these vitamins were included in the ration at a level several times the requirement. Slanetz and Scharf[2] reported that soybean phosphatides promoted proper utilization of vitamin A in the rat. Quackenbush, Cox and Steenbock[3] found that dl-alpha-tocopherol was an antioxidant for vitamin A and carotene.

The percentage composition of the basal ration was as follows: Dextrin 52.3, Cellophane 3, casein (purified) 30, gelatin 5, salts 4.6, lard 5 and choline 0.1. In addition each one hundred grams of the ration contained 200 I. U. vitamin D_3, 800 I. U. vitamin A (natural esters), 0.1 mg 2-methyl-1,4-naphthoquinone, 0.5 mg thiamin, 1 mg riboflavin, 0.5 mg pyridoxin, 2 mg Ca-pantothenate, 2 mg nicotinic acid, 30 mcg biotin, 1 mg inositol and a fuller's earth eluate equivalent to 12 grams of dried brewers' yeast. This ration is adequate in all water-soluble nutrients required for normal growth of the chick; however, it is inadequate in vitamin E and an unrecognized fat-soluble substance which is necessary for proper utilization of vitamin E. This unrecognized nutrient is found in yeast and soybean phosphatides. It can be removed from yeast by extraction with hot Skellysolve B and is soluble in ether, Skellysolve B and Stoddard solvent.

The data presented in Table 1 summarize the study on the unrecognized fat-soluble nutrient. Chicks receiving only the basal ration (Trial 1) started to develop vitamin E deficiency symptoms at about 12 days of age, and by the 28th day severe vitamin A and E deficiency symptoms were present. Those receiving 0.001 per cent. dl-alpha-tocopherol, trial 2, developed vitamin A and E deficiency symptoms simultaneously with those in trial 1. When the basal ration was supplemented with 0.001 per cent. dl-alpha-tocopherol plus 5 or 10 per cent. dried brewers' yeast, they developed normally. If they received 0.001 per cent.

TABLE 1

Influence of Different Supplements on the Development of Vitamin E and A Deficiency Symptoms in Chicks

Trial	Supplement to basal ration	Observations up to 5 weeks of age: Mortality	Vitamin E deficiency	Vitamin A deficiency
		Per cent.	Per cent.	Per cent.
1	None	100	83	100
2*	dl-alpha-Tocopherol	100	90	100
3*	dl-alpha-Tocoperol, 5 per per cent. yeast	0	0	0
4*	dl-alpha-Tocopherol, 10 per cent. yeast	0	0	0
5*	dl-alpha-Tocopherol, 2 per cent. soybean phosphatides	0	0	0
6*	dl-alpha-Tocopherol, 5 per cent. extracted yeast	100	70	100
7	5 per cent. extracted yeast	100	60	100
8*	dl-alpha-Tocopherol, massive vitamin A dosage	20	67	0

* dl-alpha-Tocopherol was added at a level of 0.001 per cent.

dl-alpha-tocopherol plus 5 per cent. brewers' yeast which had been extracted for 72 hours in a Soxhlet extractor with hot Skellysolve B, they developed vitamin E and A deficiency symptoms. If the basal ration was made adequate in dl-alpha-tocopherol and supplemented with 2 per cent. soybean phosphatides the chick developed normally. When the chicks were given massive dosages of vitamin A (4,000 I. U. per day) for the first three days of life and also the basal ration made adequate in vitamin E, they developed only vitamin E deficiency during the first 35 days of life.

H. Patrick
C. L. Morgan
Poultry Department,
Clemson Agricultural College,
South Carolina

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR INDICATING THE MOISTURE CONTENT OF FOODS DURING DEHYDRATION[1]

In the dehydration of foods, such as vegetables, fruits, meats, etc., there is a great need for a method which will indicate, in the dehydrators, the moisture content of the dehydrating material and which will tell when the material has dried to the proper or preferred moisture content and is ready to be removed. At the present time, three different methods are used for this purpose: (1) appearance and feel of the material by hand; (2) taking a sample and determining its moisture content; and (3) dehydrating the material for a definite and predetermined length of time. Obviously, for one reason or another, these methods can not be considered entirely satisfactory.

It is the purpose of this note to present a method which can be used in dehydrators to indicate, by proper calibration, the moisture content of the dehydrating material at the various stages of dehydration and to tell when the material has dried to the proper or preferred moisture content and is ready to be removed.

