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Protecting Dried Fruits and Vegetables Against Insect Pests Invasions During Drying and Storage

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Abstract

Knowledge of the species and habits of insect pests that damage to dried fruits and vegetables gives a basis for planning control programs. The possibility of this paper is to report on insect species involving to damage stored dried products and deals with some of control measures to get rid of losses. Dried fruits and vegetables are one of the techniques of preserving food for later use, and it can either be an alternative to canning or freezing, or compliment of these methods. Drying foods is simple, safe and easy to learn, and drying removes moisture from food so bacteria, yeast and mold cannot grow and spoil food. Although consumers get higher fiber and more potassium with dried foods, yet these are also more calorie-dense, and sweet and healthy snack on their own. Insects infesting stored dried fruits and vegetables are one of the most common household pest problems. Nearly all dried food products are susceptible to insect infestations, including dried fruit and vegetable products. Dried food product pests are often discovered when they leave infested foods to crawl or fly about the house and most peoples find the contaminated products unfit for consumption. The infestation of these dried fruits and vegetables leads to loss of quantity, quality and market value. Adoption of modern drying technologies, occasional re-drying, good packaging and storage facilities coupled with good market structures can reduce losses of these valuable crops. The first line of defense against insect pests is good management during production, second is careful harvesting and preparation for market in the field, and thirdly sorting out damaged or decaying produce can limit contamination of remaining healthy products. Yet, even when the greatest care is taken, sometimes produces must be treated to control insects or decay-causing organisms. Use of insecticides within the storeroom area is not generally recommended and normally can give little additional control in the absence of an aggressive sanitation program. Some household formulations of pyrethrins are labelled for use as crack and crevice treatments near food storage areas. There are also some formulations of pyrethroid insecticides including bifenthrin, permethrin, and tralomethrin that allow general use in home and may help to manage insects that are widely dispersed. Often it is best to never apply insecticides in a manner that allows direct contact with food or food utensils, so, remove all food and utensils during insecticide treatment to avoid accidental contamination.

Keywords

Stored Products, Dried Fruits and Vegetables, Storage Insects, Pest Control

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1. Introduction

Before refrigerators and electricity, peoples used to preserve their food by removing its water or in other words, drying it. Earlier, in few areas the peoples preserved fruit by wrapping it in palm leaves and burying it in hot sand to dry. These days, there are ovens and dehydrators to get the job done easily. Not only does this lead us to enjoy fruits and vegetables all year long, but the dried products are portable and shelf-stable too. Dried fruits are more flavourful than fresh or frozen because everything i.e., their flavours, sugars and nutrients is concentrated. Dried fruits are unique, tasty and nutritious and drying foods allows to choosing the best, tastiest varieties for

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peoples that can be buy or pick fresh from the garden. Home drying also leads us to enjoy dried fruits and vegetables that the grocery stores do not carry, and the foods dried ourself cost a lot less than the ones that is purchased. Foods can be dried in an electric dehydrator, in the sun, in a solar dryer, or in a regular oven by using the right combination of warm temperature, low humidity and air current. In drying, warm temperature causes the moisture to evaporate and low humidity allows moisture to move quickly from the food to the air. Air current speeds up drying by moving the surrounding moist air away from the food (Degri and Zainab, 2013)

2. Dried Fruit and Vegetable Products

Thousands of dried fruits and vegetables products are available for delivery and pickup by consumers from various markets.

2.1. Drying Fruits

The high-quality fruits make the best dried products. The major dried fruits commonly used and marketed are dried apples, apricots, cherries, figs, mandarins, melons, nectarines, peaches, persimmons, plums, jumbos, coconuts, mulberries, pomegranate seeds, chia seeds, swater melons, olden berries, papayas, mango slices, blueberries, chilies, cranberries, dried bananas, pears, olives, tamarind, prunes, currants, raisins and guava slices. Choose firm, fully ripped fruit that is heavy for its size and process them immediately because fruit ready for drying is very fragile. Use overripe or bruised fruits in other ways, for example, as fruit leathers. Grapes are grown on a trellis and need special care to ensure the right balance of shade and sun. To turn them into raisins, the grapes are dried in a tray, which takes up to 21 days, or on a vine, which takes six to eight weeks. For drying, fruits can be cut in half or sliced and some can be left whole (Marilyn and Sandra, 2003).

