

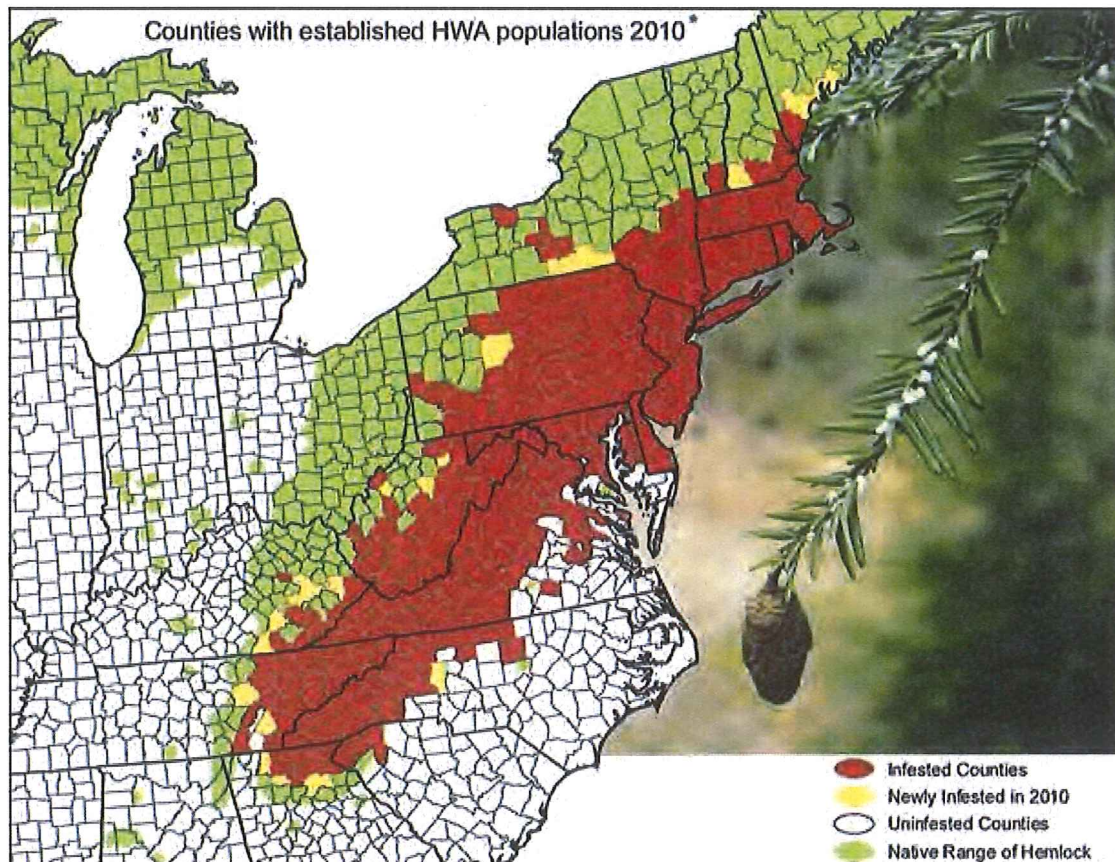
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PACKAGING AND PRESENTATION OF ARTIFICIAL DIETS FOR HEMLOCK WOOLLY ADELGID PREDATORS

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ABSTRACT

We have determined that artificial diets that we developed for *Sasajiscymnus tsugae* were prone to deterioration from microbes, desiccation, and free-radical damage. Therefore, we undertook studies of diet packaging techniques that would help protect the diets from forces of deterioration. We used as controls our FDFE3 and F100 Diets (both based on chicken egg yolks and functional diet components such as fructose, preservatives, vitamins, and texturing agents). The control diets were hydrated either with water or honey. Both diets were attractive to both adult and larval *S. tsugae*, but the honey-diets lasted longer than the water-based diet in terms of mold and complete desiccation to crisp dryness. We used packaging techniques that included stretching Parafilm around diet (by hand and with the Cohen, Harsh, Smith 2002 technique). We also used encapsulation with molten wax droplet technique (Cohen, 1983), and we also created films from coatings of alginate (activated with calcium) and chitosan (activated with acetic acid). All the film-coatings were attractive to the *S. tsugae*, but the Parafilm and wax droplets were not attractive and elicited almost no feeding. We are continuing to work on improvements of the packaging techniques, using improved wax mixtures that are softer and thinner, and we are undertaking tests with spray encapsulation with alginate, chitosan, and wax mixtures. We are also making further exploration of making the diet itself more attractive and nutritive by using fermentation technology coupled with our existing diet technology and volatile attractants to formulate field manipulation (attraction, retention, and nutrition).