The method is based upon the well-known phenomenon that the evaporation of water lowers the temperature. When the fresh material is being dehydrated, there are two temperatures, that of the chamber and that of the material itself. At the beginning, when

[2] C. A. Slanetz and A. Scharf, *Proc. Soc. Exp. Biol. and Med.*, 53: 17, 1943.
[3] F. W. Quackenbush, R. P. Cox and H. Steenbock, *Jour. Biol. Chem.*, 145: 169, 1942.
[1] Journal article No. 660, new series.

the material contains its maximum water content, the evaporation of the water lowers its temperature far below that of the chamber. As the material becomes progressively drier its temperature becomes progressively higher, until finally both temperatures come close together. At this point, the material reaches a degree of dryness which is very close to the commonly desired moisture content.

The procedure consists of placing two thermometers in the dehydrator. The bulb of one thermometer is bare and is simply hanging in the chamber. The bulb of the second thermometer is covered with a definite amount of the dehydrating material contained in a small bag of cheesecloth and is placed on one of the loaded trays. The bag with the material is held around the bulb by rubber bands which tend to exert pressure continuously. The area and amount of material placed in the cheesecloth bag are definite and constant and are related to the amount and thickness of the layer of the material on the trays.

The cheesecloth bag technique is universal in application, in that, by means of it, almost any kind of material can be tied around the bulb of the thermometer. For example, peas and carrots can be tied as effectively and readily as slices of potatoes, apples or leaves of spinach.

The thermometers used in this method are specially devised and are well suitable for the purpose. They are electrical resistance thermometers, using, as resistor, a liquid instead of metal. They have a range from 2,500,000 ohms at 32° F. to 25,000 at 185° F. They are about 30,000 times more sensitive than the metallic electrical resistance thermometers. The electrical resistance values are read on a special wheatstone bridge. The bulb of the thermometers is made of glass and is 25 mm long and 8 mm in diameter. The wire leads are composed of the ordinary lampcord and can be of any length. These new electrical thermometers seem to be admirably suited for dehydration work. The wire leads make it possible and convenient to read the temperatures from the outside of the dehydrator.

The type of results obtained by this method is shown in Fig. 1. The material dehydrated is cabbage. It will be seen that the electrical resistance of the uncovered thermometer attains the temperature of the chamber very quickly and fluctuates as that temperature varies. The electrical resistance of the covered thermometer, however, remains at a higher level (lower temperature) for some time, and when the bulk of the water is evaporated, it begins to decrease, and finally almost reaches, to within 1,000 ohms, the resistance of the uncovered thermometer. At this point, the moisture content of the cabbage is 4.5 per cent., by vacuum oven determination, which is close to the lower range of the preferred moisture content. It is clearly evident from this chart that by calibration it is possible to know during the dehydration when the material has reached the desired moisture content.

The method has been tested on almost all the various materials commonly dehydrated, and in every case it has proven successful, dependable and accurate. Relying entirely upon this method, it has been possible to dehydrate many materials for the first time down to the preferred moisture content with surprisingly persistent accuracy and without resorting to any other aid. Results of checks agreed to within about 1 per cent.

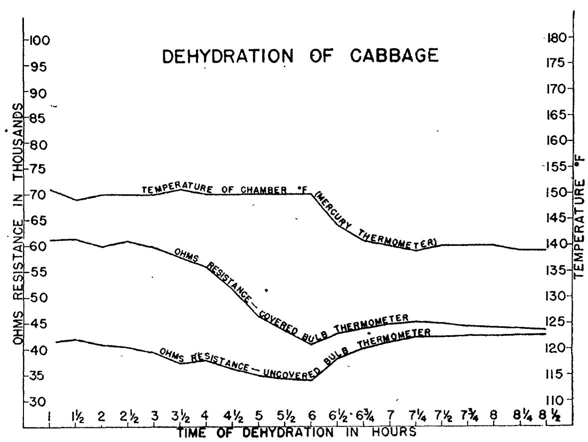

FIG. 1

While the method has been used thus far mainly in the non-moving type of dehydrators, there is no reason why it can not be adopted and used also in the conveyor or any other type of dehydrator.

The method is based upon sound fundamental principles and should fill the great need for a simple, direct and reliable method for indicating the moisture content of the dehydrating material, and for telling when the material has reached the desired moisture content and is ready to be taken out of the dehydrators. A comprehensive report is forthcoming.

GEORGE BOUYOUCOS
H. A. CARDINELL

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