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Mold mites *Tyrophagus putrescentiae* (Shrank) in stored products

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Abstract

The purpose of this study was to understand the extent that Tyrophagus *putrescentiae* was present in the stored food industry using new monitoring tools in laboratory and commercial retail settings. We also wished to determine what effect if any that the fumigants sulfuryl fluoride, phosphine, and common liquid cleaning agents had on the mortality of *Tyrophagus putrescentiae* mites in the stored product environment. Sulfuryl fluoride is being registered throughout the world for stored product applications as an alternative to methyl bromide. It's effects on mites using the labeled rates was unknown and the question of whether or not it could be used to eliminate this pest as an alternative to methyl bromide was investigated. A comparison to sulfuryl fluoride, phosphine and liquid cleaning agents will be discussed.

Key words: Mold mites, *Tyrophagus putrescentiae*, phosphine, sulfuryl fluoride, IPM, methyl bromide alternative.

Introduction

Several species of mites infest stored foods and other organic debris such as grain, flour, cereals, pet foods, and mold (Rodriguez and Rodriguez, 1987; Chambers, 2002). These mites often prefer moist, tropical environments. Sometimes the surface of infested materials appears to move due to the enormous numbers of mites (barely visible to the unaided eye). A coating or pile of pale brownish "mite dust" may appear on open shelving, around the base of bags containing seeds, pet food, and other foods. Such piles consist of dead and living mites, cast skins and feces. Sass (2006) showed that in a wet condition, mold mites in the 20 ºC and 25 ºC temperature range remained alive for 31 days with no food.

In a five year survey conducted in Indonesia food stores, *Tyrophagus putrescentiae* (Shrank) was the most often found non-predatory mite species. It was found in 151 records that represented 12.23 % of all samples. In this survey, 1,202 records of 61 species were recovered. Fourteen species of the main mite pest group, the Acaridae, was found in a wide range of commodities (Haines 1997).

Under moist conditions (12 -18 % moisture content, MC) and warm summer temperature, a generation can be completed in 8 to 21 days. As the temperature falls, the length of the life cycle increases greatly. The mold mite will breed readily above 30 ºC. The mold mite is less tolerant to low temperature and cannot develop below 10 ºC. However, in an inactive state, this mite can survive 0 ºC. At favorable temperatures and 90 to 100 % relative humidity, the female can lay an average of 437 eggs (Rodriguez and Rodriguez, 1997). At a given temperature, larval and nymphal stages require about equal time for development. The mold mite is a pest of many foods, especially those having a high fat or protein content and moisture content in the range of 12-18 percent.

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Mite monitoring

High moisture food products where collected from retail groceries in many locations in the USA and Europe. Special mite monitors designed to detect low level mold mite activity in food products were used. Table 1 summarizes the data high moisture food products.

Table 1. Percent moisture content found in soft moist food product found on the retail shelf.

Moisture Content (MC) (%)	Relative Humidity (%)
10	39
12	42 - 51
14	55 - 69
18	58 – 67
20	66 -67
25	81

1. Half of the bags sampled had mold mites (n = 110).
2. The oldest dated material had the most mold mites (>1,000/cm^2).
3. Foods with > 14 % MC had relative humidity of 60-80 % in the head space which attracts mites and promotes development.
4. All manufacturers with glue sealed, paper bagged, and high moisture food had mold mites.
5. All heat sealed bags mite free (n= 45).

Fumigation with Sulfuryl Fluoride, Phosphine

The fumigant Profume™ fumigant gas was tested against mold mites in a laboratory setting using four replicates of three infested pieces of dog food in a 250 ml round flask. The flask was capped off by a rubber septum stopper to eliminate gas escape. A 5 ml vial containing a water/salt solution and a wicking device was suspended in the vial to keep humidity level above 70 % during the entire treatment period Figure 1.

The sulfuryl fluoride (SF) was taken from a cylinder of Profume and held in a balloon. Using a 1.0 ml gas tight glass syringe the sulfuryl fluoride was taken from the balloon and injected into the 250 ml flask test chamber containing mites, dog food and a humidifying vial.

