The American Psychiatric Association was accepted as an affiliated society. (This organization has a total membership of 1,912. Of this number 135 are members of the association, 73 of these being fellows. The organization is entitled to one representative in the council of the association, who will be *ex-officio* a member of the section committee of the Section on Medical Sciences.)

The Florida Academy of Science was accepted as an affiliated state academy, with one representative in the council of the association.

The Alpha Epsilon Delta Pre-Medical Fraternity was accepted as an associated society. (This organization has a total membership of 985 members. Of this number, 47 are members of the association, 37 of these being fellows.)

Dr. Conklin was appointed the representative of the association at the Centennial celebration of Emory University in December, 1936.

The permanent secretary and the general secretary were appointed representatives to the First National Conference on Educational Broadcasting, to be held in Washington, from December 10 to 12, 1936.

Dr. Caldwell was appointed the association's representative to the Tokyo Conference of the World Federation of Education Associations, and he was asked to confer with Dr. Paul Monroe on the possibility of the association's cooperation in organizing the program of the section on science for this congress.

Certain matters were reported for record:

President Conklin served as delegate at the meeting of the British Association at Blackpool, from September 9 to 16, 1936.

For the International Conference on Letter Symbols for Heat and Thermodynamics, held at the headquarters of the American Society of Mechanical Engineers, New York City, from September 14 to 15, Dean George B. Pegram, Columbia University, and Professor George F. Bateman, Department of Mechanical Engineering, Cooper Union, were selected as representatives and served in that capacity.

For the Centennial Celebration of the Chartering of Wesleyan College, Macon, Ga., on Friday, October 23, Dr. A. S. Edwards, head of the Department of Psychology at the University of Georgia, was appointed and served as delegate.

The meeting adjourned at 3:30 P. M. to meet in Atlantic City on December 27.

HENRY B. WARD,
Permanent Secretary

SPECIAL ARTICLES

VITAMIN C IN PASTEURIZED MILK

OUR results and those of Whitnah and Riddell[1] indicate that the vitamin C or ascorbic acid content of fresh milk is relatively constant throughout the year, although variations occur in individual cows. No increase in the ascorbic acid content of cow's milk was produced by green feeding nor of goat's milk by intrajugular injection of 4 grams of ascorbic acid daily.

Plant tissues which contain ascorbic acid apparently also contain an ascorbic acid oxidizing enzyme which is liberated when the cells are crushed. The enzyme in some plants is very active. For example, the large amount of ascorbic acid present in cabbage is completely oxidized within 5 minutes after the previously frozen raw cabbage cells are disintegrated. While the feed is masticated and stored in the rumen by the cow, all the ascorbic acid it contains is probably oxidized. Therefore the cow and animals with similar digestive systems, and possibly birds, must either synthesize ascorbic acid or reverse the oxidation.

Variations in the rate of oxidation of ascorbic acid in milk can be explained best by assuming the presence of an ascorbic acid oxidase, the action of which is markedly accelerated by traces of dissolved copper.

[1] SCIENCE, 83: 162, 1936.

The milk from individual cows varies in ascorbic oxidase activity. Our experiments indicate, although the proof is not yet conclusive, that ascorbic acid disappears more rapidly from winter milk (dry feed) than it does from summer milk (pasture feed). This may be due to a difference in amount of enzyme or of copper. Some investigators report that the vitamin C feeding value of summer milk is higher than that of winter milk. Failure to feed immediately after milking, or immediately after pasteurizing, accounts for some of the conflicting conclusions which appear in the literature.

A very slight destruction of the enzyme occurs in milk pasteurization by the "holder" method (30 minutes at 62–63° C., 143–145° F.). This method gives satisfactory bacterial destruction without injuring creaming ability. Heating for one-half minute or longer at 77° C. (170° F.) destroys the enzyme and so retards the oxidation of the ascorbic acid, but it also destroys the creaming ability which is demanded by consumers. Less severe heating exerts some preserving effect, depending on the partial destruction of the enzyme.

Traces of dissolved copper in milk heated to 77° C. or higher have very little accelerative effect on the oxidation of ascorbic acid when compared with the

accelerative effect produced in raw or holder pasteurized milk, because heating to 77° C. destroys the enzyme.

