

# RESISTANCE OF FREEZE-DRIED PRODUCTS TO SOME INFESTING INSECTS

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## Abstract

The reproduction and the development of Tribolium confusum Duv. on freeze-dried substrates of vegetal origin (French beans, tomatoes, and wheat flour) with negligible water content (1-2%), kept in chambers at constant temperature (25°C) but different moisture levels (20% and 65%), were investigated. In both test groups insect development on freeze-dried substrates was compared with that on normal wheat flour with 14.2% moisture (control substrate).

There was no marked difference between the number of first-stage larvae grown in the freeze-dried flour kept at 20% and 65% r.h. This seems to indicate that the development of Tribolium is dependent on substrate moisture rather than on environmental humidity. Infestation level (larval stage) was lower in freeze-dried flour than in the control substrate.

There was no significant difference in the number of pupae obtained at 20% r.h. in either freeze-dried flour or normal flour and those obtained at 65% r.h. There were significant differences ( $P < 0.01$ ) in the duration of the pupal stage between freeze-dried and normal flour, at both 20% and 65% r.h. It was shorter in freeze-dried flour at 20% r.h. than at 65% r.h. ( $P < 0.01$ ), and than in the control substrates at both 20% and 65% r.h. Insects seem to shorten their pupal stage when the conditions are unfavorable.

The freeze-dried substrate greatly influenced the development time of Tribolium. Statistical analysis showed that at both r.h. levels the freeze-dried flour led to a slower development for insects as compared with the control substrate ( $P < 0.01$ ).

On freeze-dried French beans and tomatoes, reproduction by T. confusum was not recorded, and larvae failed to reach the second stage.

## Introduction

Freeze-drying has been used for years in the drug and food industry because it guarantees almost unlimited preservation, and the necessary microbiological stability of the product is obtained without any addition of chemical preservatives.

The freeze-dried final product differs from the initial one due to loss of water by causing reduction in moisture content (m.c.) of the treated commodity to 1-2%. The technique prevents the destructive activity of fungi and bacteria, and inhibits oxidation phenomena which cause undesirable changes in food.

Development of insects infesting foodstuffs is influenced by several factors, among them food m.c. In fact each vital process of the insect,

from growth to reproduction, necessitates a specific water balance.

Investigations on development time of common storage pests under different moisture and temperature conditions have shown the poor adaptability of most insects to low m.c. For this reason the capability of stored product insects to survive and develop in freeze-dried food-stuffs was considered worthy of investigation, and a preliminary study is reported here.

The investigation was aimed at examining the development and reproduction of Tribolium confusum Duv. on freeze-dried substrates of vegetable origin (French beans, tomatoes and wheat flour) with negligible m.c. held in constant temperature chambers at 25°C with different air relative humidities (r.h.) of 20% and 65%. In both test groups insect development on freeze-dried substrates was compared with development on normal wheat flour at 14.25% m.c.

Sets of sixteen test-tubes were filled with each substrate (normal and freeze-dried wheat flour, French beans, and tomatoes freeze-dried in smithereens); then 3 males and 3 virgin females of Tribolium confusum (reared on normal wheat flour + 5% yeast), that were sexed in the pupal stage, were placed in each test tube. The test-tubes were then held in a climatic test-chamber at 25°C and 20% r.h.

The freeze-dried flour and the test flour were also used for tests at 65% r.h. For each substrate sixteen test-tubes were filled and infested according to the above described procedure.

Fifteen days later the substrates were sifted to remove the adults that had been originally placed in the test-tubes. Thirty-two days after initiation of the experiment the number of larvae present was first counted. All stages of development were examined for each substrate in groups of four test-tubes at fourteen days intervals.

The test-tubes, once examined, were held separately from the others, and then examined later for pupal and adult emergence. Pupal and adult counts were made on all test-tubes at ten day intervals.

Every week fluctuations in moisture content of each substrate were examined to investigate the influence of atmospheric humidity on the media.

It should be noted that the m.c. of the freeze-dried flour had increased to over 8% at the end of the test, while the normal flour showed no increment.

## Results

Results of the tests are given in figures 1 to 4.

From figures 2 and 4 it can be seen that is no noteworthy difference between the number of 1<sup>st</sup> stage larvae that developed in the freeze-dried flour kept in chambers at 20% and 65% r.h. This seems to indicate that development depended more upon substrate moisture than environmental humidity. Infestation level (larval stage) was lower in freeze-dried flour than in the control substrate.