The objective was to reach a gas concentration within the flask that is comparable to gas levels during a Profume™ fumigation within a structure. The target level was 30 g/m^3 (30 oz/ 1,000 cu ft.) or an application rate at 7,071 ppm @ 20 ºC. Table 2 shows the 4 replicates with

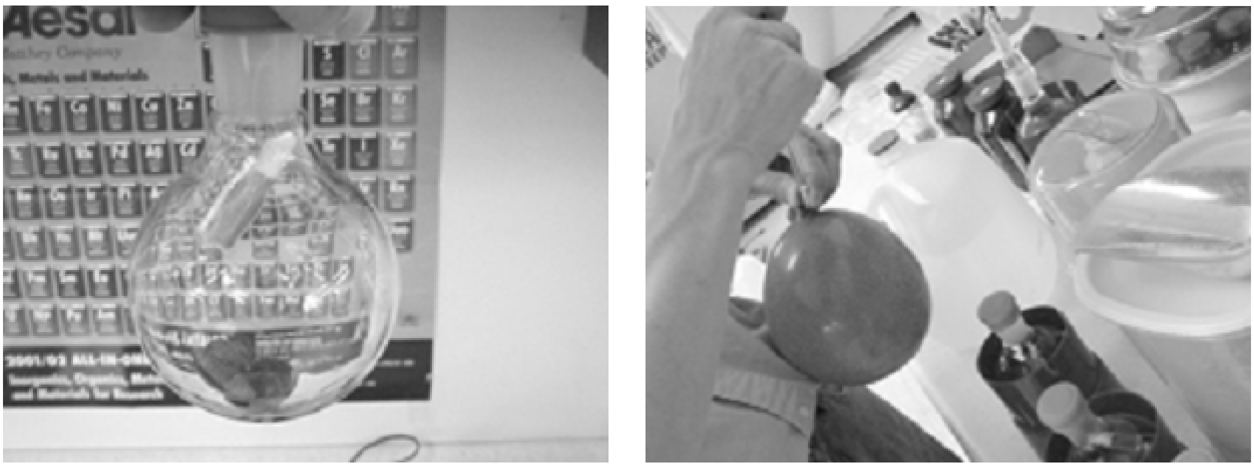

Figure 1. A 250 ml flask test chamber containing mite infested food and suspended vial to add humidity. Removing sulfuryl fluoride from balloon with syringe

their respective volumes and gas concentrations.

All pieces of dog food that were placed into the test chambers were heavily infested with Tyrophagus *putrescentiae* mites. It is estimated that each test chamber contained > 300 mites. The temperature inside the chambers was a room temperature of 24 ºC.

After injection of the fumigant the chambers were visually inspected for live mite activity. The mites were crawling on the inside of the glass of the test chambers and they could be easily inspected to see if they were alive and active.

Observations

We observed the mites immediately after the gas was injected into the chambers and then every 4 hours. At the 24 hour and 48 periods there was live mite activity on the glass. The chambers were opened at 64 hours. The gas levels in the chambers ranged from 8- 20 g/m^3. This gave CT levels (Concentration X Time) of between 512 and 1,280 oz/hours. This is a high dosage rate when compared to fumigating other stored product pests. The mites on the food were very active upon inspection with a microscope. Mortality was estimated at less than 50 %. This initial test leads us to believe that sulfuryl fluoride is not a good option to kill *Tyrophagus putrescentiae* mites at the standard labeled rates. More testing is needed.

A second set of bench top fumigations was performed with phosphine gas. Phosphine was generated from aluminum phosphide pellets in water and extracted by a gas tight syringe from the headspace. For this trial we injected three different concentrations into 250 ml round bottom flasks (n=1) in order to make qualitative observations (Table 3).

Approximately 2 hours after injection, visual observations of mites detected no movement in all three treatments indicating knockdown or narcosis. Exposure was allowed to continue for the duration (72 hours) where upon flasks were aerated. No live mite activity was detected during the remaining time of the fumigation. No live mite activity was found on the product after 24 hours aeration and no delayed egg hatch occurred for 30 days post treatment. Preliminary data indicates 100 % control by phosphine at below label rates, and at low and high ranges of label dosages.

