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Brief communication

# Maltodextrin and sucrose preferences in sweet-sensitive (C57BL/6J) and subsensitive (129P3/J) mice revisited

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Mice are attracted to the tastes of sugar and maltodextrin solutions. Sugar taste is mediated by the T1R2/T1R3 sweet taste receptor, while maltodextrin taste is dependent upon a different as yet unidentified receptor. In a prior study sweet-sensitive C57BL/6J (B6) mice displayed similar preferences for sucrose and maltodextrin solutions in 24-h saccharide vs. water choice tests that exceeded those of sweet-subsensitive 129P3/J (129) mice. In a subsequent experiment reported here, sucrose and maltodextrin (Polycose) preference and acceptance were compared in the two strains in saccharide vs. saccharide choice tests with isocaloric concentrations (0.5–32%). The 129 mice displayed significantly greater maltodextrin preferences than B6 mice at mid-range concentrations (2–8%), while the mice displayed an opposite preference profile at the highest concentration (32%). As in prior studies, 129 mice consumed less total saccharide than B6 mice at lower concentrations. These findings show that the conclusions reached from tastant vs. water tests may differ from those pitting one tastant against another. The increased sucrose preference and intake of B6 mice, relative to 129 mice, is consistent with their sweet-sensitive phenotype.



## 1. Introduction

The taste of sugar is highly attractive to humans and many other animal species. Studies of inbred mouse strains led to the identification of the T1R2 and T1R3 receptor proteins that dimerize to form a sweet taste receptor responsive to natural sugars and artificial sweeteners [14]. Selective elimination of the T1R2 and/or T1R3 receptors in knockout (KO) mice attenuates or completely blocks the behavioral response to sweeteners [4,44]. Sweetener preferences are also blocked by deletion of taste signaling elements downstream from the T1R2/T1R3 receptor, including α-gustducin, Trpm5, Calhm1, and P2X2/P2X3 [5,33,36,39].

In addition to sugars, rodents are strongly attracted to maltodextrins derived from partial hydrolysis of starch, exemplified by the commercial maltodextrin Polycose [24,29]. Rats prefer Polycose to the disaccharides sucrose and maltose and to the monosaccharides glucose and fructose at low concentrations [16,25–28]. This and other findings indicate that the palatability of Polycose is not explained by the small amount of free sugars (~9% glucose and maltose) contained in the maltodextrin. Rather, rodents appear to be highly attracted to maltooligosaccharides having ~4–8 glucose units [6,9,20,27]. Maltodextrin and sucrose have distinctive tastes to rodents as indicated by behavioral and electrophysiological studies, and recent data from KO mice confirm this distinction. Aversions conditioned to Polycose or sucrose, for example, do not cross generalize [17,23], and various taste inhibitors selectively reduce the electrophysiological response to sucrose and maltodextrin [23,38]. The gustatory receptor that mediates maltodextrin taste does not require the T1R2 or T1R3 receptor proteins, as demonstrated by tests of KO mice missing T1R2, T1R3, or both [40–42,45]. Yet, deletion of other taste signaling elements (gustducin, Trpm5, Calhm1, P2X2/P2X3) attenuates maltodextrin preferences just as it attenuates sugar preferences in mice [5,33,36,39]. These findings confirm that maltodextrin preference is mediated by the taste system but the identity of the taste receptor remains unknown.

Comparisons of inbred strains have revealed substantial differences in responsiveness to a variety of sweet tastants [3,8,10,13]. The mouse strains have been characterized as sweet “sensitive” and “subsensitive” based on their differential preferences for sweeteners at low concentrations. Consistent with behavioral findings, sucrose and saccharin stimulate greater neural activity in gustatory nerves of sweet sensitive than of subsensitive strains [7,11,15]. Genetic differences in the TasR1 gene coding for the T1R3 sweet receptor are implicated in the differential sweet taste sensitivity of inbred mouse strains [21]. Mouse strain differences in maltodextrin taste have been less extensively studied. Recently, Poole et al. [19] compared the avidity for maltodextrin and sucrose in eight inbred mouse strains. They reported that in brief-access tests CAST/EiJ and PWK/PhJ, unlike the other strains, licked less for maltodextrin than for sucrose. In 24-h 2-bottle saccharide vs. water tests the CAST and PWK mice drank less 4% maltodextrin than sucrose, whereas the

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other strains drank similar amounts of the two saccharides. Poole et al. [19] proposed that strain variations in maltodextrin preference can be exploited to reveal the gene(s) coding the maltodextrin taste receptor.

Among the strains tested by Poole et al. [19] that displayed similar preferences for 4% maltodextrin and sucrose were C57BL/6J (B6) and 129S1/SvlmJ (129) mice. However, this contrasts with early reports by Bachmanov et al. [2,3] that B6 mice have stronger preferences for dilute sucrose and maltodextrin solutions than do 129 mice (129/P3J). Sclafani [30] confirmed this finding in a subsequent study that revealed that B6 mice displayed nearly identical preferences for isocaloric sucrose and maltodextrin solutions that exceeded those of 129 mice at 0.5 to 4% concentrations (Fig. 1). Based on these results, Sclafani [30] speculated that the T1R3 receptor, which is more sensitive to sweet tastants in B6 than 129 mice, may be a component of the hypothesized maltodextrin taste receptor. This idea was refuted by the discovery cited above that deletion of the T1R3 receptor greatly attenuates sweet but not maltodextrin preference in mice [40–42,45]. As reported in the present paper, the apparent similar within-strain preferences for sucrose and maltodextrin suggested by saccharide vs. water choice tests were not confirmed in two-bottle tests that gave the mice the choice between sucrose and maltodextrin. Although less common than tastant vs. water tests, direct choice tests between two tastants or nutrients provide a particularly sensitive measure of taste preferences.

