(Sample Lab Report)

Perception of Different Sugars by Blowflies

Alexander Hamilton
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Lab Partners:
Sharon Flynn,
Andi Alexander

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 (Arms & Camp, 1995), 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, pers. comm.). Flies 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).

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. Because saccharin is also sweet tasting to people, I expected the flies to respond positively to it as well.

METHODS

We stuck flies to popsicle 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 and rinsing the flies between tests. See Biology Department (1995) for details.

RESULTS

A fly responded to high concentrations (1M) of sugar by lowering its proboscis 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 are considered together, this difference was significant ($t=10.46$, $df=8$, $p<.05$).

DISCUSSION

The results supported my first hypothesis that sucrose would be the most 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 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, 1976). 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. I think 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 to people (Budavari, 1989), flies taste the sodium and so reject saccharin as a salt. Two flies did respond positively to saccharin, but this could have happened because that lab group did not give the flies enough time to respond or did not rinse them off properly before the test with saccharin.

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, 1976). The membranes located on the tarsi are the actual functional receptors since it is their depolarization which propagates the stimulus to the fly (Dethier, 1976). Of the five cells, the stimulation of the water and sugar cells will induce feeding, while stimulation of the salt, alcohol, and oil receptors will 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 stimulates salt and sugar receptors 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. Substances such as alcohols and salts could dehydrate the fly and have other deleterious effects upon its homeostasis (Dethier, 1976). Thus, flies are well adapted to finding food for their own survival.

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LITERATURE CITED

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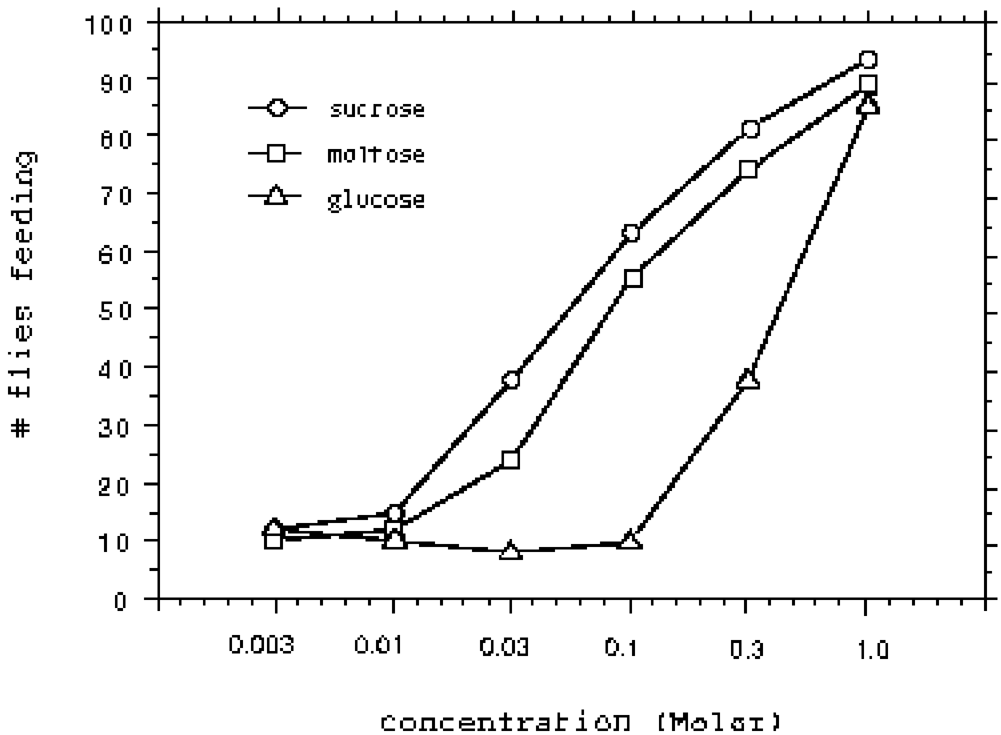

Fig. 1. Taste response curves of flies to different concentrations of the sugars glucose, maltose, and sucrose.

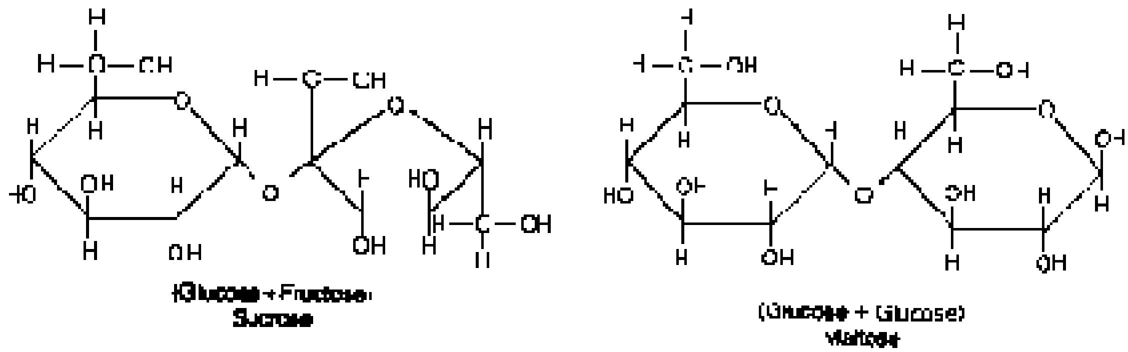

Fig. 2. Chemical formulas of sucrose and maltose (Biology Department, 1995). Glucose is a monosaccharide and is shown as part of each of these molecules.

Table 1. The average number of flies in each lab group that fed from 0.3M concentrations of each chemical tested. The mean + 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