The Effect of Shelf Cleaning Agents On *Tyrophagus putrescentiae* mites

The purpose of this study was to determine what effect, if any that the standard retail shelf cleaning agents used at retail grocery stores has on the migration and mortality of *Tyrophagus putrescentiae* mites.

Two liquid cleaning agents were used: DCT CitriBrite® containing d-Limonene and Clean Quick® Liquid Quaternary Sanitizer from P&G containing dimethyl benzyl ammonia chloride. These were selected because these were the products being used by the commercial retail grocery already.

A 1 meter x 1 meter x 30 centimeter enclosed arena was used for this test. The humidity was regulated by an open glass dish of water/sodium carbonate mix with paper towels wicking into the solution to give a greater surface area. The humidity with the chamber reached a constant 71 % and 26 ºC for the duration of the experiment. See Figure 2.

A non-porous plastic plate was used as the substrate. One side was marked as control and the other as either a citrus cleaner or ammonia based cleaner. A cloth dampened with the citrus cleaner or ammonia cleaner was wiped to cover the entire side of the dish that was marked as such. The dishes were then allowed to air dry for a period of 1 hour. Pieces of 14 % moisture content cereal based food had been placed inside a mite colony 24 hours prior to this experiment. All of these pieces had heavy mite infestations on them at the time of the experiment. One infested piece was placed on each plate on the control side. A similar, but un-infested or "clean" piece of pet food was placed onto the side of the plate which had been wiped down with the particular cleaning solutions.

Table 2. Dosage and calculated concentration of SF (at 20 °C) in each chamber.

Flask	Volume	Volume of gas injected	Concentration ppm
#1	275 ml	1.95 ml	7,071
#2	277 ml	1.96 ml	-
#3	281 ml	1.99 ml	-
#4	289 ml	2.05 ml	-

Table 3. Dosage and calculated concentration of phosphine (at 25 °C) in each chamber.

Flask	Volume	Gas injected	Concentration ppm
#1	262 ml	0.10 ml	381
#2	275 ml	0.20 ml	762
#3	277 ml	0.30 ml	1,081

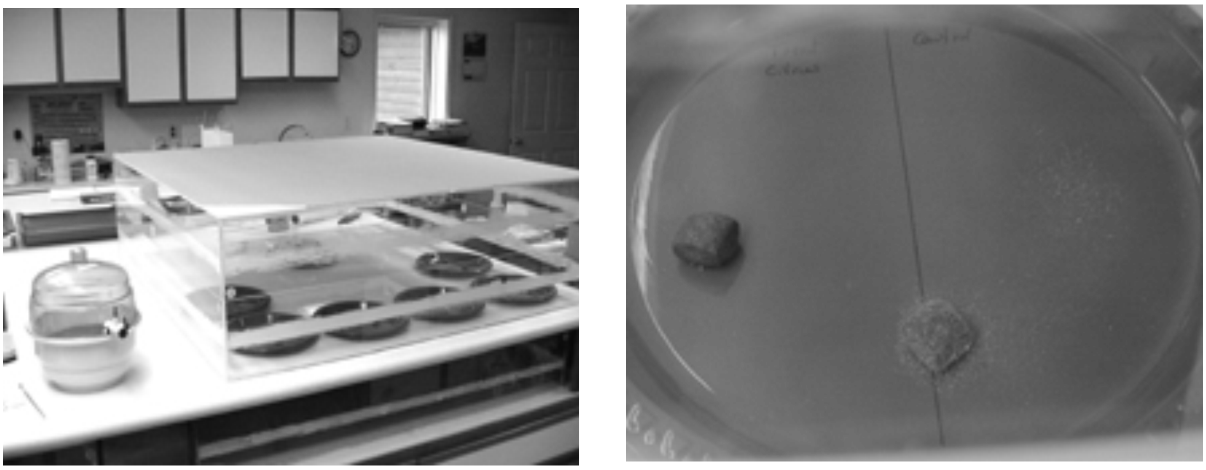

Figure 2. An enclosed 1 m x 1 m x 30 cm arenas with ~70 % relative humidity. The mite mass was able to physically move this piece of pet food 10 cm in 6 hours.

