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NUTRITIVE VALUE OF BEER YEAST FOR *ERATIRIS CAPITATA* (DIPTERA, TEPHRITIDAE)

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RESUMO. *Foram feitas investigações sobre os requisitos alimentares de* ***Ceratitis capitata*** *para determinar a quantidade mínima de levedura de cerveja necessária para assegurar o bom desenvolvimento dessa mosca. As variações de tempo de empupação, tempo de emergência, porcentagem de empupação e desenvolvimento ovariano estão diretamente relacionadas às quantidades aumentadas de levedura de cerveja na dieta. Os resultados indicam que o intervalo apropriado para a levedura é de 4,0 a 4,5 g/150 ml de meio.*

ABSTRACT. *Investigations of food requirements were carried out to determine the minimum amount of beer yeast needed to produce the best development of* ***Ceratitis capitata.*** *Variations in pupation time, emergence time, pupation percentage, emergence percentage, and ovarian development were directly related to increased amounts of beer yeast in the diet. Results indicate that the appropriate range of beer yeast is about 4.0 to 4.5 g/150 ml of diet.*

INTRODUCTION

Ceratitis capitata, commonly known as Mediterranean fruitfly, represents today a feared agricultural pest, since few types of fruit escape its attack. In Brazil, *C. capitata* infests and develops in the following fruits: sweet oranges, sour oranges, tangerines, coffe, guava, pears, peaches, plums, apples, and others (Mariconi & Iba, 1955).

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Many studies using artificial diets have been carried out for mass breeding of the pest in the laboratory. The first attempt was made by Marlowe (1934), and interest in the subject grew since the early fifties with studies using different protein sources (Maeda et al., 1953; Steiner, 1952; Hagen, 1953; Delanique, 1955; Steiner *et al.*, 1966; Peleg & Rhode, 1970; Schroeder *et al.*, 1972; Souza *et al.*, 1978). Maeda *et al.* (1953) were the first investigators to use beer yeast for raising *C. capitata* with the objective to determine the appropriate concentration for the development of this insect. These authors only considered larval weight and percentage of larval recovery. However, we believe that other additional relevant features should be investigated, since nutrition affects all developmental stages. Thus, the need was felt for a study that would the effect of beer yeast on *C. capitata*.

Beer yeast is commonly used as a protein and vitamin source in artificial diets used for insect pest breeding because it contains most vitamins of the B complex and 18 of the most commonly utilized amino acids, which permit good insect development by supplying as yet unidentified factors and perhaps by protecting vitamins during heating (Acker, 1962). Soudek (1929), Haydak & Tanquary (1942) and Wahl (1954, 1964) tested several protein substances as substitutes for pollen on bees, and obtained good results with beer yeast.

The objective of the present study was to determine the minimum requirement for beer yeast that may reduce breeding time and larval mortality and increased percent emergence when an economically viable diet is used.

MATERIALS AND METHODS

Larvae obtained from females maintained in cages in the laboratory by the method of Nadel (1965) modified by Wiendl (personal communication) were used in the present study. The adults were fed the diet described by Souza *et al.* (1978) and submitted to a light period of approximately 10 hours in order to induce oviposition. Collected eggs were placed on filter paper and immediately transferred to Petridishes lined with moistened cotton wool to facilitate larval eclosion. Twenty newly-hatched larvae were used per experiment. Each experiment was replicated three times and the data were analyzed statistically by the Kruskal-Wallis test at the 5% level of significance (Hollander & Wolfe, 1973).

Different groups were fed diets containing different amounts of beer yeast (Table I). The diets were prepared as described by Zucoloto *et al.* (1979). All experiments were carried out at 27 ± 1ºC.

The nutritive value of the various diets was tested on the basis of the following parameters: pupation time, percentage, time for adult emergence, emergence percentage, wing length of males and females,

and ovarian size (largest lenght and width). Wings and ovaries were measured using a Nikon magnifying glass with a micrometric eyepiece.

Pupation time and percentage, emergence percentage and cycle duration were studied because we know that the protein source, and beer yeast in particular, has a direct influence on these parameters, as reported by Message & Zucoloto (1980) for *Anastrepha obliqua.* Ovarian development is highly affected by the nutritive value of the diet, as shown by several studies on *A. obliqua* (Testa & Zucoloto, 1976; Braga & Zucoloto, 1981; Ferro & Zucoloto, 1983) and on other insects (Massoniê, 1971; Zucoloto, 1977; Tziropoulos, 1978).

TABLE I. Comosition of the experimental diets offered to newly-emerged *C. capitata* larvae

	Diets									
	1	2	3	4	5	6	7	8	9	10
Beer yeast (g)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
Wheat flour (g)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Sucrose (g)	12.0	11.5	11.0	10.5	10.0	9.5	9.0	8.5	8.0	7.5
Agar (g)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Nipagin (ml)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Propionic acid (ml)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Distilled H_2O (ml)	150	150	150	150	150	150	150	150	150	150

RESULTS AND DISCUSSION

The diets tested and the biological responses of the larvae are shown in Table II and Figure 1. Statistical analysis showed that diets 9 and 10 promoted best larval development, thus demonstrating that the minimum beer yeast requirement for *C. capitata* larvae is arround 4.0 to 4.5 g. Diets 4, 5, 6 and 7 produced reasonable results in terms of pupation percentage, but a low percentage of adult emergence. This appears to indicate that increased yeast concentrations induce larval development up the pupa stage, thus increasing pupation percentage, although the percentage of adult emergence continues to be low. In contrast, larvae fed diets 2 and 3 did not grow, probably because of insufficient protein levels.

