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Report

The Effects of Light, Sucrose, and Water on Twenty-four Hour Survival of *Musca domestica* L. (Diptera: Muscidae).

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Abstract: The effects of sucrose, water, and light were examined on the survival of the common house fly, *Musca domestica* L. (Diptera: Muscidae), in a 24-hour test. Conducting tests in continuous darkness significantly improved survival, as did the inclusion of both sucrose and water to the testing chamber. Sucrose and water added separately also improved survival, but to a lesser degree than when both were present at once.

Keywords: survival, bioassay design, nutrition, light

Introduction

Reliable bioassay methods are crucial to toxicity evaluation of candidate compounds to test organisms. One such bioassay is the fumigation test. In such a test, the organisms are placed in a sealed container with a known amount of test substance (for example, Peterson et al 1998). This substance may be a suspected (or known) toxicant, carcinogen, mutagen, etc. After a period of time, set by the researcher, the organisms are counted, assayed or subjected to any number of tests.

Background mortality in such tests due to factors other than the factor of interest can severely interfere with, if not invalidate, any results or subsequent analysis of the data. Reducing background mortality should be a top priority of scientists conducting toxicity assays.

This paper investigates the effects of three factors (sucrose, water, and light) on the survival of common house fly (*Musca domestica* L. (Diptera: Muscidae)) adults in fumigation bioassays.

Materials and Methods

Clear glass jars (500 ml) were used as the test chambers. Depending on treatment, each jar received sucrose (factor F), water (factor W) or both. The sucrose was a commercially available brand of granulated table sugar. One gram of sucrose was placed in a small polyethylene dish at the bottom of the jar. The water was distilled water placed in a 16-ml glass vial fitted with a 6-cm cotton roll. The water was allowed to wick up the cotton and hence be available to the flies. The water vial was suspended inside the jar by using a wire. The light condition (factor L) was achieved by disabling the rearing room's light controls, causing the lights to remain on constantly. The dark condition was accomplished by covering the specified jars with aluminum foil.

Adult *M. domestica*, Orlando regular strain, from a colony maintained in our laboratory for several years, were anesthetized by using carbon dioxide. Ten flies were placed in each jar and each jar was fitted with a metal ring and wire mesh to prevent escape of the flies. No determination was made of the male: female ratio, because previous researchers found no effect due to sex on house fly longevity (Lysyk 1991).

There were eight treatments in a 2^3 factorial arrangement with three replicates in a completely randomized design. Each jar in each treatment was given a binary designation for each of the three factors: 0 meaning "no" and 1 meaning "yes". For example, the treatment receiving sucrose, no water but exposed to light was designated as 1, 0, 1. The treatment receiving no sucrose, but with water provided and kept in the dark was designated 0, 1, 0. Separate controls were conducted for the light and dark treatments, and in both cases the control jars had no sucrose or water.

After twenty-four hours, the jars were examined and the number of dead and living flies was counted. The result, percentage survival, was determined by the following formula (1):

$$\%\text{Survival} = \left(\frac{F_{\text{living}}}{F_{\text{total}}}\right) * 100 \qquad (1)$$

Here, F_{living} = the number of flies surviving 24 hours and F_{total} = the total number of flies used at the start of the test. The data were analyzed by using analysis of variance.

Results and Discussion

Table 1 reports the results of the study. In both cases where both sucrose and water were provided, survival was 100%. Survival was lowest in cases where neither sucrose nor water were provided, though survival was higher in the dark (59%) than in the light (18%). It is possible that the flies were more quiescent in the dark, and therefore were less susceptible to dehydration or starvation.

Table 1. Summary of treatment means. For factors F, W and L, 1 = condition present, 0 = condition not present.

F	W	L	Survival	SEM
1	0	1	73	3.9
0	1	1	65	3.3
1	1	1	100	0.0
0	0	1	18	9.2
1	0	0	97	1.5
0	1	0	70	2.8
1	1	0	100	0.0
0	0	0	59	5.0

These data agree with the work of Glaser (1923). Glaser found that when flies are left without sucrose or water in a photoperiod of 16: 8 hours light: dark, a survival of only 16.7% was observed in a twenty-four hour period. We found 18.3% survival (in twenty-four hour light period). Glaser also found that when sucrose and water were used in combination under the same photoperiod, it took fifteen days for the first fly to die. In twenty-four hours in our study, we observed 100% survival among the corresponding group.

Analysis of variance was conducted to look for any interactions among the factors (Table 2).

Table 2. Analysis of variance table.

Source	df		SS	F value	p>F
Model	7		1.5905	13.82	0.0001
W		1	0.2860	17.40	0.0007
F		1	0.9282	56.47	0.0001
W*F		1	0.0280	1.70	0.2102
L		1	0.1908	11.61	0.0036
W*L		1	0.1350	8.21	0.0112
F*L		1	0.0182	1.10	0.3090
W*F*L		1	0.0043	0.26	0.6174
Error	16		0.2630		
Total	23		1.8535		

The only significant interaction was between the water factor and light, indicating that the effect of water depends on whether the tests are conducted in the light of the dark. Variation in survival was significantly affected by light, the presence of water, and by the presence of sucrose.

A separate analysis of variance was conducted to determine which combinations best increased house fly survival (Table 3).

Table 3. Analysis of variance for contrasts.

Source	df		SS[a]	F value
Treatment	7		1.5905	
Light v Dark		1	0.1944	11.85
1,0,1 v 0,0,1		1	0.4538	27.67
1,0,0 v 0,0,0		1	0.2166	13.21
0,1,1 v 0,0,1		1	0.3314	20.21
0,1,0 v 0,0,0		1	0.0182	1.11
1,1,1 v 0,0,1		1	1.0100	61.58
1,1,0 v 0,0,0		1	0.2520	15.36
Error	16		0.2360	
Total	23			

[a]Due to interaction among the factors, the sums of squares (SS) may not sum to the sum of squares for the treatment

The contrasts were chosen on the basis of practical applicability. When a researcher knows the conditions of the test, say, if it will be run in the light or dark, he or she can then choose which combination of sucrose and water will minimize mortality. There seems no point in contrasting, for example, water in the light versus sucrose in the dark.

All of the contrasts were significant, except for the comparison of water versus no water in the dark. The most significant contrast (i.e. the contrast with the largest F-value) was the contrast of sucrose and water combination in the light versus the light control. This supports the data in Table 1, indicating that survival is maximized by the inclusion of both sucrose and water.

It can be concluded from these data that the researcher may reduce background mortality in tests involving houseflies by conducting such tests in the dark. The researcher may further benefit by providing the flies with sustenance of some sort, such as sucrose or water, while the most effective treatment is a combination of the two factors. If both food and water are included, then the experiments may be run in the light with no known decrease in survival as compared to running the experiment in the dark.

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