Onion Thrips (Thysanoptera: Thripidae) Damage and Contamination in Sauerkraut[1]

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ABSTRACT

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Studies conducted to determine *Thrips tabaci* Lindeman damage and contamination in sauerkraut revealed that both occur at detectable levels in processed cabbage, although such levels are much lower than predicted from examination of fresh cabbage. Addition of the chemical preservatives sodium benzoate (0.1%) and potassium metabisulfite (0.05%) had no effect on plant tissue damage or insect contamination. Although tolerance levels for insect contamination in many other vegetables have been established, the FDA has not established such a tolerance for insect contaminants in sauerkraut. To avoid discretionary seizure, and in light to these findings on this newly important pest of cabbage, guidelines should be established for plant injury and insect tolerances.

Onion thrips, *Thrips tabaci* Lindeman, attack numerous field and vegetable crops and have recently infested cabbage in New York. There are few previous reports of this pest on cabbage (Sirrine and Lowe 1894, Quaintance 1898, Wolfenbarger and Hibbs 1958), and these have dealt primarily with insecticidal control of the pest.

Detection of thrips in commercial cabbage fields is difficult because of their small size (2 mm) and propensity to seek sheltered places on cabbage. Because they are parthenogenetic, they may reproduce rapidly and cause severe damage inside cabbage heads. Once inside the head, they are sheltered from insecticides (Shelton et al. 1981). Infested cabbage heads may appear clean until wrapper and underlying leaves are peeled back and the bronze color and rough texture, typical of thrips damage on cabbage, become evident. Damage may only be on certain layers of the outer one-third of the head, making it difficult for graders to detect thrips and their feeding damage.

On cabbage destined for fresh market, thrips injury will remain visible, thus making the product unmarketable. This may not be the case with processed (sauerkraut) cabbage. Cabbage processed for sauerkraut must conform to USDA standards which require sauerkraut to be "practically free from defects and blemishes" (Anonymous 1967). Since no tolerances have been established for insect contamination of sauerkraut (Anonymous 1980a), processors have invoked a tolerance of zero insect contaminants to avoid any discretionary seizure by the Food and Drug Administration (FDA). With the increasing incidence of thrips on cabbage in New York, the leading producer of sauerkraut in the United States, there is a need to determine if contamination or tissue damage resulting from infestation of the raw product can be detected in processed sauerkraut.

Materials and Methods

Detection of Thrips Contamination and Plant Injury

About 125 heads of cabbage, cv. 'Hinova,' were harvested from a commercial field known to have a high level of thrips-infested cabbage and processed at the New York State Agricultural Experiment Station's Food Processing Laboratory. Cabbage was divided into three treatments: (1) no damage—trimmed of green and thrips-infested leaves; (2) commercial grade-trimmed of green leaves only; and (3) extreme damage—containing only thrips-infested leaves. Treatments 1 and 2 were replicated three times with 10 kg of shredded cabbage each, whereas treatment 3, because of a limited quantity of severely infested leaves, was replicated twice with one 10-kg and one 8-kg sample. Cabbage leaves were segregated into one of the three treatments and shredded. During shredding, small subsamples (700 g) of shredded cabbage were collected to determine levels of insect contamination and thrips damage before processing. Five hundred shreds from each subsample were checked for thrips injury, and the remainder (ca. 600 g) was washed with 1 liter of water, filtered, and examined for insect fragments (all examinations for insect contaminants followed accepted practices [Horwitz 1980]). The eight main samples, containing 8 to 10 kg of shredded cabbage, were salted with sodium chloride (2.25% wt/wt), and were packed in plastic containers (35 by 25 cm). Containers were capped with a water seal (10-cm depth) to insure anaerobiosis and incubated at 20°C.