Figure 1 - Average numbers of larvae (L), pupae (P) and adults (A) reared on normal wheat flour at 25°C and 65% r.h. Data on adults are cumulative

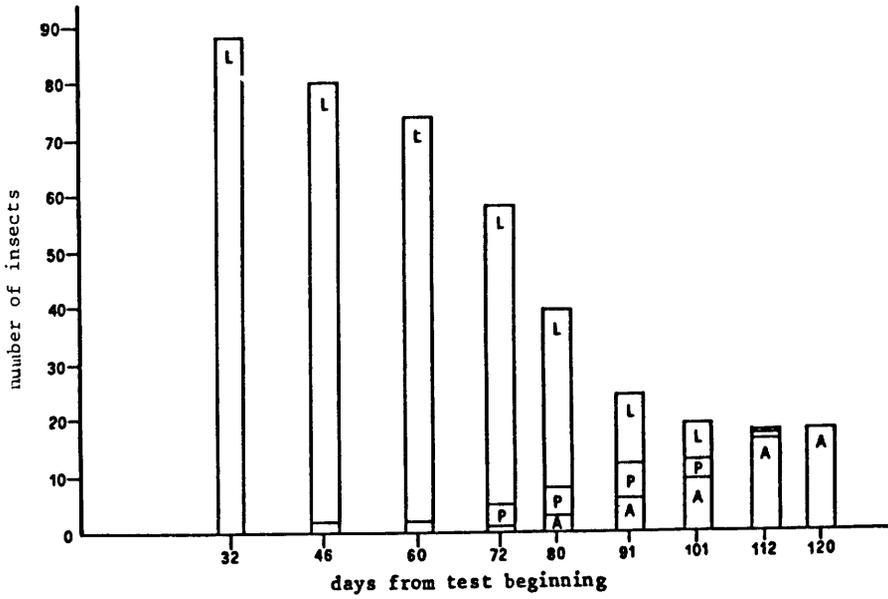


Figure 2 - Average numbers of larvae (L), pupae (P) and adults (A) reared on freeze-dried flour at 25°C and 65% r.h. Data on adults are cumulative

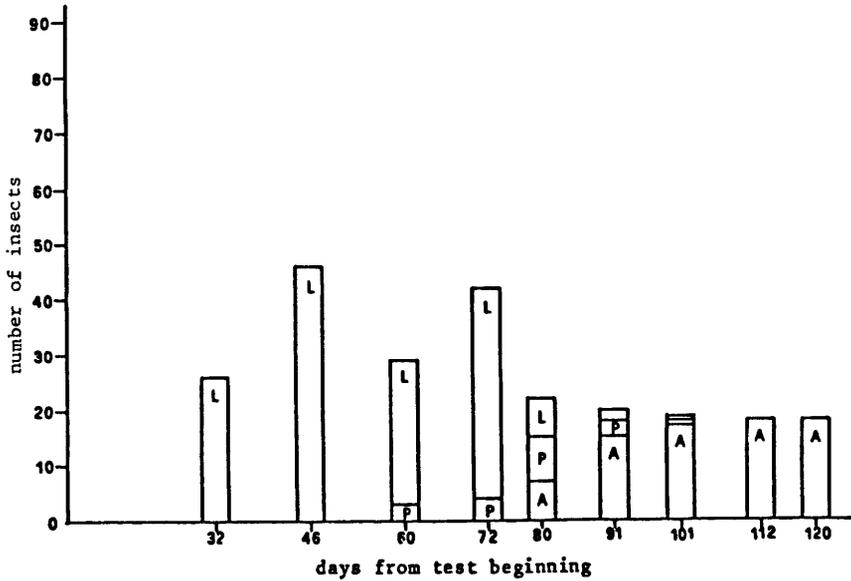


Figure 3 - Average numbers of larvae (L), pupae (P) and adults (A) reared on normal wheat flour at 25°C and 20% r.h. Data on adults are cumulative

