Short Articles

COPPER BOILERS AND THE OCCURRENCE OF SCURVY: AN EXPERIMENTAL APPROACH

by

ELERI JONES AND R. ELWYN HUGHES*

IN 1757, JOHN TRAVIS, a surgeon at Scarborough, discussed the causes of sea scurvy in a letter to Dr. John Fothergill.[1] Travis, after commenting on the currently popular theories of the cause of scurvy observed, " . . . That bad provisions and moist foul air (which are generally esteemed the principal cause of it at sea) do not produce similar effects in our ships . . ." (p. 5), and indicated that there were presumably other causes or predisposing factors. ". . . According to my idea of the scurvy," he wrote, "any acrimonius matter, whether it be produced in the body itself, or accidentally received into . . . may become a proximate cause of the disease . . ." (p.4). In this category he placed mercury, quoting reports by Harvey and by Huxham of its scorbutogenic nature. ". . . Now we are assured," he reasons, "by physicians of the greatest eminence, that all mineral poisons, *caeteris paribus,* act on the human body nearly alike; may it not then be concluded that verdigrease, and a solution of copper, taken in the same manner, must necessarily bring on *nearly* the same complaints . . .?" (p. 10). Travis underlined his point by remarking that on board ships where food was prepared in "iron potts" highly scorbutic symptoms were absent, a situation which was, he claimed, in marked contrast with that on ships where the food was prepared in copper boilers. ". . .I flatter myself," he wrote, "it will be evidently perceived, why the crews of some ships are more afflicted with the scurvy than others; . . . why those officers, who have not their provisions boiled in the ship's copper, are free from the worst symptoms . . ." (pp. 15–16). " . . . Is it not highly probable then, that experience may hereafter shew this to have been the principal (though not sole) cause of scurvy in the royal navy . . .?" (p. 14). He concluded his letter by suggesting that ". . . the boilers of copper, used by all the ships in the navy should, as soon as possible, be changed for others of iron . . ." (p. 16).

The aetiology of scurvy is today clearly definable in nutritional and biochemical terms. It is a deficiency disease resulting from a dietary lack of vitamin C; it is unlikely therefore that an excess intake of copper could be an additional principal cause, as suggested by Travis. Nevertheless, his observation that the incidence of scurvy

*Eleri Jones, B.Sc., and R. Elwyn Hughes, M.A., Ph.D., F.I.Biol., Department of Applied Biology, University of Wales Institute of Science and Technology, Cardiff.

[1] John Travis, 'A letter from Mr. John Travis, Surgeon at Scarborough, to Dr. John Fothergill, tending to shew, that the use of copper vessels in the Navy, is one principal cause of the sea scurvy (read Oct. 31, 1757)', *Medical Observations and Inquiries*, 1762, **2**: 1–16.

https://doi.org/10.1017/S0025727300021839 Published online by Cambridge University Press

could be correlated with the type of metal boiler used, could be of some significance. Copper ions are potent catalysts in the aerobic breakdown of vitamin C; iron ions are less effective in this respect and would therefore promote vitamin C loss less rapidly.[2] Non-coated copper and iron boilers could presumably release sufficient metal into solution to influence the breakdown of vitamin C during the preparation of food. If the bulk of a sailor's vitamin C came from vegetables boiled in such boilers then the rate of destruction of vitamin C could influence the incidence of scurvy.

A simple experiment was done to test this hypothesis. A model system was devised in which weighed amounts of cabbage were boiled in water in non-coated copper and iron vessels respectively and the amount of vitamin C remaining after specific intervals determined by a standard technique.[3] A sailor's diet often contained simple vegetable soups of this type. Lind referred to "the most incontestable experience that a soup of boiled cabbage and onions will cure an adventitious scurvy,"[4] and Cook incorporated greens of different types in the soups that were prepared daily for his crew.[5]

Twelve experiments were done. In the "cabbage soup" prepared in the copper pot the percentages of vitamin C remaining after 10, 20, 30 and 40 minutes' boiling were 90, 40, 30 and 25 respectively: the corresponding values for "cabbage soup" prepared in the iron pot were 98, 80, 84 and 56. Thus a simple cabbage soup prepared in a copper pot lost its vitamin C more than twice as rapidly as a similar soup prepared in an iron pot.

Travis's observation that the nature of a ship's boiler could apparently influence the incidence of scurvy was therefore presumably a perfectly valid one. He was incorrect, however, in implying that copper exerted a direct toxic influence in this respect. The extent to which this copper-catalysed destruction of vitamin C could contribute to the incidence of naval scurvy in general would of course be related to the proportion of antiscorbutic vegetables subjected to "boiler" treatment before consumption.

[2] G. W. Hay, B. A. Lewis and F. L. Smith, 'Chemistry of ascorbic acid', in W. H. Sebrell and R. S. Harris (editors), *The vitamins*, New York and London, Academic Press, 1967, vol. 1, p. 307.

[3] R. E. Hughes, 'Use of a cation-exchange resin in the determination of urinary ascorbic acid', *Analyst*, 1964, **89**: 618–620.

[4] James Lind, *A treatise of the scurvy*, Edinburgh, Sands, Murray & Cochran, 1753, p. 215.

[5] E. Kodicek and F. G. Young, 'Captain Cook and scurvy', *Notes Rec. R. Soc. Lond.*, 1969, **24**: 43–63.