2.2. Drying Vegetables

The major dried vegetables normally used and marketed are mixed dried vegetables, cabbage, carrot, ginger, potato chips, kale chips, chill pepper, tomato, bell-shaped pepper and okra. Vegetables for drying should be fresh, tender and just mature. Avoid drying immature vegetables because their color and flavor tend to be weak or poor. Also avoid excessively mature vegetables, which are inclined to be tough, woody, or fibrous. For the best quality and nutrition, dry vegetables as soon as possible after harvest. Vegetables, on the other hand, are a little harder to find and most grocery stores can carry sun-dried tomatoes and an assortment of dried mushrooms. Dried vegetables further include dried eggplant, zucchini, cherry tomatoes, red bell peppers, pumpkin and more. Vegetables can be preserved by drying, because these contain less acid than fruits, and vegetables are dried until they are brittle. At this stage, only 10% moisture remains and no microorganism can grow (Marilyn and Sandra, 2003).

Nearly all dried food products are susceptible to insect infestations and foods of any age can become infested. Dried food products can become infested with pests anywhere during the process from production to arrival at home, however, dried stored food is most likely to become infested in stores or in homes. Most of the stored grain insects also are pests of dried fruits and vegetables or other commodities. Wherever dried fruits are produced, their chief insect pests are the same species and these have been distributed by commerce, probably for several thousand years. Losses caused by insects in dried fruits are difficult to estimate and the loss of weight from insect feeding is usually trivial. The most serious loss is in appearance and quality, which lowers or destroys market value. Also, the presence of insects or any other foreign material in dried fruit is objectionable to consumers. Thus, it is insisted that dried fruits should be prepared in a sanitary manner, and regulations are strictly enforced. Other losses from insects in dried fruits include the cost of construction and maintenance of facilities for fumigation, the cost of fumigants, and the expense of applying them. Insects are chiefly responsible for the wastage involved in culling out damaged dried fruit, the costs of screening and washing of fruit, general plant sanitation, and cold storage. Special packages designed to resist and exclude insects further add to the expense. Major insect pests that are associated with stored dried fruits and vegetables include confused flour beetle (*Tribolium casteneum* Heb.), rust red grain beetle (*Cryptolestes ferugineus*) Steph., cadelle (*Tenebroides mauritanicus* L.), khapra beetle (*Trogoderma granarium* Eve.), drugstore beetle (*Stegobium paniceum* L.), coffee bean weevil (*Araecerus fasciculatus* (Deg.), spider beetle (*Ptinus tectus* Boield), cigarette beetle (*Lasioderma serricorne* F.), *Ephestia elutella* Hubn.), Indian meal moth (*Plodia interpunctella* Hubn.), flour mite (*Tyroglyphus farinae* L.) and Sitophilus spp., (Lale, 2002; Walter, 2002; Williams et al., 2002).

3. Insects on Dried Fruits and Vegetables

A number of moths, beetles and to few extent flies are important pests of dried fruits, although some of them may be equally or even more important as pests of nuts, cereals, and other stored products (Simmons and Howard, 1975; Mound, 1989; Lewis, 1995; Okunade et al., 2001; Degri, 2007; Linda and Timothy, 2008).

3.1. Dried Fruit Beetles

There are several species of beetles that are problematic to growers and they have distinguishing features that make them severe pests, Dried fruit beetles are members of the certain insect family like Nitidulidae, a beetle known for its wide host range and willingness to chew on many different garden fruits and vegetables. These pests are tiny, with elongated bodies and short clubbed antennae. Adults are typically brown or black, some bearing yellow spots on their backs. The larvae of the dried fruit beetle resembles a tiny grub, with a tan head, white body and two hornlike structures coming out of its end. Adult beetles are active feeders and damage dried fruits even more than their larvae because some of them live longer in the adult stage. All of the principal species, except sawtoothed grain beetle, infest commodities by flying or crawling into storage buildings or by being carried in with dried fruits.

