Sugar Feeding Preference of Male Face Flies

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Feeding behavior of male face flies has been studied to gain information which may be useful in a multipronged approach to face fly control in North Dakota. Attractants and feeding stimulants may become part of integrated survey and control technologies in the future.

Sugar feeding studies in the laboratory showed 3 day old male *Musca autumnalis* DeGeer imbibed more 0.1M fructose when compared with water than 9 other sugars tested. In paired sugar studies, 0.1M sucrose was preferred over fructose, glucose, and maltose. Males fed more on a combined solution of sugars (glucose, xylose, galactose) found in sunflower seed heads than on glucose alone. Peak feeding by 2-10 day old males on 0.1M sucrose occurred at age 5-8 days.

The face fly, *Musca autumnalis*, is a serious pest of range cattle in many areas of North Dakota. These flies do not have mouthparts capable of piercing the skin of cattle, so they are not blood feeders; however, they cause annoyance while feeding on moist mucus secretions around the eyes and face. When flies are present in large numbers animals group together in an attempt to keep the flies off. Face fly populations have also been associated with pinkeye incidence and have been shown to transmit pinkeye at population levels as low as 1-2 flies per animal. Presently chemical control methods used are inadequate. Nationally, annual losses in control costs and production losses are estimated to be in excess of $150 million (Anonymous, 1976).

Female face flies, *Musca autumnalis* DeGeer feed on secretions around the eyes and nostrils of cattle, causing a disruption of grazing patterns and resultant reductions in weight gain and milk production. Turner and Hair (1967) found sugar was essential for face fly survival and a protein source was necessary for reproduction. Wang (1964) found flies could live for 3 weeks to 3 months on a diet of sugar, milk, and bovine blood.

Male face flies feed on flowers and are usually found near pasture margins and fence rows. In order to develop methods of face fly control which would affect males as well as females we have studies feeding behavior of the males in the field and in the laboratory.

Hansen and Valiela (1967) observed face fly males only on flowers. White (1960) reported that wild parsnip was attractive to males and Matthysse (1961) reported feeding on pollen of Umbelliferae. Miller and Treece (1968), in the laboratory, found that males showed little variation in daily feeding and fed primarily on malt.

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A cattle exclosure, located in the East I grazing allotment of the Sheyenne National Grasslands, Richland Co., N. Dak. (Peterson and Meyer, 1978) served as a study area for observation of male face fly activity as it related to flowering plants. Observations indicated that plants inside the exclosure included both native and introduced species. Early spring flowers had predominantly white blooms (choke cherry, *Prunus virginiana* L.; wild plum *P. americana* Marsh; raspberry, *Rubus idaeus* L.; and apple, *Malus* sp.). As the summer progressed, yellow blooms became dominant (wild sunflowers, *Helianthus* spp.; goldenrod, *Solidago* spp.; gumweed, *Grindelia squarrosa* (Pursh.); leafy spurge, *Euphorbia escula* L.; and sweet clover, *Melilotus alba* Desr.). Plants observed to be used as food or resting sites for male face flies included: wild sunflower, *Helianthus maximiliani* Schrad.; goldenrod, *Solidago canadensis* L.; leafy spurge, *E. escula*; gumweed, *G. squarrosa*; choke cherry, *P. virginiana*; American elm, *Ulmus americana* L.; and smooth sumac, *Rhus glabra* L. The meadow parsnips, *Zizia aptera* (A. gray) and *Zizia aurea* (L.) Koch. (Umbelliferae), were located in the study area but face flies were not collected on these species.

The present study evaluated male face fly feeding preferences using a two choice bioassay technique. Comparisons were made on the amount of 0.1M solutions of simple sugars consumed when paired with distilled water, when paired with another sugar, and the effect of fly age on sucrose consumption.

METHODS AND MATERIALS

Feeding by male flies was evaluated using a modification of the bioassay technique of Dethier and Rhoades (1954). Feeding tubes were made by uniformly bending 23 cm Pasteur-type transfer pipets into a U-shape. The tubes were then filled with 1 ml of distilled water and scored at the miniscus. One-quart canning jars, with a 1 cm layer of plaster of paris thinly coated with paraffin in the bottom, served as test chambers. Two feeding tubes were positioned upright in each chamber by partially imbedding them in a

flattened sphere of plasticene centered in the bottom of the chamber. Each feeding tube was covered with gauze secured by a rubber band. The chambers were covered with nylon screen secured by screw-type jar rings. Ten chambers were constructed; five were used as feeding chambers and five as controls.

