THE FATE OF YEAST IN THE DIGESTIVE TRACT OF DROSOPHILA

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The importance of yeasts as a food for Drosophila was well established by Delcourt and Guyenot (1910), Guyenot (1913), and Northrop (1916 and 1917). In line with this, it has been customary for many years for biologists, and particularly geneticists, experimenting with Drosophila to use yeast in the food of their fly cultures. Considerable information on the nutritive value of yeasts to Drosophila is available in reports by Baumberger (1919), Chevais (1942), Chiang and Hodson (1950), Gordon and Sang (1941), Robertson and Sang (1944), and others. There is, however, no information on the fate of yeasts ingested by Drosophila or the rate at which they are digested. Recently the authors were concerned with the isolation of yeasts from the intestinal tracts of Drosophila flies collected in the mountains of central and southern California. The flies were shipped to Berkeley and yeast isolation made in the shortest time possible after collection. The initial collections of flies yielded relatively few yeasts. Since the crops of the flies were well distended at the time of collection, it was presumed that the yeasts were digested before isolations were attempted in the laboratory. It became necessary to develop a procedure for the transportation of flies to the laboratory with a minimum destruction of yeast, or abandon the project. In the development of this procedure, certain data of interest to Drosophila workers were obtained. These are reported below:

DIGESTION OF YEAST CELLS BY DROSOPHILA

D. pseudoobscura flies were held in a bottle at room temperature without food for twenty-four hours before the introduction of a paste of bakers' yeast on a glass slide. The flies were permitted to feed on the yeast paste for two hours, after which time they were well fed, as indicated by distention of the entire abdomen. The flies were then removed and placed in clean bottles which were stored at different temperatures. At various intervals, flies were withdrawn from each bottle and the alimentary tract removed from plating. The number of yeast cells in the alimentary canal of each fly was determined by the quantitative plating method as described by Henrici and Ordal (1948). The results of these tests are given in table 1.

It is obvious that digestion is very rapid at room temperature and much slower when the temperature is appreciably lower. The crops of flies held

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at room temperature were almost empty 24 hours after feeding. This is in agreement with the findings of Dobzhansky and Epling (1944) that contents of the crop pass into the gut in about 24 hours after ingestion of the food. On the other hand, crops of flies stored at 0°C. appeared full at the time of dissection, but the extent of distention decreased when the storage period was increased. The experiment showed the importance of cooling flies as soon as they are collected, so the internal flora can be studied without much change during transportation. Accordingly the writers adopted the following procedure for the handling and transportation of flies from their native habitat to the laboratory.

TABLE I

SURVIVAL OF YEASTS IN D. PSEUDOOBSCURA STORED FOR VARIOUS PERIODS OF TIME AT DIFFERENT TEMPERATURES

Storage time after feeding	Average number of cells per alimentary tract			
	Room temperature	15° C	5° C	0° C
Immediately after feeding	150,000	150,000	150,000	150,000
24 hours	65	300	3,200	93,000
48 hours	0	160	1,500	62,000

The flies were collected in a test tube which was cooled immediately by placing in a "super-ice" package. This is a commercial package consisting of an insulated box containing a frozen block[3] which holds the surrounding temperature at about 0°C. The container with flies was shipped on the evening of the collection enabling the isolation of yeasts from the flies early the next morning.

FATE OF YEAST CELLS IN THE DIGESTIVE TRACT OF DROSOPHILA

Although many investigators have shown the importance of yeast in the nutrition of Drosophila, there is no information indicating the effect of the digestive mechanism of Drosophila on yeast cells. In our work, the question arose as to whether or not fly pellets might be used as a source of cultures as indicated by the work of Hedrick and Burke (1950).

Flies (*Drosophila pseudoobscura*) were permitted to feed on bakers' yeast as indicated above. Fecal pellets were then collected on slides for examination. The direct microscopic examination of fecal pellets showed that they were composed almost entirely of intact rather than broken yeast cells. There was no indication of cell wall breakage during the digestive process. Upon applying a solution of methylene blue (1:100,000) to fecal pellets, the

[3] This block is a commercial preparation consisting of a mixture of sawdust and certain chemicals enclosed in a coarse fiber paper covering. In using the block, it is first submerged in water, then frozen at −6°F or less. When placed in the insulated box, it remains cold for a much longer period than does ice.

yeast cells stained instantly, indicating that they were killed by passage through the digestive tracts. Furthermore, microscopic examination revealed that each pellet contained 20-30 yeast cells and that practically all the cells were more or less empty. There was no evidence to indicate that more than a stray yeast cell, if any at all, could survive passage through the intestinal tract of *D. pseudoobscura.*

According to Lamanna and Mallette (1950), yeast cells are gram positive because of the presence of ribonucleate. Therefore, if this substance is removed, the cells should become gram negative. This proved to be the case upon application of the gram stain to yeast cells in fecal pellets, indicating the removal of ribonucleate during passage of the yeast cells through the digestive tract.

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