Comparison of the different diets tested showed no statistically significant differences in individual growth as measured by wing length, but statistically significant differences as measured by ovarian length and width, with diet 10 being the most effective.

TABLE II. Pupation time, emergence time, pupation percent, emergence percent, wing length, and ovarian length and width obtained at different beer yeast concentrations in the diet. The results are expressed as means ± SD of three replications.

Experimental group	Beer yeast concentration (g)	Pupation time (days)	Emergence Time (days)	Cycle duration (days)	Pupation percent	Emergence percent	Male and female wing length (mm)	Sum of ovarian length and width (mm)
1	0.0	–	–	–	–	–	–	–
2	0.5	–	–	–	–	–	–	–
3	1.0	–	–	–	–	–	–	–
4	1.5	22.07±1.96	12.46±2.58	30.08±4.69	38.33±20.82	15.00±5.00	3.51±0.11	0.70±0.08
5	2.0	18.89±1.80	10.69±0.81	28.09±1.24	51.67±7.64	36.67±12.58	3.59±0.08	0.84±0.08
6	2.5	13.72±1.77	12.42±2.98	25.00±1.89	51.67±10.41	20.00±0.00	3.18±0.15	1.10±0.16
7	3.0	16.73±1.41	10.67±2.84	27.83±0.76	46.67±15.28	20.00±0.00	3.82±0.05	0.97±0.11
8	3.5	15.78±3.84	11.90±1.50	26.03±1.54	63.33±23.63	36.67±12.83	3.84±0.18	1.47±0.16
9	4.0	14.83±2.55	10.53±1.25	24.19±1.93	65.00±8.66	45.00±0.00	3.83±0.00	1.45±0.08
10	4.5	14.89±1.12	13.10±1.31	27.57±2.98	60.00±15.00	40.00±10.00	3.89±0.12	1.58±0.21

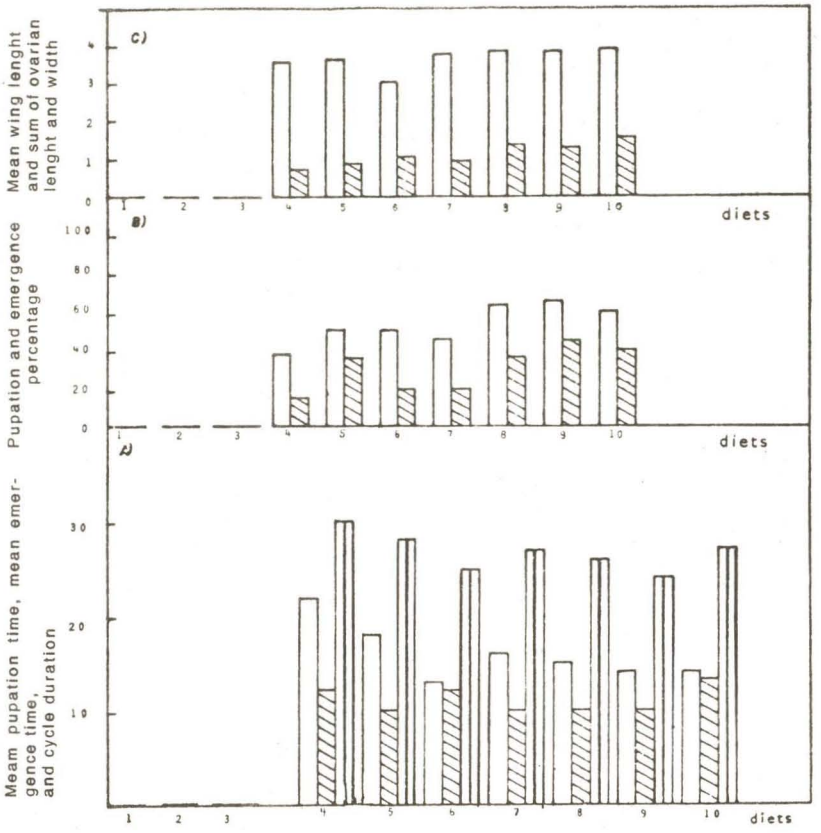

Fig. 1 – Parameters investigated

Graph A: ☐, mean pupation time; ▨ mean emergence time; ▥, mean cycle duration

Graph B: ☐, mean pupation time; ▨ mean emergence time

Graph C: ☐, mean male and female wing lenght; ▨, sum of ovarian lenght and width.

On the basis of these results, we conclude that the minimum amount of beer yeast needed for *C. capitata* growth is around 4.0 to 4.5 g, which leads us to hypothesize that it is in this protein range that the other nutrients present in the diet are better utilized. Once this better utilization is achieved, protein can exert its primordial function. Similar results were obtained by Zucoloto *et al.* (1979) and Message and Zucoloto (1980) for *A. obliqua*.

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