SAMPLE LAB REPORT

Perception of Different Sugars by Blowflies

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ABSTRACT

To feed on materials that are healthy for them, flies (order Diptera) use taste receptors on their tarsi to find sugars to ingest. We examined the ability of blowflies to taste monosaccharide and disaccharide sugars as well as saccharin. To do this, we attached flies to the ends of sticks and lowered their feet into solutions with different concentrations of these sugars. We counted a positive response when they lowered their proboscis to feed. The flies responded to sucrose at a lower concentration than they did of glucose, and they didn't respond to saccharin at all. Our results show that they taste larger sugar molecules more readily than they do smaller ones. They didn't feed on saccharin because the saccharin we use is actually the sodium salt of saccharin, and they reject salt solutions. Overall, our results show that flies are able to taste and choose foods that are good for them.

INTRODUCTION

All animals rely on senses of taste and smell to find acceptable food for survival. Chemoreceptors are found in the taste buds on the tongue in humans (Campbell, 2008), for example, for tasting food. Studies of sensory physiology have often used insects as experimental subjects because insects can be manipulated with ease and because their sensory-response system is relatively simple (E. Williams, personal communication). Flies are able to taste food by walking on it (Dethier, 1963). Hollow hairs around the proboscis and tarsi contain receptor neurons that can distinguish among water, salts, and sugars, and flies can distinguish among different sugars (Dethier, 1976). These traits enable them to find necessary nutrition.

In this experiment we tested the ability of the blowfly *Sarcophaga bullata* to taste different sugars and a sugar substitute, saccharin. Because sucrose is so sweet to people, I expected the flies to taste lower concentrations of sucrose than they would of maltose and glucose, sugars that are less sweet to people. Because saccharin is also sweet tasting to people, I expected the flies to respond positively and feed on it as well.

METHODS

We stuck flies to popsickle sticks by pushing their wings into a sticky wax we rubbed on the sticks. Then we made a dilution series of glucose, maltose, and sucrose in one-half log molar steps (0.003M, 0.01M, 0.03M, 0.1M, 0.3M, and 1M) from the 1M concentrations of the sugars we were given. We tested the flies' sensory perception by giving each fly the chance to feed from each sugar, starting with the lowest concentration and working up. We rinsed the flies between tests by swishing their feet in distilled water. We counted a positive response whenever a fly lowered its proboscis. To ensure that positive responses were to sugars and not to water, we let them drink distilled water before each test. See the lab handout Taste Reception in Flies (Biology Department, 2000) for details.

RESULTS

Flies responded to high concentrations (1M) of sugar by lowering their probosces and feeding. The threshold concentration required to elicit a positive response from at least 50% of the flies was lowest for sucrose, while the threshold concentration was highest for glucose (Fig. 1). Hardly any flies responded to saccharin. Based on the results from all the lab groups together, there was a major difference in the response of flies to the sugars and to saccharin (Table 1). When all the sugars were considered together, this difference was significant ($t = 10.46$, $df = 8$, $p < .05$). Also, the response of two flies to saccharin was not statistically different from zero ($t = 1.12$, $df = 8$, n.s.).

DISCUSSION

The results supported my first hypothesis that sucrose would be the most easily detectable sugar by the flies. Flies show a selectivity of response to sugars based on molecular size and structure. Glucose, the smallest of the three sugars, is a monosaccharide. The threshold value of glucose was the highest in this experiment because a higher concentration of this small sugar was needed to elicit a positive response. Maltose and sucrose are both disaccharides but not with the same molecular weight or composition. It has been shown that flies respond better to alpha-glucosidase derivatives than to beta-glucosidase derivatives (Dethier 1975). Because sucrose is an alpha-glucosidase derivative, it makes sense that the threshold value for sucrose occurs at a lower concentration than that for maltose. This might also be the reason why sucrose tastes so sweet to people.

My other hypothesis was not supported, however, because the flies did not respond positively to saccharin. The sweetener people use is actually the sodium salt of saccharic acid (Budavari, 1989). Even though it tastes 300 to 500 times as sweet as sucrose to people (Budavari, 1989), flies taste the sodium and so reject saccharin as a salt. Two flies did respond positively to saccharin, but the response of only two flies is not significant, and the lab group that got the positive responses to saccharin may not have rinsed the flies off properly before the test.

Flies taste food with specific cells on their tarsal hairs. Each hair has, in addition to a mechanoreceptor, five distinct cells – alcohol, oil, water, salt, and sugar – that determine its acceptance or rejection of the food (Dethier, 1975). The membranes located on the tarsi are the actual functional receptors since it is their depolarization that propagates the stimulus to the fly (Dethier, 1975). Of the five cells, stimulation of the water and sugar cells induce feeding, while stimulation of the salt, alcohol, and oil receptors inhibit feeding. More specifically, a fly will reject food if the substrate fails to stimulate the sugar or water receptors, stimulates a salt receptor, or causes a different message from normal (e.g., salt and sugar receptors stimulated concurrently) (Dethier 1963).

