

NUTRITION REPORTS INTERNATIONAL

INFLUENCE OF ORAL CARNITINE ON THE BODY WEIGHT AND SURVIVAL TIME OF AVITAMINOTIC-C GUINEA PIGS

Eleri Jones and R.E. Hughes

Department of Applied Biology, University of Wales
Institute of Science and Technology, Cardiff, Wales

ABSTRACT

Two groups of guinea pigs received 1% ascorbic acid in their drinking water to achieve tissue saturation and were afterwards maintained on an ascorbic acid-free regime till death. One group received fresh, aqueous DL-carnitine (10mg/ml/kg body weight) daily, the other an equivalent volume of water. The carnitine-supplemented group survived for a significantly longer period than the non-supplemented group ($p < 0.01$). The results suggest that carnitine synthesis is an important extra-antiscorbutic role of vitamin C.

INTRODUCTION

Historical accounts of human scurvy (avitaminosis C) have almost invariably indicated that fatigue and lassitude were the earliest features of the disease - a finding underlined more recently in reports of experimentally-induced scurvy in man (1). The current Recommended Daily Amount for vitamin C (ascorbic acid) in the United Kingdom (30 mg) is, however, based on the later emergence of the traditional symptoms of 'clinical' scurvy - enlargement and keratosis of hair follicles, formation of 'scorbutic spots' and characteristic gum changes (2,3).

Recent studies have provided a probable biochemical explanation of the role of ascorbic acid in the prevention of fatigue. Ascorbic acid is involved in two hydroxylation stages in the endogenous biosynthesis of carnitine from lysine (4). Carnitine, in turn, is necessary for the proper utilisation of fatty acids as a source of muscle energy; lassitude and fatigue are features of systemic carnitine deficiency (5).

A previous study with guinea-pigs indicated that hypovitaminosis C resulted in a significant fall in the skeletal muscle carnitine well before the emergence of any of the classical symptoms of guinea-pigs scurvy (6) - a situation which may be compared with human scurvy where lassitude and fatigue precede the emergence of the more traditional 'overt' signs.

NUTRITION REPORTS INTERNATIONAL

This report describes a study designed to extend this finding by determining the influence of carnitine supplementation on the body weight changes and survival times of guinea-pigs given a scorbutogenic diet.

METHODS

Two groups of eight male albino guinea-pigs (Dunkin-Hartley strain) were used. Both groups received a semi-synthetic scorbutogenic diet (6) and, for 3 days prior to the depletion period, a supplement of 1% ascorbic acid in their drinking water to produce tissue saturation. After this no further ascorbic acid supplements were given. On day 5 of the depletion period, and daily for the remainder of the experiment, the animals in the test group received a daily oral supplement of 10 mg DL-carnitine/ml/kg body weight, dissolved in water; the control group received an equivalent volume of water. All animals were weighed daily and survival periods noted.

RESULTS

The influence of the carnitine supplement on the body weights and survival times of the scorbutic guinea-pigs is shown in Figures 1 and 2. Carnitine supplementation