3.1.1. Sawtoothed Grain Beetle *Oryzaephilus surinamensis* (Linnaeus)

The adult sawtoothed grain beetle family Silvanidae, is chocolate brown and has six tooth like projections along each side of the margin of the body in front of the wings. It is a general feeder and in raisins stored this insect can become very abundant. It's both larvae and adults attack grain, cereal products, nuts, copra, dried fruits, botanical drugs, tobacco, candy, dried meats, other commodities, and even unrefined sugar.

3.1.2. Darkling Beetle *Blapstinus rufipes* Casey

Blapstinus species of darkling beetle is a dull-black, somewhat flattened and these congregate on ripe figs that have fallen to the ground or may be completely cover a fig. These beetles attack tender plants, girdle young bell pepper plants at the soil surface, and attack young plants of sugar beet, lima bean, and tomato.

3.1.3. Hairy Fungus Beetle *Typhaea stercorea* (Linnaeus)

It is a polished, brown, elongate-oval beetle and body is well covered with short and fine hairs. This is common in moldy dates lying on moist soil and in moldy raisins, and other foods eaten by this species include stored grain and seeds, tobacco and cacao.

3.1.4. Dried Fruit Beetle *Carpophilus hemipterus* (Linnaeus)

Adults of dried fruit beetle are black and with two amber-brown spots on each wing cover, one nears the tip and a smaller one at the outer margin of the base. Larvae when fully grown are white or yellowish, head and the rear end of the body are amber-brown, sparsely hairy, and have two prominent spine like projections at the tail end, with two smaller ones in front of them. The adults and larvae are among the chief pests of ripening and drying figs, and may be found in fruit dumps, rotting melons, stick-tight pomegranates, dropped peaches, plums, citrus fruits, cull figs, and moist raisins.

3.1.5. Corn Sap Beetle *Carpophilus dimidiatus* (Fabricius)

The adults of this species resemble dried fruit beetles, but have no spots, and their color ranges from brownish-yellow through brown to black tinged with red. They are very common in cull grapefruit and in cull dates. Among their host foods are apple pomace, rotten watermelons, stored peanuts with split hulls, inferior copra, sago flour, coarse bran, and nuts. Corn sap beetles are particularly fond of developing ears of sweet corn that have been damaged by insects or birds.

3.1.6. Yellow Nitidulid *Haptoncus luteolus* (Erichson)

These beetles are shorter than the dried fruit beetle or the corn sap beetle and have a blunt shape and are yellowish brown. Their food is the same as that of the dried fruit beetle and the corn sap beetle.

3.1.7. Pineapple Beetle *Urophorus humeralis* (Fabricius)

Pineapple beetles are shiny black and more numerous in date gardens than in the fig orchards and feed in bunches of dates ripening on the palms, pineapple fields, damaged sugarcane seed pieces underground, and abundant in waste grapefruit.

3.1.8. Lead Cable Borer *Scobicia declivis* (LeConte)

Lead cable borers are cylindrical, dark-brown or black beetles, develop in dead parts of trees and are attracted to the fermenting dried fruits.

3.1.9. Date-Stone Beetle *Coccotrypes dactyliperda* (Fabricius)

The date-stone or button beetles are minute, cylindrical, shiny, and dark brown and are common in seeds of waste date, infest sweet almonds, hard seeds, betel nut, nutmeg and cinnamon bark.

3.1.10. Rusty Grain Beetle *Cryptolestes ferrugineus* (Stephens)

The rusty grain beetle *Cryptolestes ferrugineus* (Stephens) of the family Laemophloeidae, prefers raisins that have been damaged by rain and have become moldy, and infests dates both in the field and in storage. This very small cosmopolitan beetle is usually found in stored grain and other foodstuffs

and under the bark of trees. It can also be found in stored fruits, and is sometimes the dominant species in moldy ones, and the adults frequently infest fallen, moldy, drying fruits, particularly figs.

3.1.11. Merchant Grain Beetle *Oryzaephilus mercator* (Fauvel)

The merchant grain beetle is similar in appearance, life history, and habits to the sawtoothed grain beetle, but in *O. mercator*, the length of the temple (the region directly behind the eye) is less than half the vertical diameter of the eye, while in *O. surinamensis*, it is greater than half of that dimension. It is capable of flight and has been found in waste dates, date gardens, and in cull figs, but mostly in recessed cereals (rolled oats, rice, flour, cake mixes, macaroni and cookies). In addition, it is found infesting nuts, coconut, and candy bars made with peanuts and puffed rice. It is found most frequently in imported commodities, those most often infested are copra, peanuts, and cashews, confirming that *O. mercator* is chiefly associated with oil bearing seeds.

