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PRELIMINARY REPORT

Impaired Responses to Sweet Taste in Vitamin A–Deficient Rats

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In brief-exposure, two-choice preference tests (sucrose solution *v* water), vitamin A–deficient (VAD) rats exhibited a decreased preference for sucrose relative to control rats. There was no difference in total fluid intake from both choices between the two groups, nor was any significant difference found in circumvallate taste papilla keratin size. It is concluded that the impaired preference for sucrose in VAD rats is due to a specific impairment in taste sensation rather than general malaise.

EPITHELIAL CELLS are functionally impaired in vitamin A–deficient (VAD) mammals, probably due to decreased differentiation, and under extreme conditions, keratinization. Malfunction of the visual and auditory senses has been established in VAD rodents.[1] Impaired behavioral and electrophysiological responses to bitter and salty stimuli have been reported. The responses to salty, but not to bitter, stimulation could be restored by dietary treatment with vitamin A.[2,3] VAD also leads to abnormalities in the olfactory system.[4]

Keratin accumulation in the trenches of the circumvallate papillae occurs only when VAD becomes extreme over a long (3-month) period.

This study explored whether impaired taste function in VAD rats is related to sweet taste, and determined whether changes in preference behavior are related to a peripheral taste deficit or to postingestive signals.

MATERIALS AND METHODS

Animals and Diets

Eighty rats (strain lbm: RORO, specific pathogen-free) were obtained from the Biological Research Laboratories, Hoffman-La Roche (Basel, Switzerland). They were fed a special breeding diet (KLIBA 331; Klingentalmuhle, Kaiseraugst) with reduced vitamin A content (1,000 IU/kg) for the parent colony or 10^3 IU/kg vitamin A for the control group.

The offspring were transferred to our laboratory. The control group received VAD diet 103 (Hoffman-LaRoche). Mixed glycerides (0.2 mL) containing 500 IU vitamin A palmitate were administered twice weekly through a stomach tube. VAD rats were fed the same diet and treated with 0.2 mL mixed glycerides as a placebo. This vitamin A dose corresponds to a supplementation of 10^3 IU/kg and a daily feed consumption of 15 g. The animals were housed individually in 30 × 25 × 15-cm cages at 28°C with a 12-hour light/dark cycle, and food and water were supplied ad libitum. They were weighed twice weekly, and then daily toward the end of the experiment. The latter measurements were performed to detect the change from the steep to the asymptotic portion of the individual growth curve. Once this curve reached a plateau, two animals were killed and the vitamin A level was analyzed in the liver and plasma.

Procedure

After a 12-day acclimation period, the two groups were subjected to a brief-exposure, two-choice preference test (taste solution *v* water) performed three to four times per week at 6 PM and lasting for 10 minutes.[5] Results of brief-exposure preference tests are known to be dominated by sensory signals, with little confounding by postingestive signals.[6] The rats were first trained using saccharin solution,[5] and upon reaching the 90% preference levels (intake of sucrose solution/total intake × 100) for saccharin, they were exposed to two-choice preference tests between a single concentration (3, 6, 7.5, 10, 15, 75, and 250 mmol/L) of sucrose and water performed three times during the week on alternate days.[5] The same groups were subjected to sequential low to high sucrose concentrations. Intake and preference data were subjected to two-way ANOVA with repeated measures (group × day), and a paired *t* test with Bonferroni correction was used to test differences on single days. Logarithmically transformed preference data were analyzed by regression versus log (concentration), taking into account the repeated-measures structure of the data.

The final body weight was 231 ± 3.3 g (mean ± SEM) and 205 ± 5.3 g for the control and VAD groups, respectively.

Biopsies from the tongue of both VAD and control rats were sectioned and stained with hematoxylin and eosin following formalin fixation. In addition, image analyses of the tongue derived from five control and five VAD rats were also performed.