Prior to use in feeding studies, the tubes in the feeding chambers were calibrated so that an estimate of volume loss due to evaporation during feeding tests could be made. This calibration consisted of calculating an expected proportional evaporation (EPE_{ij}) for each tube in relation to the observed mean evaporation from all 10 tubes in the control chambers. The evaporation calibration was based on three replications using distilled water and run for 22 hours under test conditions. Volume loss was measured as the amount of water required to refill a tube to the 1 ml score mark after the termination of the test. The EPE was then calculated as follows:

$$EPE_{ij} = \frac{EC_{ij}}{EC_{6\text{-}10}}$$

EC = Mean Evaporation during calibration
i = Jar 1-5
j = Tubes A or B in a jar

The actual amount of feeding by the male flies during feeding studies was obtained by measuring the volume required to refill each tube after the test and applying an evaporation correction based on the EPE for each tube and volume loss for tubes in the control chambers where no flies were present.

$$AC_{ij} = Y_{ij} - (ET_{6\text{-}10})(EPE_{ij})$$

$ET_{6\text{-}10}$ = Mean Evaporation in control jars during test

Y_{ij} = Volume loss during test

Temperature during the experiments was 22°C and a 10 hour light 12 hour dark photo-period was maintained during the 22 hour test. Flies were maintained on a diet of sucrose, dried milk, and beef blood prior to testing. Jars, feeding tubes, and gauze were washed between tests. Paired comparison analyses were used to determine whether solutions being compared were consumed in significantly different amounts.

Three series of feeding experiments were conducted. the first series tested whether 0.1M simple sugars (sucrose, glucose, fructose, xylose, rhamnose, galactose, mannose, maltose, ribose, or lactose) were consumed in preference to distilled water. The second series compared selected pairs of 0.1M sugar solutions (fructose/sucrose, sucrose/glucose, sucrose/maltose, fructose/glucose, fructose/maltose, maltose/glucose, and sunflower head sugars/glucose). The latter solution was 0.1M with respect to D-xylose and contained D-glucose and D-galactose in proportions simulating the proportions of these sugars found in sunflower (*Helianthus annus* L.) seed heads: 59.3%, 23.5% and 16.2% respectively (Bishop, 1955). The third series evaluated the effect of fly age (2-10 days old) on amounts of 0.1M sucrose ingested.

In the first and third series of tests one tube in each chamber was filled with a sugar solution and the other with distilled water. In the second series, one tube was filled with each of the solutions being compared. Twenty 3 day old male face flies were placed in each test chamber during series one and two. In the third series, 20 males of the appropriate age were used in each chamber.

RESULTS

The amounts of feeding by 3 day old *M. autumnalis* males on 0.1M sugar solutions is shown in Fig. 1. Significantly greater amounts of fructose, glucose, sucrose and maltose were consumed when compared with water, with fructose yielding the largest difference. Water consumption ranged from 0.6-2.3 µliter per fly.

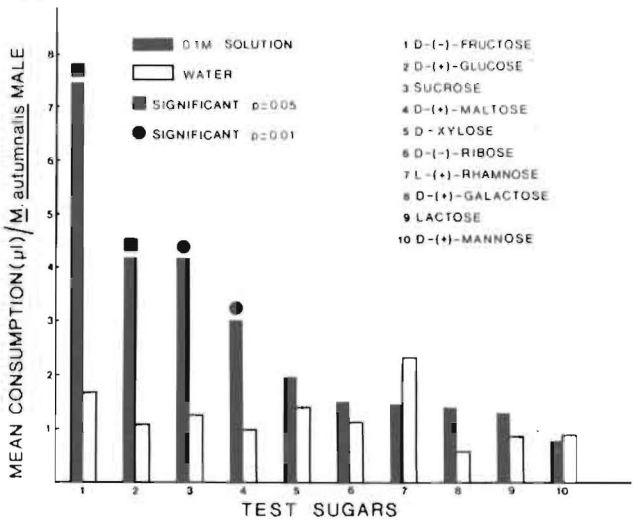

Figure 1. Consumption of 0.1M sugar solutions by 3 day old *M. autumnalis* males.

When flies were given a choice of two sugars, significantly greater amounts of sucrose were consumed when compared with glucose, fructose and maltose (Fig. 2). No significant differences were observed when fructose was paired with glucose and maltose although in both cases more fructose was consumed. The largest significant difference between sugars was between maltose and glucose. Dethier and Rhoades (1954) using 2 day old *Phormia regina* Meigen found sucrose preferred when sucrose and glucose were paired in equal concentrations. When a combination of the predominant sugars in the cultivated sunflower seed head were paired with glucose, significantly more of the combination was consumed.