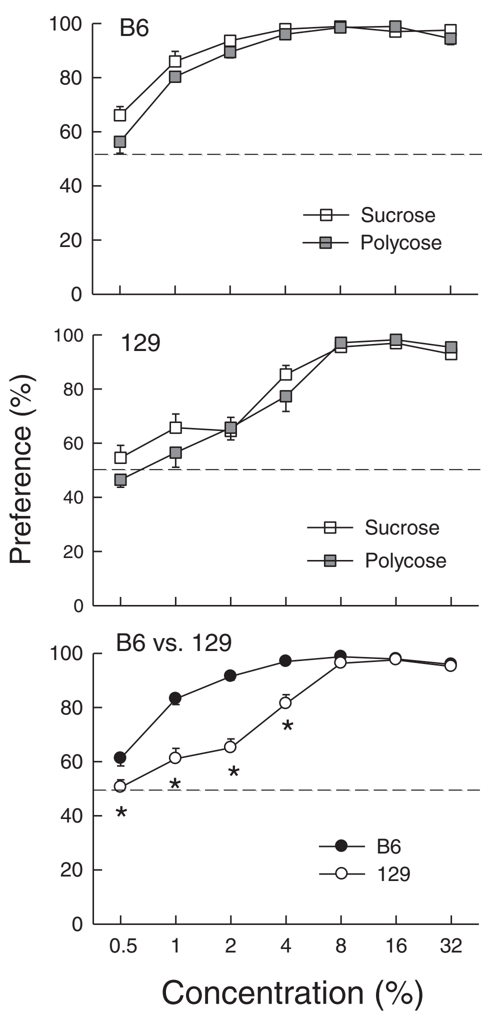


**Fig. 1.** Mean (±SEM) saccharide preferences of C57BL/6J (B6) (top panel) and 129P3/J (129) (middle panel) mice in two-bottle tests with Polycose vs. water and sucrose vs. water in Sclafani [30]. Separate groups of B6 and 129 mice ($n = 10$ each) without prior saccharide experience were given 2-day access to the 0.5–32% Polycose or sucrose solutions presented in an ascending order. Bottom panel: Mean (±SEM) saccharide preferences of the B6 vs. 129 mice. The percent saccharide preference data are the means of the B6 Polycose and sucrose groups and 129 Polycose and sucrose groups. Significant ($p < 0.05$) between-strain differences are indicated by an asterisk (*).

## 2. Methods

### 2.1. Subjects

Male C57BL/6J ($n = 10$) and 129P3/J (n = 10) mice were obtained from the Jackson Laboratory (Bar Harbor, ME) at 7 weeks of age. The animals were housed in individual plastic tub cages in a room maintained at 22 °C with a 12:12 h light-dark cycle. Purina Chow (5001, PMI Nutrition International, Brentwood, MO) and, prior to carbohydrate testing, deionized water were available ad libitum. Experimental protocols were approved by the Institutional Animal Care and Use Committee at Brooklyn College and were performed in accordance with the National Institutes of Health Guidelines for the Care and Use of Laboratory Animals.

### 2.2. Taste solutions and intake measures

Polycose (Ross Laboratories, Columbus, OH) and sucrose (Domino Foods, Inc., Yonkers, NY), solutions were prepared using deionized water. Polycose is a starch-derived maltodextrin containing 2% glucose, 7% maltose, and 91% glucose polymers, and has an average molecular weight of about 1000 [22]. Polycose and sucrose were presented at 0.5, 1, 2, 4, 8, 16 and 32% solutions by weight.

### 2.3. Procedure

The mice were adapted to the laboratory for 2 weeks. Water was available through two sipper spouts attached to 50-ml plastic tubes that were placed on top of the cage. The sipper spouts were inserted 7 mm into the cage through holes positioned 3.7 cm apart in a stainless-steel plate and the drinking tubes were fixed in place with clips. Fluid intakes were measured to the nearest 0.1 g by weighing the drinking tubes on an electronic balance interfaced to a laptop computer. Intakes were corrected for spillage estimated by recording the change in weight of two bottles placed on an empty cage. Following adaption, preference tests with Polycose vs. sucrose at 0.5–32% concentrations were conducted. The solutions were available 23 h/day and the bottles were weighed and refilled during the remaining 1 h. The solutions were presented in order of increasing concentration. Each concentration was presented for 2 days with the left-right position of the Polycose and sucrose alternated daily. The mice were not given water during the tests.

### 2.4. Statistical analysis

Daily fluid intakes were averaged for each strain and the absolute intakes were evaluated using repeated measures analysis of variance (Strain × Concentration × Solution). Saccharide preferences were expressed as percent intakes (saccharide intake / total intake × 100). Significant interaction effects were evaluated using simple main effects tests according to Winer [43]. The significance of the solution preference at each concentration was evaluated for each strain using paired *t*-tests corrected for multiple comparisons using the Bonferroni procedure.

## 3. Results

Prior to testing, the mean body weights of the B6 and 129 mice were similar at 23.6 and 23.5 g, although the B6 consumed more water than did the 129 mice [6.0 vs. 5.0 g/day, $t(18) = 3.05, p < 0.01$]. Overall, the mice consumed more sucrose than Polycose [Solution $F(1,18) = 22.36, p < 0.001$], but the relative intakes of the two solutions varied in the B6 and 129 mice as a function of concentration [Strain × Solution × Concentration, $F(6,108) = 13.23, p < 0.0001$] (Fig. 2).