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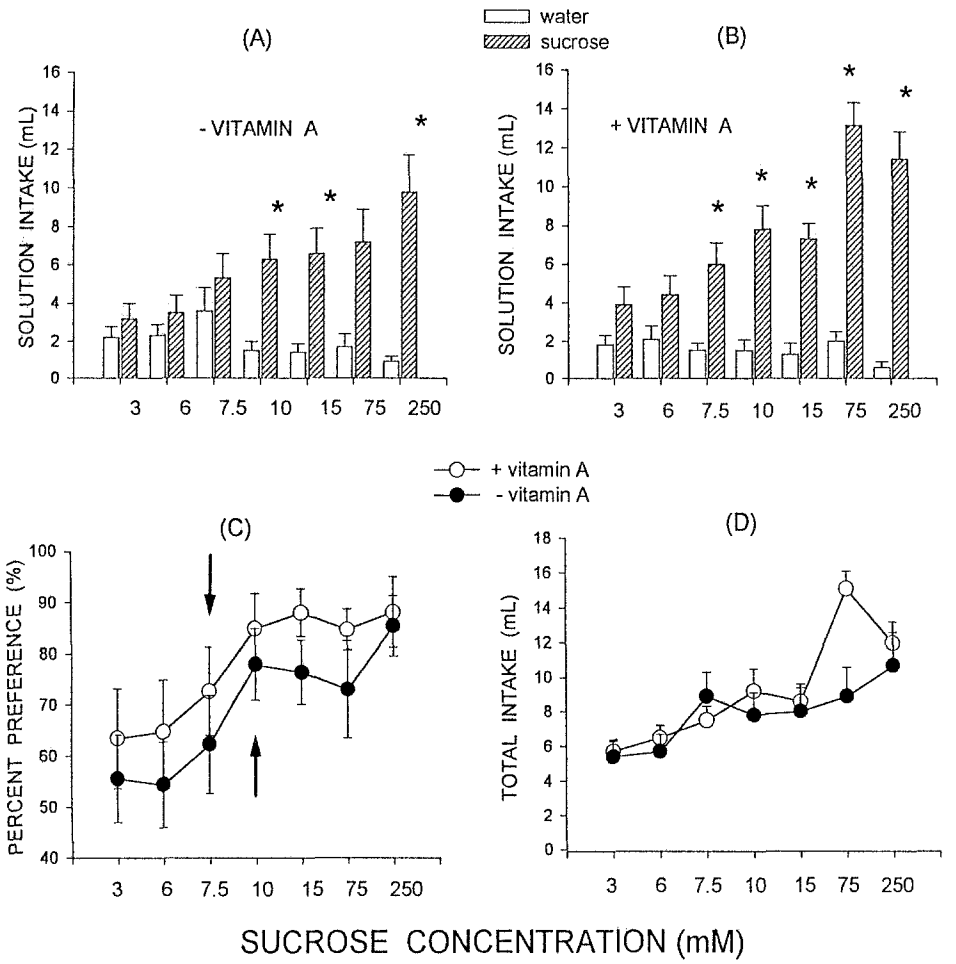

Fig 1. (A and B) Intake of sucrose solution (■) *v* water (□), (C) percent preference for sucrose solution, and (D) total liquid intake by VAD (●) and control (○) rats. Values are the mean ± SEM for 11 to 13 rats per group. *$P < .05$ (after Bonferroni correction), sucrose *v* water. ⇅, lowest concentration for which the percent preference was significantly different from 50% for control and VAD rats, respectively.

RESULTS AND DISCUSSION

Vitamin A deficiency was defined as 0 to 1 μg/kg vitamin A in the liver. This level was monitored in VAD rats throughout the experiment. In line with responses to bitter and salty tastes, the preference threshold for sucrose was significantly higher in VAD rats ($P < .03$) than in control animals (Fig 1C). As expected, the intake of sucrose solution under conditions of choice increased with increasing sucrose concentrations in both groups (Fig 1A and B). However, the magnitude of the sucrose intake was higher in control versus VAD rats (Fig 1C: the preference curve for sucrose solutions was consistently higher by ~15%, $P < .04$ for control *v* VAD animals). Analysis of the percent preference indicated that 7.5 mmol/L sucrose was the preference threshold for control rats, whereas in VAD rats it was 10 mmol/L (Fig 1). Most intriguing is the fact that the total liquid intake from both solutions did not differ between control and VAD rats up to 15 mmol/L sucrose (Fig 1D). Thus, the reduced preference for sucrose in VAD versus control rats (Fig 1C) is likely to be related to a peripheral gustatory deficit rather than to a general debility or postingestive signals associated with vitamin A deficiency.

Although in VAD rats keratinization of taste buds might occur following long-term vitamin A deficiency,[7] no significant differences in taste bud keratinization between control and VAD rats were found by biopsy and image analysis.

In conclusion, in line with previous studies indicating impaired taste responses to bitter and salty stimuli in VAD rats, the present results suggest that vitamin A deficiency induces a peripheral gustatory impairment in rats leading to impaired sweet taste preferences.

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