INTRODUCTION

Development of artificial diets for predators of hemlock woolly adelgids (HWA) would be a very important aid in management of HWA because mass rearing programs for adelgid predators are often impeded by the lack of fresh, high quality food sources for their predators. Therefore, an artificial rearing system for the predators, including a suitable artificial diet would help offset costs and losses of predator stock. We have been engaged in development of artificial diets, and we have succeeded in developing two relatively successful diets based on chicken eggs and supplementary materials. Though we have not been able to successfully rear the predators through their entire life cycle, we have been able to sustain adult predators for several months free of natural host materials (HWA). This was considered a breakthrough, but our diet delivery system where we used gelling materials such as alginate did not have a suitable shelf-life. Therefore, we undertook a research project on a diet packaging/presentation system. We used several existing systems and some novel ones that have not been used previously with arthropods.

MATERIALS AND METHODS

We used several film/membrane systems to coat proprietary formulations known as FDFE3 and F100 as follows: 1. sodium alginate (1% added to the diets and activated to form a skin or artificial cuticle on its surface) 2. chitosan (1% added to diets and activated to form a film or skin with 20% acetic acid), 3. Parafilm stretched by hand and with various pointed implements (as described in a US patent by Cohen et al. 2003), 4. semi-liquid cells coated with various wax mixtures, including soft dental wax, beeswax, paraffin, and petroleum jelly mixtures heated in a Reacti-therm hot plate and dipped onto Parafilm sheets (Cohen 1983). We also presented the insects (*Sasajiscymnus tsugae* and *Laricobius nigrinus*) with diets that were not packaged with coatings or films. We also used diets suspended in honey with no film after freeze-drying the diets then combining them with honey.

RESULTS

All diets were accepted by both species of predators, with the highest acceptance (> 90%) for the uncovered diets and for those with films of alginate or chitosan. The lowest acceptance was with the wax-encapsulated diets (< 5%) and Parafilm-covered diets (< 20%). The diet coatings that gave the best protection from desiccation and oxidation of diets were the wax encapsulations (which lasted more than 10 days without drying out or discoloring) and the Parafilm, which gave equal protection to the diets. All of the chemical film diets (alginate and chitosan) and uncovered diets quickly dried out and became discolored within 24 hours. We did find that the diet coatings without protection against desiccation could be rehydrated with addition of fresh water. However, addition of water caused acceleration of the onset of mold. One of the best behavioral responses was with diets suspended in undiluted honey.

DISCUSSION

We found such extensive acceptance of the diets that were uncoated, suspended in honey, or coated with thin alginate or chitosan films that we are optimistic about our progress with artificial diets. The lesser acceptance of the diets coated with artificial membranes or wax encapsulation media was less encouraging in terms of our ability to maintain colonies with minimal labor which would be involved with changing the diet every two days. However, the most encouraging aspects of this work are the prospects of our being able to use the diet formulations in situations when suitable field-collected adelgids are not available, but when our colonies of predators are still active and need some source of nutrition. This success has also suggested the possibility of using the diets under field conditions to sustain predator populations in off seasons so that when the adelgids again become active, we can have healthy, robust predators that are in adequately healthy condition to begin control of HWA populations. This work suggests that the artificial diets along with appropriate packaging systems and delivery systems for the diets can help make predators more available to forest managers who rely on robust, active predators of HWA.

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