *Jour. Nutrition*, 8: 269–83, 1934.

[9] L. A. Moore, *Ind. Eng. Chem., Anal. Ed.*, 12: 726–8, 1940.

[10] H. S. Olcovich and H. A. Mattill, *Jour. Biol. Chem.*, 91: 105–117, 1931.

stance is harmless when ingested by animals before it can be used in food or feed. Since such information is not yet available for diphenylamine, it is not safe to make any practical application of the results of this study.

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EDEMA IN VITAMIN E DEFICIENT CHICKS[1]

INCREASING the concentration of soluble salts in the diet has been stated by Dam and Glavind[2] to be an effective means of increasing the severity of the edema which develops in chicks fed a diet low in vitamin E. Experimental results confirming this statement have been obtained in this laboratory and were reported at the Ninth Informal Poultry Nutrition Conference held in Boston on March 31, 1942. For example, in one experiment 100 per cent. mortality resulted in a group of 9 three-week-old chicks given daily doses of NaCl solution (20 gms/100 ml) during a six-day period. Eight of the 9 chicks showed some form of edema. One of 8 control chicks given no NaCl died during the same period but showed no evidence of edema. The group given NaCl solution received 0.017 ml/gm body weight on the first day of treatment and the dose was gradually increased, reaching 0.021 ml/gm body weight on the sixth day. All chicks were fed a vitamin E-low diet consisting of dextrinized corn starch 59, dried skimmilk 20, casein 13, butyl fermentation residue 3, oyster shell flour 1, calcium phosphate 2, sodium chloride 1 and cod liver oil 1. To each kg were added 120 mg $MnSO_4 \cdot 4H_2O$, 2 mg thiamine, 2 mg 2 methyl 1–4 naphthoquinone and 1 gm choline hydrochloride.

Administration of NaCl solution was first tried because chicks fed diets similar to that given above did not develop edema as readily as did chicks fed the diet previously described,[3] which contained 54 per cent. of dried skimmilk. It appears that disturbance of the osmotic equilibrium is necessary in addition to vitamin E deficiency to cause generalized edema.

Supplementation of the diet outlined above with 20 per cent. of a practical chick mash protected chicks against edema even when NaCl solution was administered. Lower levels of the practical mash were not effective. These results were interpreted as an indication of the vitamin E content of this mash, but some doubt is cast on this interpretation by the report of Dam and Glavind that inositol and lipocaic also protect against edema.

Experiments in this laboratory on the specificity of the protective effect of vitamin E were directed toward compounds having similar antioxidant properties. Toluhydroquinone, p-xyloquinone and trimethyl hydroquinone were inactive when fed at four times the effective level of alpha tocopherol. They are also ineffective when fed to rats.[4] Beta tocopherol[5] was about half as potent as alpha tocopherol, and this also conforms to the results of rat experiments.[6]

Pappenheimer, *et al.*,[7] in their extensive studies on encephalomalacia in chicks showed that the primary changes in this manifestation of vitamin E deficiency were edema and hemorrhage resulting from alteration of the capillary walls in the brain. It now appears that such alteration occurs in other parts of the vitamin E deficient organism but is not usually sufficient to permit exudation unless the normal osmotic relationships are disturbed. The question may well be raised as to the possible relationship of capillary changes to the various manifestations of vitamin E deficiency in other species.

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ISOMORPHISM AND ISOTYPISM AMONG SILICATES AND PHOSPHATES

RECENT advances in the study of isomorphism and isotypism may be illustrated through examples taken from compounds related to two mineral groups, the garnets and the apatites. Investigations by numerous chemists and mineralogists have revealed new isomorphic and isotypic relationships among silicates and phosphates, such as the isotypism of $AlPO_4$ and SiO_2 reported by Huttenlocher. However, a complete discussion is beyond the scope of these brief comments and complete references to the diverse sources of the data are purposely omitted.

Isomorphism, in the sense of the mineralogist, is characteristic of those compounds which exhibit stereochemical miscibility (so-called mixed crystals). Limited isomorphism obtains when the stereochemical miscibility is limited, whereas complete isomorphism exists when numerous intermediate members have been proven.

[1] Scientific paper No. A36a, Contribution No. 1857 of the Maryland Agricultural Experiment Station (Department of Poultry Husbandry).
[2] H. Dam and J. Glavind, SCIENCE, 96: 235, 1942.
[3] H. R. Bird and T. G. Culton, *Proc. Soc. Exp. Biol. and Med.*, 44: 543, 1940.
[4] C. Golumbic and H. A. Mattill, *Jour. Biol. Chem.*, 134: 535, 1940.
[5] Alpha and beta tocopherol and trimethyl-hydroquinone were furnished by Merck & Co., Inc., Rahway, N. J., through the courtesy of Dr. D. F. Green.
[6] P. Karrer and H. Fritzsche, *Helv. Chim. Acta*, 22: 260, 1939.
[7] A. M. Pappenheimer, M. Goettsch and E. Jungherr, *Conn. Agr. Exp. Sta. Bul.*, 229, 1939.