Change in taste preference related to aging of taste cells in rat

K. Sugimoto and T. Sato[1]

Department of Oral Physiology, School of Dentistry, Tokyo Medical and Dental University, Yushima, Bunkyo-ku, Tokyo 113 (Japan), 4 October 1977

Summary. Following the suppression of renewal of rat taste cells by vinblastine sulphate, the preference for sucrose decreased markedly while the aversion to quinine did not change. The results suggest that the sensitivity of taste cells to sucrose decreases with their aging, but the sensitivity to quinine increases.

Histological studies indicate that the life span of rat taste cells is on the average 10 days and the renewal of taste cells occurs continuously from the epithelial cells surrounding taste buds[2]. A question arises whether or not the sensitivity of taste cells to chemical stimuli is changeable depending on their aging. Here we report on a change in taste preference related to the aging of taste cells in rats.

Materials and methods. Female Wistar albino rats weighing 210–280 g were individually caged with ad libitum supply of food and water. In order to make a population of aged taste cells, the renewal of taste cells was suppressed by a single i.p. administration of vinblastine sulphate (VLS), which is well known to inhibit cell mitosis by arresting it at the metaphase stage. Taste preference for 0.05 M sucrose and aversion to 0.0001 M quinine-HCl were observed behaviourally by a 2-bottle choice test, deionized water vs a test solution.

Results and discussion. Figure 1 illustrates intakes of water and 0.0001 M quinine-HCl after single injections of 2.0–5.0 mg/kg b.wt of VLS at the end of day 0. Marked aversion to quinine continued consistently during 11 days observed after the injection, whereas water intake decreased rapidly during 2 days after VLS and recovered gradually. The loss of b.wt was less than 10%. Since it is well accepted that the rat gustatory nerve does not respond to pure water applied to the tongue[3], it is likely that the water intake in rats is not dependent on activities of taste receptors but is dependent on their internal physiological need. Thus, the decrease in the water intake for 4 days as seen in figure 1 may be ascribable to the adverse effect of the drug, which is well known in therapies of leukemia and other diseases by use of VLS[4].

Figure 2 shows intakes of 0.05 M sucrose (A) and water (B) after a single injection of 3.0 mg/kg of VLS at the end of day 0. On day 0 before the injection, the sucrose intake was much larger than the water intake. However, the sucrose intake (solid line) decreased rapidly for 4 days after VLS but recovered gradually from the 9th day. In contrast, water intake increased gradually during 8 days after VLS and then decreased gradually. Like the decrease in the water intake in figure 1, the large fall of sucrose intake from day 2 through day 4 in figure 2, A is considered to be due not only to taste cell aging but also the adverse effect of VLS.

Histological studies on frog taste organ[5] and mammalian bone marrow[6,7] indicate that a single i.p. injection of VLS of similar doses inhibits strongly cell division at the metaphase 7–10 days. Thus, the recovery of sucrose intake from the 9th day in figure 2, A may be due to the reappearance of young taste cells following disappearance of old cells. We assume that the recovery rate of sucrose intake at the right of figure 2, A would be equal to the reduction rate of sucrose intake at the left when the adverse effect of VLS is excluded. By such a way, estimation of reasonable sucrose intakes correlated with only aging and loss of taste cells is illustrated as the closed circles in figure 2, A. Figure 3 illustrates a percent sucrose preference curve. It is seen that sucrose preference after VLS decreased gradually to the point of sucrose aversion. Sucrose preference reappeared on day 9 and recovered progressively to the control level.

There is considerable evidence that taste preference and aversion are greatly associated with taste receptor activities[8]. We found that there was a directly proportional