It has been stated repeatedly that raw milk contains more vitamin C than holder pasteurized milk. The difference has been erroneously attributed to oxidation caused by the heating. Milk heated in glass for one hour at 63° C. actually contains more ascorbic acid after holding cold for 3 days than does an aliquot held raw for the same time. This is because more of the enzyme than of the ascorbic acid is destroyed by 1 hour's heating. An insignificant amount of ascorbic acid is destroyed by heating in glass for 30 minutes at 63° C. and the enzyme is weakened slightly.

This leads to the very important conclusion that milk heated under the conditions of time and temperature specified for holder pasteurization may for all practical purposes be as potent in vitamin C as raw milk. The interrelations between the effects of enzyme, copper and pasteurization were studied on 355 aliquoted samples. The values below are the averages expressed in mgms of ascorbic acid per liter of milk:

Fresh milk	20.1
Held 3 days at 2° C.	
Raw	11.3
Past. (30 min. 62–63° C.)	11.0
Past. (30 min. 62–63° C.) + .13 p.p.m. Cu	1.7
Past. (10 min. 77° C.)	15.7
Past. (10 min. 77° C.) + .13 p.p.m. Cu	12.4

If appreciable destruction of ascorbic acid occurs during commercial pasteurization it is caused by copper contamination from the equipment. However, even with copper contamination most of the destruction in commercial bottled milk occurs in the cold milk during holding after pasteurization, and not during pasteurization.

While every contingency of the commercial application of these results has not been investigated, yet experiments up to this time indicate that if milk has not been contaminated with copper, pasteurization by the holder method in glass, aluminum or chromium steel containers will not accelerate appreciably the rate of destruction of ascorbic acid. It is not sufficient to have only the main parts of the equipment of the approved materials; parts of the equipment which are often overlooked, such as thermometer couplings, valves, pumps, unions, pipes and bottling equipment must be free from copper and its alloys. Completely tinned copper, while satisfactory when new, soon wears through and therefore is a common source of copper contamination.

Dr. E. S. Guthrie took daily samples at various stages during the passage of milk through a small commercial market milk plant. Milk which when fresh contained about 20 mgms of ascorbic acid per liter, after holder pasteurization in a chromium steel vat and holding for 3 days at 2° C. contained 11.0 mgms (raw milk about 11.3); after passage over a well-tinned, external, tubular cooler (through aeration and exposure to oxygen absorption) the amount was about the same; and after bottling, 5.5 mgms. The milk came in contact with small areas of exposed copper and copper alloy in the bottler.

The ascorbic acid content of samples of commercial bottled milk, obtained from various distributors in different cities, was determined when the milk was about 3 days old. The average of 457 samples of pasteurized milk was 2.2 mgms, and of 63 samples of raw milk 7.9 mgms of ascorbic acid per liter. Many of the raw milk samples contained no ascorbic acid, which was to be expected, since much of the raw milk sold comes in contact with copper. The addition of 0.13 mgm of copper per liter to milk pasteurized in glass (62–63° C. for 30 minutes) reduced the ascorbic acid to 1.7 mgms per liter at the end of 3 days at 2° C. This amount of copper corresponds roughly to the amount which much of the milk acquires as it is now handled commercially.

Reports in the literature indicate that ascorbic acid is the only substance present in milk which is oxidized with 2–6 dichlorphenolindophenol and that the biological test for ascorbic acid is in general agreement with the amount determined by titration. The values for ascorbic acid reported here are all based on the results obtained by titrating, with 2–6 dichlorphenolindophenol, 10.0 ml of milk which was acidified with 25 ml of 0.1 N sulfuric acid. Direct titration of the milk eliminates the error due to the destruction of ascorbic acid which occurs during the filtration involved in older methods, and apparently the proteins do not interfere. By using 4 burettes and titrating 4 samples simultaneously, to an end point which is permanent for 30 seconds or more, 40 or more determinations can be made in an hour. An approximation of the amount of copper in milk can be obtained by heating for 10 minutes at 77° C., cooling, adding a definite amount of ascorbic acid, and determining its rate of disappearance.

This investigation indicates that it is commercially feasible to pasteurize milk by the holder method and maintain essentially as high an ascorbic acid content as that of raw milk at the same age. This removes the main nutritional objection to pasteurized milk. Furthermore, it is possible by using higher temperatures to produce pasteurized milk which when held will exceed in ascorbic acid potency raw milk of the same age.

PAUL F. SHARP

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