Flies accept sugars and reject salts as well as unpalatable compounds like alkaloids (Dethier & Bowdan, 1989). This selectivity is a valuable asset to a fly because it helps the fly recognize potentially toxic substances as well as valuable nutrients (H. Cramer, personal communication). Substances such as alcohols and salts could dehydrate the fly and have other harmful effects on its homeostasis (Dethier, 1976). Thus, flies are well adapted to finding food for their own survival.

ACKNOWLEDGMENTS

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LITERATURE CITED

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Table 1. The average number of flies in each lab group that fed from 0.3M concentrations of each chemical tested. The mean $\pm$ standard deviation is shown.

chemical tested	number of 10 flies responding
glucose	3.2 ± 1.5
maltose	7.8 ± 2.3
sucrose	8.6 ± 2.1
saccharin	0.2 ± 0.5

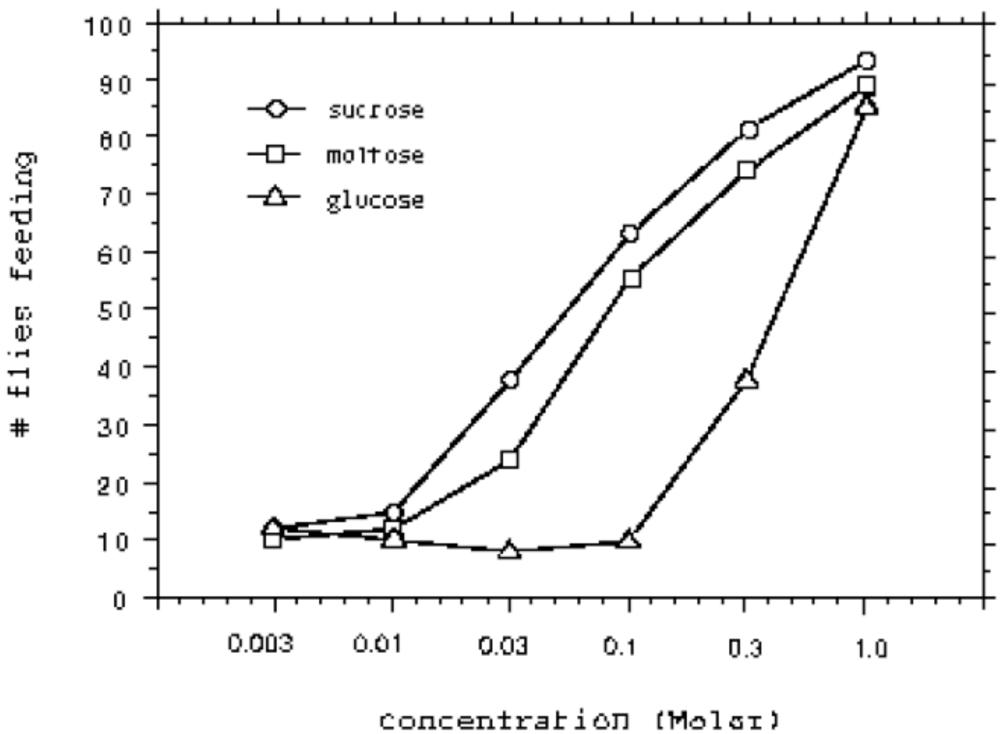

Fig. 1. Taste response curves of flies to different concentrations of the sugars glucose, maltose, and sucrose.

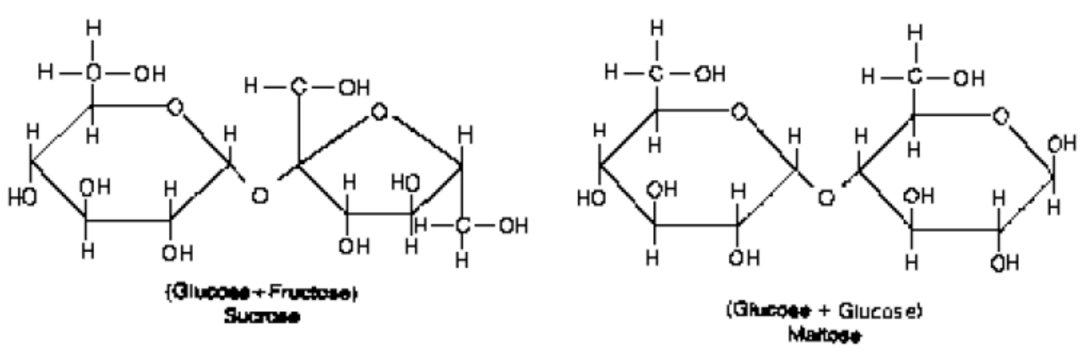

Fig. 2. Chemical formulas of sucrose and maltose (Biology Department, 2000). Glucose is a monosaccharide and is shown as part of each of these molecules.