Consumption of 0.1M sucrose solution increased with age of flies and peak consumption (9.65 µliter) occurred at 7 days of age (Fig. 3). Consumption then decreased steadily and at 10 days, males feed on 3.4 µliter of solution. At all ages the sucrose solution was ingested in significantly larger volume than was the water. Water consumption ranged from 0.05-1.25 µliter, with indications of slightly decreasing consumption from age 3-10 days. Greenberg (1959), using the feeding technique of Dethier and Rhoades (1954) fed 6-20 day old *M. domestica* males and females solutions of sucrose and casein hydrolysate and found age had no effect on consumption.

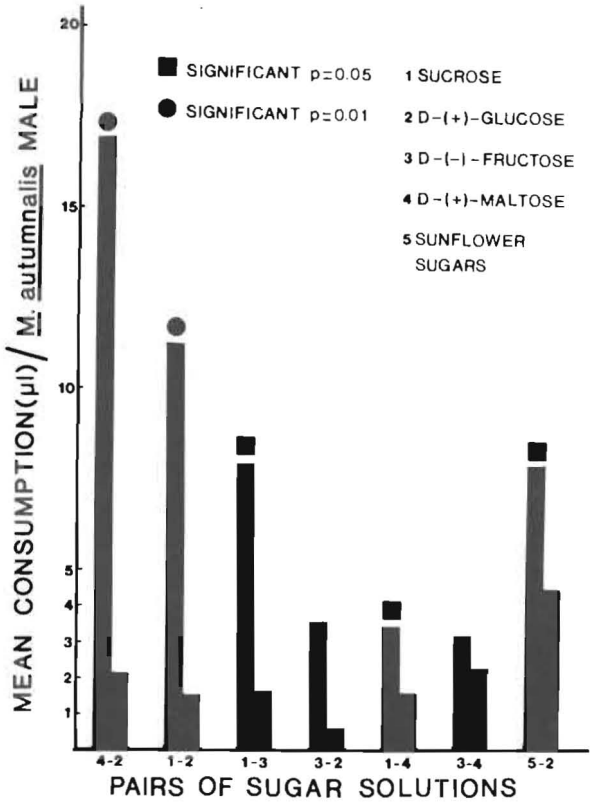

Figure 2. Consumption of paired 0.1M sugar solutions by 3 day old *M. autumnalis* males.

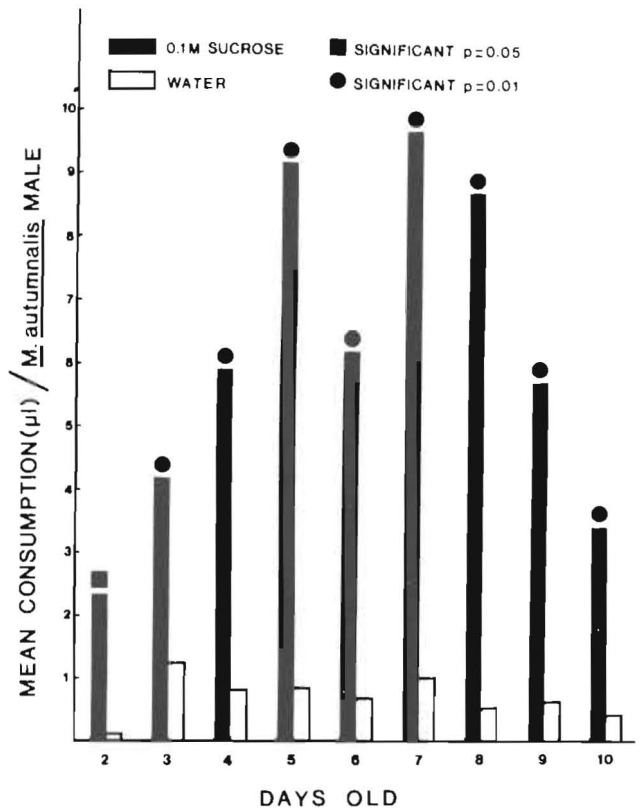

Figure 3. Consumption of 0.1M sucrose by different aged *M. autumnalis* males.

DISCUSSION

In general, *M. autumnalis* males consumed more 0.1M sugar solution when pairs of sugars were fed than when single sugar solutions and water were paired. Greater amounts of maltose and sucrose were consumed when paired with glucose than when either maltose or sucrose were fed paired with water. Perhaps male face fly longevity could be extended in the laboratory if fed a combination of maltose, sucrose, and glucose.

Observations of our colony (fed a diet of sucrose, dried milk and blood) indicate male face flies begin mating at age 5-8 days, the time when the most feeding on 0.1M sucrose solution occurred in our laboratory studies.

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