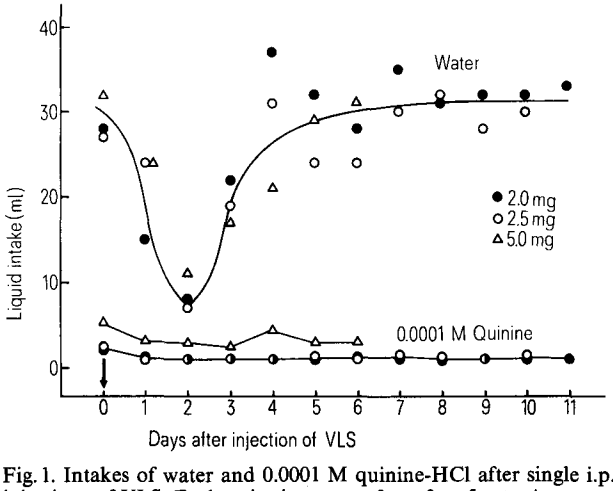

Fig. 1. Intakes of water and 0.0001 M quinine-HCl after single i.p. injections of VLS. Each point is a mean from 3 to 5 rats. An arrow on day 0 shows the injection of VLS after the measurement of liquid intakes. Before the experiment, each rat was given choice of 2 water bottles to make sure of no difference in water intake from either bottle.

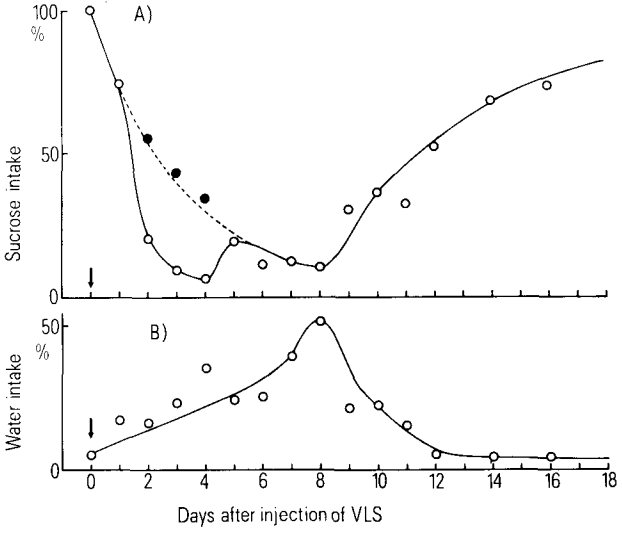

Fig. 2. Daily intakes of 0.05 M sucrose *(A)* and water *(B)* after a 3.0 mg VLS injection/kg b.wt at the arrow. Each point is a mean from 3 to 4 rats. Amounts of solution intakes in ordinates of *A* and *B* are expressed as percent of sucrose intakes in control rats each day. For correction of the drug-induced adverse effect, estimated sucrose intake value on day 18 in the recovery curve was taken as 100% and extremely decreased sucrose intakes on days 2, 3 and 4 were corrected as closed circles by the recovery rate on days 10, 11 and 12, respectively.

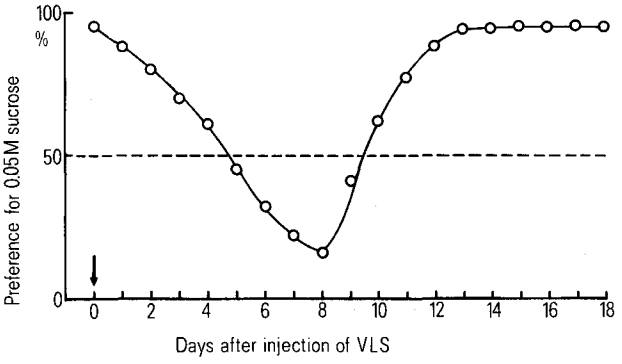

Fig. 3. Change in preference for 0.05 M sucrose after VLS. The preference is expressed as

$$\frac{\text{sucrose intake}}{\text{total intake of sucrose and water}} \times 100.$$

Sucrose intake values were obtained from the corrected curve in figure 2, A. The horizontal line indicates a 50% water intake level that separates preference from aversion.

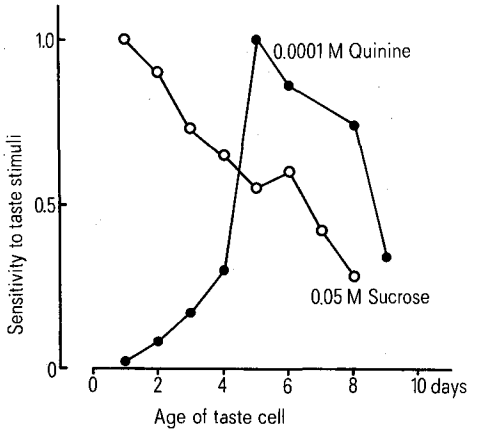

Fig. 4. Estimated relationship between age of taste cells and their sensitivity to taste stimuli. In ordinate, maximum sensitivity of taste cells to either stimulus is given as 1.0. The sensitivity to quinine was calculated from the quinine intake curve for 2.5 mg VLS in figure 1.