3.1.12. Cigarette Beetle *Lasioderma serricorne* (F.)

The adult beetle is light brown, small, oval, and about 3 mm long. In common with other anobiids, the ptinids, and the bostrichids, the head and prothorax are bent downward so as to give the insect a strongly humped appearance. It has occasionally been confused with the drugstore beetle (*Stegobium paniceum*), but *L. serricorne* has serrate antennae and smooth elytra, whereas in *S. paniceum* the last 3 antennal segments are long and broad, forming a distinct 'club' and the elytra are striate. The full-grown larvae are about 4 mm long, curved, hairy and pupate in silken cocoons covered with bits of foodstuffs. This beetle is considered to be the most destructive pest found in stored tobacco, but it also has the reputation of attacking a wider range of foods than any other storage pest. Based on the records of many investigators, plant materials attacked by the cigarette beetle include, aniseed, areca nuts, wheat produce, bamboo, beans, biscuits, cassava, chickpeas, cigars, cigarettes, cocoa beans, coffee beans, copra, coriander, cottonseed (before and after harvest), cottonseed meal, cumin, dates, dried banana, dried cabbage, dried carrot, dried fruits, drugs, flax tow, ginger, grain, herbs, herbarium specimens, insecticides containing pyrethrum, juniper seed, licorice root, paprika, peanuts, rhubarb, rice, seeds of various trees and plants, spices, and yeast. It also breeds in animal matter, such as dried insects and dried fish, fishmeal, and meatmeal, and has been recorded attacking leather, stored wax, furniture stuffing, and may incidentally damage cloth, upholstery, paper, and books.

3.1.13. Drugstore Beetle *Stegobium paniceum* (L.)

The adult is cylindrical, color is uniformly reddish to reddish brown and very fine hairs are arranged in longitudinal rows on the elytra. This cosmopolitan species resembles the cigarette beetle, and rivals it as a pantry pest. The drugstore beetle can be distinguished from the cigarette beetle by the distinctly striate elytra, the 3 enlarged segments at the tips of the antennae, and by the less hairy larva. When comparing the 2 specie, the sides of the pronotum of the cigarette beetle are more uniformly rounded than those of the drugstore beetle. The drugstore beetle resembles even more closely with another anobad, the furniture beetle *Anobium punctatum*, which also has striate elytra and a 3-segmented antennal club. However, the front margin of the pronotum of the drugstore beetle is much more rounded than that of the furniture beetle, which is more squared off (truncate). There is also a close resemblance in the appearance of the larvae, although that of the drugstore beetle is less hairy. It feeds on any of the household foods and spices, as well as wool, hair, leather, horn, museum specimens, and drugs. It has been known to perforate books and wooden objects, and even tin or aluminium foil and lead.

3.1.14. Tobacco Moth *Ephestia elutella* (Hubner)

The adult moth has brownish gray forewings, crossed with 2 oblique, light-colored bands, while the hindwings are uniformly gray. The mature larva is creamy white, tinged with yellow, brown, or pink. This cosmopolitan pest of stored tobacco is also a pest of cereals, chocolate, cocoa beans, coffee, cottonseed, dried fruits, flour, nuts, seeds and spices.

3.1.15. Miscellaneous Beetles

The *Cryptophagus laticollis* Lucas, a member of the family Cryptophagidae, is found in raisins in storage. The two spider beetles of the family Ptinidae, *Trigonogenius globulus* Solier and *Ptinus gandolphei* Pic, infest raisins. A considerable numbers of darkling ground beetles (Tenebrionidae), for example *Blapstinus dilatatus* LeConte and *Blapstinus sulcatus* LeConte, *Apsena rufipes* (Escherich) and *Cnemeplatia sericea* Horn, at times are very numerous on both raisins and fallen figs. The confused flour beetle *Tribolium confusum* Jacquelin duVal, and the red flour beetle *Tribolium castaneum* (Herbst), are sometimes found in dried fruits. Several beetles of the family Dermestidae that are found in dried fruits are *Trogoderma variabile* (Ballion), *T. simplex* Jayne, *T. sternale* Jayne, and the black larder beetle *Dermestes ater* DeGeer. A beetle of the family Curculionidae, *Dinocleus capillosus* Csiki, is abundant in vineyards and later in the boxed raisins. The species of beetles uncommonly found in figs include the foreign grain beetle *Ahasverus*