After 8 weeks of incubation, each container was drained of brine. A 200-ml sample of the brine was filtered and examined for thrips contamination. The drained solids from each container were divided into four sections, i.e., top, surface spoilage (an effect normally observed in sauerkraut fermentation), and equal thirds of the remainder. This partitioning was done to determine the distribution of thrips within the sealed tank. Three 500-g samples of each of the four sections per container were washed with 1 liter of water and examined for thrips contamination. The remaining solids (except the spoiled section)

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were mixed to form a single sample. From this sample, which represented usable sauerkraut, six 400-g subsamples were taken. The chemical additives, sodium benzoate (0.5 g) and potassium metabisulfite (0.175 g) were dissolved in the cover brine (100 g) and subsequently added to three of these subsamples. The finished product (500 g) was sealed in plastic bags. These additives are used when sauerkraut is commercially packed in plastic bags but are not included in canned sauerkraut. This treatment was added because of the suspected beneficial effect of these additives on disguising thrips injury. Shreds from all six subsamples were washed, as mentioned above, and checked for thrips parts, and 200 shreds per subsample were examined for thrips damage. All treatments were analyzed for total titratable acidity (expressed as lactic acid), pH, salt, and color quality as required by the USDA (Anonymous 1963).

Commercially Produced Sauerkraut

Cabbage, cv. 'Hinova,' heavily infested with thrips, was shredded by a local processor, mixed with salt, and divided into two 10-kg samples. This cabbage was obtained from a field rejected by this packer because of thrips infestation. These samples were brought to our laboratory and examined, as mentioned above, except that preprocessed samples were not obtained.

Effects of Brine and Sodium Bisulfite plus Potassium Metabisulfite on Thrips

Investigations were conducted to determine any effects of brine and commercial additives on thrips in sauerkraut. Brine was composed of 2.25% NaCl, 2.02% lactic acid, and 0.3% acetic acid, and had a pH of 3.4. An additional 0.1% sodium benzoate and 0.05% potassium metabisulfite were added to half of the brine samples to make a second treatment. A total of six vials (15 ml per vial) of each treatment were used. Into each vial, 10 adult and 10 immature thrips were added. Three vials of each treatment were kept at 27 and 16°C for 40 days. After this period, the solutions were examined for thrips.

Results

Detection of Thrips Contamination and Plant Injury

Thrips contamination and plant injury were detected in shredded cabbage before processing (Table 1). In treatments 1 and 2, green leaves were removed, but careful trimming of thrips-damaged leaves in treatment 1 eliminated the 2.0% thrips damage which occurred in treatment 2. As expected, treatment 3 had a high level of shred injury, i.e., >10 fold that of treatment 2. Damage to shreds was clearly evident to the naked eye by the bronze color and rough texture. Trimming of thrips-infested leaves also eliminated all thrips contaminants. Removing only the outer green leaves (treatment 2) resulted in 7.0 thrips parts per kg being detected. Thrips were usually detected intact rather than dismembered, and were easily visible under 10× magnification.

Table 1.–Plant injury and thrips contamination in fresh shredded cabbage

	Treatment		
	1; No damage	2; Commercial grade	3; Extreme damage
% Damaged shreds[a,b]	0	2.0	22.3
Thrips/kg of shreds[c]	0	7.0	53.2

[a]Bronzed discoloration or rough texture constitutes damage.
[b]Examination of 1,000 to 1,500 shreds.
[c]Examination of aqueous eluate (1 liter) from 1 kg of shreds.

After fermentation, damage to shreds was less easily detected and the addition of additives did not greatly affect the damage (Table 2). By processing the cabbage trimmed in a commercial manner (treatment 2), damage was reduced by 10- to 20-fold compared with preprocessed levels (Table 1 vs. Table 2). Similarly, a threefold reduction occurred in treatment 3. Damage to shreds was less easily detected in the fermented product because the shreds were swollen and darkened, hence making the contrasting tissue injury less apparent. No thrips were found when the processed shreds in treatments 1 and 2 were washed, and in treatment 3, the numbers of thrips per kg were reduced by ca. two-thirds compared with preprocessed shreds. The addition of additives did not affect thrips contaminants per kg.