relation between the taste nerve response to sucrose below 0.1 M and the intake of sucrose in control rats. In contrast, there was an inversely proportional relation between the taste nerve response to quinine below 0.001 M and the intake of quinine. The taste nerve response can be replaced with the taste cell response because there is a proportional relation between them[9]. These lines of evidence[10] suggest that the alteration of taste cell sensitivity by aging is closely correlated with changes in taste preference and aversion.

Based on the average life span of 10 days in rat taste cells[2], we assume that the population ratios of taste cells are linearly reduced with aging: number of 1-day-old taste cells is taken as 1.0, 5-day-old cells 0.6 and 10-day-old cells 0.1. From the corrected sucrose intake curve in figure 2, A, the average sucrose response per taste cell in a t-day age may be expressed as $(I_t - I_{t+1})/P_t$, where I_t and I_{t+1} are amount of sucrose intakes on day t and day t + 1 after VLS, and P_t is the population ratio of t-day-old taste cells. On the other hand, from figure 1 the average quinine response per taste cell in a t-day age may be expressed as $P_t/(I_t - I_{t+1})$, because the quinine intake is in an inverse proportion to the taste cell response to quinine. Figure 4 was obtained from the above equations. It is seen that the sucrose sensitivity of taste cell reduces gradually with aging, while quinine sensitivity increases till 5 days of age, after which it falls gradually.

1 We thank Professor M. Ichioka for his encouragement during this work and Dr D. Tucker for his valuable comments on the manuscript.
2 L.M. Beidler and R.L. Smallman, J. Cell Biol. *27*, 263 (1965).
3 Y. Zotterman, Acta physiol. scand. *37*, 60 (1956).
4 O.H. Warwick, J.M.M. Darte and T.C. Brown, Cancer Res. *20*, 1032 (1960).
5 T. Sato and T. Murai, unpublished data.
6 D.R. Boggs, J.W. Athens, O.P. Haab, P.A. Cancilla, S.O. Raab, G.E. Cartwright and M.M. Wintrobe, Blood *23*, 53 (1964).
7 R.L. Noble, C.T. Beer and J.H. Cutts, Ann. N.Y. Acad. Sci. *76*, 882 (1958).
8 M. Nachman and L.P. Cole, in: Handbook of Sensory Physiology, Chemical Senses, Part 2 Taste, vol. IV, p. 337. Ed. L.M. Beidler. Springer Verlag, Berlin 1971.
9 N. Akaike, A. Noma and M. Sato, J. Physiol., Lond. *254*, 87 (1976).
10 Y. Kawamura, J. Okamoto and M. Funakoshi, Physiol. Behav. *3*, 537 (1968).

Diurnal variations in cholinesterase activities in the slug, *Laevicaulis alte*

T. Pavan Kumar and K. Sasira Babu[1]

Department of Zoology, S. V. University, Tirupati 517502 (India), 17 May 1977

Summary. Cyclical variations in acetylcholinesterase (AChE) and butyrylcholinesterase (BuChE) levels in foot muscle (FM) and AChE activity in central nervous system (CNS) of *Laevicaulis*, during 24-h-day, were maximal at 04.00 h and minimal at 12.00 h. But BuChE activity was 180 °C out of phase with AChE in CNS. The rhythmic trend of AChE in CNS might be due to true cholinesterase activity.

The occurrence, distribution and localization of acetylcholinesterase (AChE) in various molluscs have been demonstrated[2]. Associated with true cholinesterases, nonspecific (pseudo) cholinesterases have also been reported in molluscs[3].

Rhythmic variations in AChE, with peak periods of activity during dark h, have been found in nocturnal animals like scorpions, cockroaches and snails[4-6]. But studies on cyclical variations in pseudocholinesterases are lacking. The present investigation reports on AChE rhythm in the slug, *Laevicaulis alte*, and a spot check study on butyrylcholinesterase (BuChE) activity.

Methods. Adult specimens of *Laevicaulis* were collected in and around Tirupati. In the laboratory they were main-