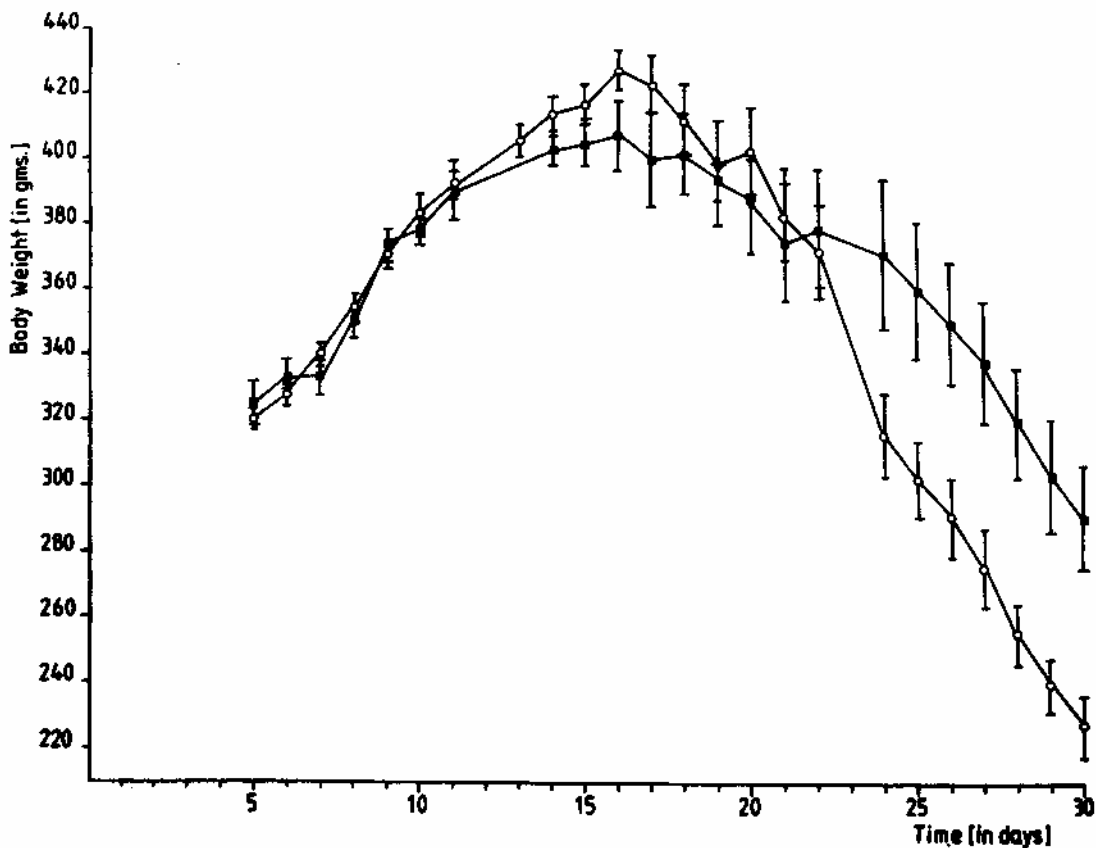


Figure 1 :

Influence of DL-carnitine ($10 \text{ mg} \cdot \text{kg}^{-1} \cdot \text{day}^{-1}$) on the body weights of guinea-pigs. Differences are significant from day 24 onwards. (o-o control group, ■-■ carnitine group)

