MANAGING INDIAN MEAL MOTH POPULATIONS BY COMPROMISING LARVAL GROWTH

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Managing insect populations that infest stored cereal products has become a greater challenge today than previously because pesticide usage is more restrictive. The search for environmentally safe alternatives is the focus of research in many laboratories around the world. In our laboratory, we are seeking new approaches based upon the insect's behavior and physiology. The focus of my work has been directed at identifying dietary factors that affect Indian meal moth growth on different processed cereal products. The growth and development of this moth is largely dependent upon the cereal product providing the nutrients. Some of the products we examined were considered nutritious as part of a more complex human diet, but were not equally nutritious for this moth when serving as their sole nutrient source.

Thus, managing moth populations infesting stored products by designing processed products that would restrict insect growth without compromising the product's nutritional value for humans was worthy of investigation. Ideally, the most desirable objective would be the prevention of the insect's growth; but, even decreasing the growth rate could be effective if it reduced the severity of the infestation and decreased the frequency needed for pesticide intervention.

The physical characteristics of a cereal product can limit nutrient availability for larval growth. For example, Indian meal moths and other flour moths, infest only the broken or damaged grain kernels because they are unable to chew through the pericarp on the intact kernel. It is the nutrients located in the grain's germ and bran that are required for growth of these moth larvae. In most processed cereals this natural barrier to infestation is lacking because the integrity of the pericarp is removed either by crushing or grinding the grain which exposes the nutrients for ingestion by moth larvae.

In our initial studies, we observed that Indian meal moths grew slower on wheat germ (their preferred nutrient source) than they did on the standardized oligidic diet (*Plodia* diet) we used for rearing test insects. We subsequently found that glycerol stimulated larval growth on wheat germ in a dose responsive manner and that wheat germ supplemented with about 25% glycerol (w/w) performed as well as *Plodia* diet. We concluded that the growth of Indian meal moth larvae relies upon both, biosynthetic activities such as lipid synthesis and water uptake, to increase larval size and weight. The biosynthetic activities are tightly coupled to the simultaneous uptake of water so that the water content in the developing larval tissues is maintained at a constant level. The function of glycerol in

stimulating growth is two-fold, it provides precursors for triglyceride synthesis in larval tissues and it's hygroscopicity increases the dietary water content which augments its uptake into larval tissues.

Since the growth rate of larval Indian meal moths is tightly coupled to the availability of dietary water, then the suppression of larval growth by limiting the moisture content of stored cereal products could be part of an effective control strategy. This could be accomplished by maintaining a dry storage environment since the moisture content of the cereal is in equilibrium with the r.h. in the surrounding air. A dry storage environment would reduce the insect damage to cereal products by slowing larval growth, reducing the number of generations per year and lowering the amount of product consumed.

Our current nutrition studies are focused upon managing Indian meal moth populations that infest processed cereal products during the storage and marketing period. We should be able to design cereal products that are nutritionally inadequate for moth growth without compromising the nutritional value for man and animal. Kellogg's corn flakes is one example of a product in the marketplace that has this type of nutritional dichotomy.

We have observed that adult Indian meal moths are attracted to corn flakes for oviposition. The eggs hatch, but the newly hatched larvae do not survive unless *Plodia* diet is added to the corn flakes after oviposition. This indicated that a nutrient(s) vital for Indian meal moth development was lacking in this processed cereal. We subsequently demonstrated that Brewer's yeast could provide this nutrient(s).

Brewer's yeast has been extracted and the active nutrient(s) has been recovered in the extraction components. Two fractions have been isolated that have growth promoting activity when added to corn flakes. Each fraction has limited activity when added to corn flakes separately, but when both fractions are added together, the growth rate is restored to that observed with unfractionated Brewer's yeast. We are currently purifying the two fractions so that the active components can be identified. After identifying the active components, we will assess the usefulness of this information for application in designing new cereal products that resist moth infestation.