When sauerkraut was examined in sections, 0.3 thrips per kg was found in the brine of treatment 2, and no thrips were found in any of the solids (Table 3). Thrips were found in the brine and all sections of solids in treatment 3. Contaminants were found throughout the solids of treatment 3 and, if equal samples of the usable portions of solids (top, mid-

Table 2.–Plant injury and thrips contamination in laboratory-processed sauerkraut

	Treatment		
	1; No damage	2; Commercial grade	3; Extreme damage
% Damaged shreds[a,b]			
No additives	0	0.2	7.3
Additives[c]	0	0.1	6.9
Thrips/kg of shreds[d]			
No additives	0	0	16.2
Additives[c]	0	0	17.0

[a]Bronzed discoloration or rough texture constitutes damage.
[b]Examination of 1,200 to 1,800 shreds.
[c]Sodium benzoate (0.1%) and potassium metabisulfite (0.05%).
[d]Examination of aqueous eluate (1 liter) from 1 kg of shreds.

Table 3.—Distribution of thrips in fermentation tank of sauerkraut

Location	Thrips/kg[a,b] in the following treatments: 1; No damage	2; Commercial grade	3; Extreme damage
Brine	0	0.3	5.1
Surface spoilage	0	0	19.4
Top	0	0	33.0
Middle	0	0	17.0
Bottom	0	0	20.0

[a]Examination of aqueous eluate (1 liter) from 1 kg of shreds.

[b]Mean values of treatments; three, three, and two replicates, respectively.

dle, bottom) in treatment 3 were taken, an average of 23.3 thrips contaminants/kg of shreds would be detected. This is similar to the level found in Table 2. Again, most thrips contaminants consisted of whole and intact thrips.

Chemical analyses of the brine generated in the thrips and nonthrips containing fermentations were similar in acid, salt, and pH values and were in accord with results reported previously for commercial-grade sauerkraut by Stamer and Stoyla (1978).

Commercially Produced Sauerkraut

Shreds with and without additives had similar thrips injury (0.9 and 1.0%, respectively). This low level was similar to our laboratory-produced "commercial" treatment. No thrips were detected in samples of washed shreds. Only 1.1 thrips per kg of brine were detected, and no thrips parts were located in any of the samples of solids. Again, chemical analyses of the brine and visual evaluation of the shreds' color indicated an acceptable product.

Effects of Brine and Sodium Bisulfite plus Potassium Metabisulfite on Thrips

Examination of the adult and immature thrips placed in brines, with and without additives, indicated that all thrips remained intact. The appearance of thrips was not affected by either solution or temperature. This supplements the observations that thrips, once entrapped in the fermenting mass, may appear or be recovered in the finished product, especially when sauerkraut is packaged in plastic bags (a process devoid of heat treatment).

Discussion

It is evident that thrips damage and contamination can be detected in processed sauerkraut, although such levels will be noticeably less than predicted from examination of the unprocessed cabbage. The sauerkraut samples produced by a local packer were made from cabbage taken from a field which had been rejected by this packer because of thrips injury. Although this cabbage appeared to be severely injured before processing, only 1% of the shreds of the final product showed evidence of thrips damage. This can be attributed to two factors. Since injury to the raw product only occurred on approximately the outer one-third of the head and this injury was spotty, damaged shreds only amounted to a small portion of all shreds. This, combined with the reduction in damage due to processing, led to low damage levels. Still, 1.1 thrips per kg of brine could cause levels unacceptable to FDA when incorporated into the sauerkraut container.

Inspecting and trimming all thrips-infested cabbage leaves is impossible under commercial sauerkraut processing. Many thrips are lost during processing, although it is not clear how. Still, some contaminants can be found if inspectors examine the product as required. Detection of any thrips contaminants could cause seizure of all sauerkraut from the packer.

Since the Food and Drug Administration (FDA) has not established a definitive defect action level for thrips in sauerkraut, the occurrence of such insects at the currently undefined level forces processors to have a tolerance of zero to avoid any possible discretionary seizure of the finished product. The FDA regulations relative to this commodity should be examined in light of the minute size and small quantity of thrips which could realistically be found in sauerkraut processed from thrips-infested cabbage. As an example, FDA standards allow up to 60 aphids, mites, or thrips per 100 g of frozen broccoli (Anonymous 1980b). Although it is evident that a larger insect could noticeably detract from the appearance of sauerkraut, it is doubtful that a thrips contaminant, barely visible to the naked eye, would have the same effect.

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