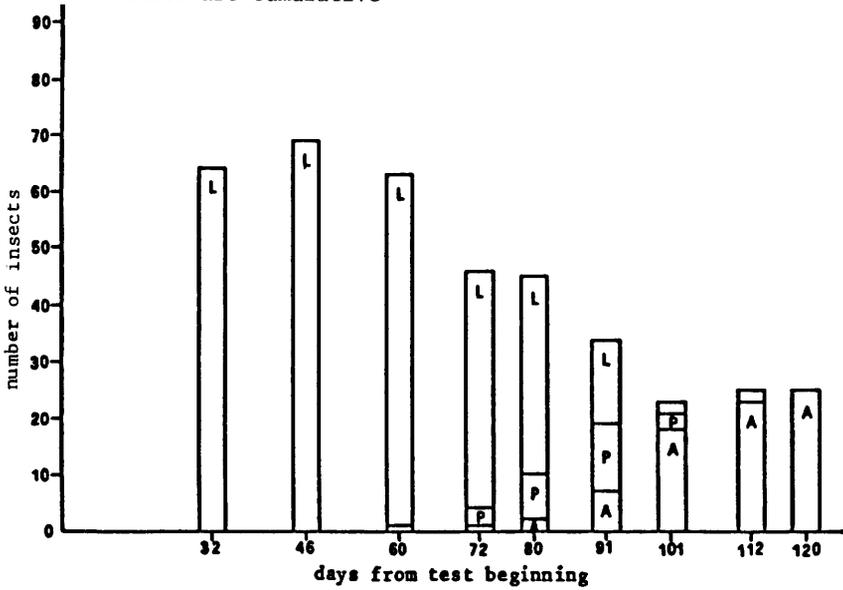
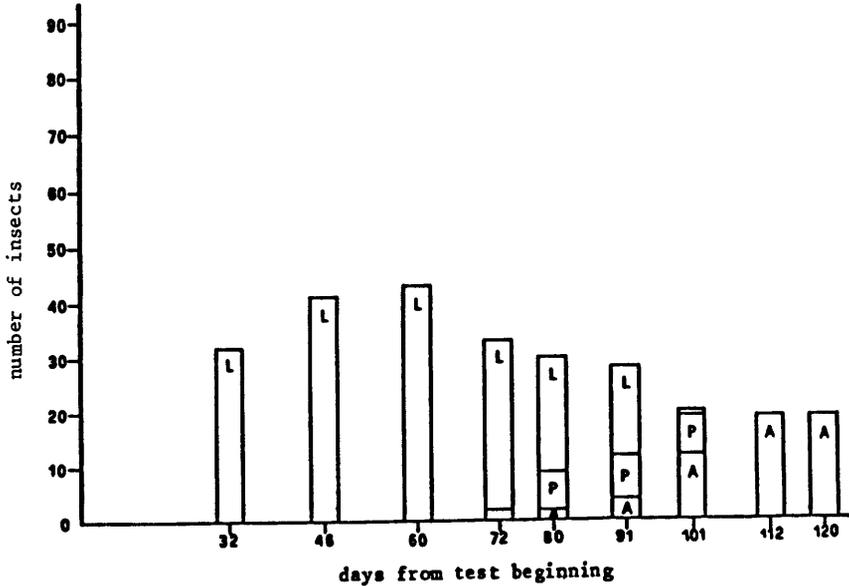


Figure 4 - Average numbers of larvae (L), pupae (P) and adults (A) reared on freeze-dried flour at 25°C and 20% r.h. Data on adults are cumulative



It can be seen that there are no significant differences in the number of pupae held at 20% r.h.; this is in accordance with investigations carried out by Fraenkel and Blewett (1944).

Duration of pupal stage shows significant differences ( $P < 0.01$ ) between freeze-dried flour and normal flour, both at 20% and 65% r.h. It is shorter in freeze-dried flour at 20% r.h. than in both freeze-dried flour at 65% r.h. ( $P < 0.01$ ) and in the control substrates at both humidity levels (20% and 65% r.h.). Thus it would seem that duration of pupal stage is shortened when the food and environmental conditions are unfavorable.

Freeze-dried substrate greatly influenced the development time of Tribolium confusum. In order to evaluate this time we considered the time elapse between the introduction of adult insects and the emergence of 50% of the new generation (T50). Statistical analysis of the data brought to evidence that at 20% r.h. and 65% r.h. development time on freeze-dried flour was lower than that in the control substrate ( $P < 0.01$ ).

On freeze-dried French beans and tomatoes, reproduction by T. confusum was not recorded, and larvae failed to reach the second stage.

Khan and Bhuiyan (1983), who reared T. confusum on different legume flours (chick-peas, peas, lentils), obtained good survival rates of larvae and development of pupae.

#### References

- Fraenkel G.S. and Blewett M.B. (1944) The utilization of metabolic water in insects. Bull. ent. Res. 35, 127-139.
- Khan A.R. and Bhuiyan A.R. (1983) Effect of foods on sex ratios of the flour beetle, Tribolium confusum. Ent. exp. and appl. 34, 123.