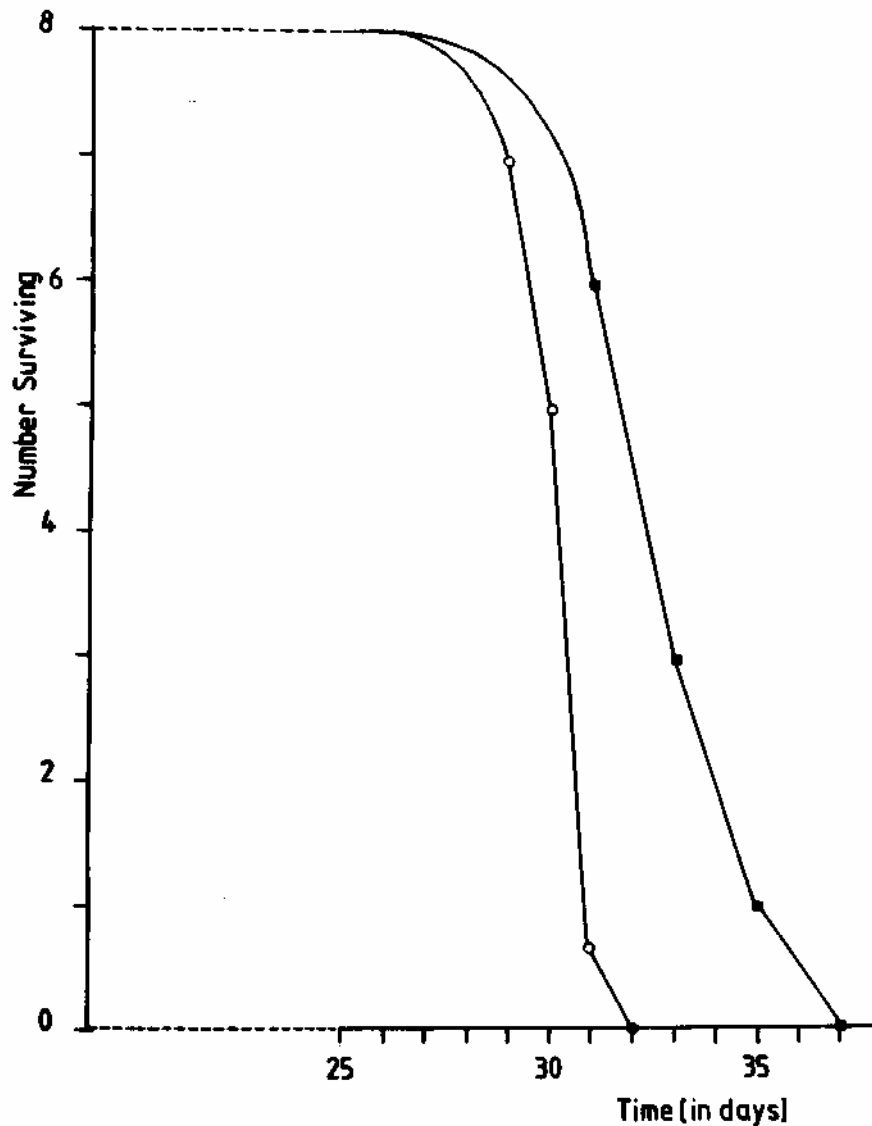


Figure 2 : Influence of DL-carnitine on the survival time of guinea-pigs. (o—o control group, ■—■ carnitine group).

produced a significant increase in the mean life span; the survival time for the control group was 30.6 ± 0.3 days and for the supplemented group 33.5 ± 0.7 days (mean values with standard errors, $P < 0.01$). There was no significant difference between the mean body weights at the beginning of the test. On day 24 of the depletion period, and daily thereafter until the end of the experiment, the mean body weight of the carnitine-supplemented group was significantly greater than that of the controls.

DISCUSSION

This influence of carnitine on the body weight and survival time of the scorbutic guinea pig may be inter-

NUTRITION REPORTS INTERNATIONAL

preted as indicating a 'sparing' effect upon endogenous demands for tissue ascorbic acid and supports previous evidence of a nutritional role for ascorbic acid in the conversion of lysine to carnitine (1,4,6). The results are in contrast with a previous study where dietary supplementation with cholesterol failed to influence the life span of scorbutic guinea-pigs although there is evidence that the vitamin is involved in cholesterol metabolism (7). This could mean that the involvement of ascorbic acid in carnitine metabolism is nutritionally significant and underlines the possible inadequacy of a Recommended Daily Amount for ascorbic acid based on considerations which do not include a probable role in carnitine metabolism.

ACKNOWLEDGEMENTS

This study was supported by a Beecham Products Ltd, research grant. Mr Stuart Barnett, assisted with the animal husbandry.

REFERENCES

- 1) Hughes, R.E. 'Vitamin C, Some Current Problems'. British Nutrition Foundation, London (1981).
- 2) DHSS Report 'Recommended Daily Amounts of Food Energy and Nutrients for Groups of People in the United Kingdom' HMSO, London (1981).
- 3) Bartley, W., Krebs, H.A. and O'Brien, J.R.P. Vitamin C Requirement of Human Adults. Medical Research Council Special Report Series No. 280 HMSO, London (1953).
- 4) Hulse, J.D., Ellis, S.R., and Henderson, L.M. Carnitine biosynthesis : β -hydroxylation of trimethyllysine by an α -ketoglutarate-dependent mitochondrial dioxygenase. J. biol. Chem. 253 1654-1659 (1978).
- 5) Hughes, R.E. Recommended Daily Amounts and Biochemical Roles : the Vitamin C, Carnitine, Fatigue Relationship. In 'Vitamin C' (editor: J. Counsell), Applied Science Publishers, London, (1982) (in the press).
- 6) Hughes, R.E., Hurley, R.J. and Jones, Eleri. Dietary ascorbic acid and muscle carnitine in guinea-pigs Br. J. Nutr. 43, 385-388 (1980).
- 7) Jones, P.R., Hurley, R.J. and Hughes, R.E. Dietary Cholesterol, sex and scurvy in Guinea-pigs. Nature 242 521-522 (1973).

Accepted for publication: November 18, 1981.