Observations

Mold mites started migrating immediately after the plates were placed into the chamber. The mites had no hesitation as they crossed over from the untreated control side to the treated side for either cleaning solution. After a period of 24 hours, there was no sign of mite mortality or repellency from either cleaning solution. The majority of the mites remained on the originally infested pet food, but new mites were beginning to colonize the uninfested pieces. Table 4 summarizes the results of our study plus some previously unpublished data.

Control measures

Controlling storage mites is difficult when moisture and temperature conditions and storage duration favor their development. The following content is provided by Ohio State University Extension Entomology website.

Table 4. Summary the products tested and effects observed in our study.

Product Used	Mold Mite Mortality
• Quaternary ammonia	No
• Chlorine cleaning compounds,	No
• Citrus cleaner; Citri Brite®	No
• Sulfuryl fluoride; ProFume™	No
• Phosphine; FumiCel®, Eco_2Fume®	Yes
Previously unpublished data	
• Eco PCO ACU: Miticide, clove oil	No
• Eco PCO, water based and aerosol	No
• Tempo SC®: Cyfluthrin	Yes

1. Carefully inspect all high moisture food and grain products. High moisture foods purchased in bulk and stored in bags for long periods of time should be checked routinely. Rotate food materials to remove the older items first.

2. Store pet food only in a clean, dry area. Never store foods under damp, poorly ventilated conditions. If necessary, increase air circulation to reduce relative humidity and prevent molds and mildews. (Reduce the relative humidity to below 55 percent and the moisture content of the media to below 12 percent). Ventilate and dry areas with a dehumidifier or fan, or simply open doors of a damp room.

3. Periodically clean the storage areas, especially cracks, crevices, shelving, etc. Vacuum and wipe up any spilled foods, eliminating the foci of infestations by cleaning with attention to horizontal surfaces such as beams and window ledges.

4. It is important to empty all vacuumed contents in a plastic bad and make sure it is discarded outdoors.

5. When products become infested with mites, locate the source of infestation and eliminate it. (Carefully check all code dates on the high moisture food bags. Especially, bags stored over a long period of time in a undisturbed storage area).

6. A recommendation to the homeowner to eliminate a mite infestation could be to super cooled -18 °C for seven days in a deep freeze), superheated (54 °C for 30 minutes in an oven in shallow pans), (5 minutes in a microwave), or disposed of in several heavily wrapped paper bags for garbage disposal.

7. Homeowners should remove all remaining food from the storage area. Place uninfested food in plastic bags and secure them. Thoroughly clean and scrub all shelves, floors, walls, etc. with hot water, strong detergents and allow to completely dry before using any registered pesticide sprays or before replacing the stored foods.

8. In the manufacturing process, bins or large containers are used for storage, do not dump new replacement foods (flour, grains, etc.) on older unused foods. Allow the original contents to become used up or exhausted, if possible. (Unused materials may become damp and moldy over time). Avoid prolonged storage. Care should be taking to prevent any pet food from being lodged in conveys, pipes, and static elbows without being cleaned regularly.

9. If the stored food mite infestations cannot be successfully controlled, contact a reputable pest control operator. (The licensed, professional pest control operator has the most effective pesticides, equipment and experience). Only licensed, certified pesticide applicators can apply approved fumigants.

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References

Chambers, J., 2002. How to decide whether the presence of storage mites in food and feedstuffs actually matters, Proceedings, Advances in Stored Product Protection, CABI. pp. 428-434.

Haines, C.P., 1997. Insects and Arachnids in Indonesian Food Stores– biodiversity in a man-made environment. Proceedings of the Symposium on Pest Management for Stored Food and Feed. BIOTROP Special Publication No. 59, 95-125, Bogor, BIOTROP.

Sass, B.D., Wyatt Hoback, W., 2006. Effects of Temperature and Humidity on Grain Mite, Acarus siro, Survival, ESA / NCB Meeting,

Rodriguez, J.G., Rodriguez, L.D., 1987. Nutritional Ecology of Stored Product and House Dust Mites. In: F. Slansky, J.G. Rodruquez (Eds). Nutritional Ecology of Insects, Mites, Spiders, and Related Invertebrates. Wiley. pp. 345-368.