advena (Waltl), and the fruit notoxus *Notoxus calcaratus* Horn. In dates, several other species of Carpophilus occur sparsely, including *C. obsoletus* Erichson and *C. decipiens* Horn. Other species taken during dried-fruit insect research include *C. discoideus* Lecanto, *C. marginalia* Motschulsky, and the dusky sap beetle *C. lugubris* Murray. A few species of beetles like *Plochionus pallens* (Fabricius) member of the predaceous beetle family Carabidae, found in raisin storages do not feed on the fruit, but on other insects that may be present. A species of dermestid beetle *Trogoderma inclusum* LeConte, has been found in raisins that contain remains of dead insects and unlikely feeds on dried fruits.

3.2. Dried Fruit Moths

Among the moths that are found in dried fruits, none of their adult moths can feed, though they do drink liquids such as plant nectar, and the damage is done while these are in larvae stage. These insects live and develop primarily out-of-doors, although they are often brought into storages with infested commodities.

3.2.1. Raisin Moth *Cadra figulilella* (Gregson)

These are small gray moths formerly known as *Ephestia figulilella*, when at rest it is with its wings folded. The forewings are grayish and the hindwings are satiny white. Both pairs have a prominent, satiny fringe. The full-grown larvae are white, with 4 rows of purple spots along their backs and attack all the usual varieties of drying and dried fruits, fallen figs, and damaged or moldy clusters of grapes on the vines. Raisins are attacked until they become too dry. Cottonseed cake, cacao beans and cashew kernels are among the other host foods. Fallen mulberries are important because they are available to the insects early in spring when other food is scarce.

3.2.2. Dusky Raisin Moth *Ephestiodes gilvescentella* Ragonot

This species resembles the raisin moth in size and appearance, but both the adults and the larvae are darker. Their food and habits are, as far as known, the same as those of the raisin moth.

3.2.3. Indian Meal Moth *Plodia interpunctella* (Hubner)

Indian meal moths are attractively marked insects, the outer two third of the forewings is reddish brown with darker markings, the inner part of the wings is gray and there is a coppery band between the two contrasting areas. This is one of the commonest of storage insects and the newly hatched larvae are usually dull white but may become yellow, pink, or greenish. It has an extensive food list which includes grain, nuts, chocolate, cornmeal, flour and beans. In the field, it infests drying and dried raisins, waste fruits, and fruit refuse, including mulberries, cherries, apricot pits, peach pits, and some dates are infested on the palms.

3.2.4. Almond Moth *Cadra cautella* (Walker)

This species resembles the raisin moth but is much less abundant on dried fruits. The life history of the almond moth resembles that of the Indian meal moth and its food list is long including cereals, beans, dried fruits, flour, grain, seeds and nuts.

3.2.5. Dried fruit Moth *Vitula serratilineella* Ragonot

The adults of the dried fruit moth are mottled gray and they have been collected from stored figs, raisins, prunes and when large tonnages of raisins are stored.

3.2.6. Dried Prune Moth *Aphelia glares* (Zeller)

Its larvae are capable of serious damage, and when fully grown produce considerable webbing and coarse excreta. In addition to prunes, the larvae infest peanuts and honeycombs, and are of considerable importance as pests of walnuts.

3.2.7. Navel Orangeworm *Amyelois transitella* (Walker)

Navel orangeworm moths are silver gray with forewings marked with irregular black patterns. Besides oranges, almonds, walnuts and figs, the food list of navel orangeworm larvae includes damaged lemons, fallen dates, dates on the palms, Valencia oranges, jujubes, loquats, mummified peaches, prunes, quinces, apples, apricots, nectarines, pecans, pomegranates, and seed pods of honey-locust, carob, bottle tree, and yucca.

3.2.8. Mediterranean Flour Moth *Anagasta kuehniella* (*Ephestia*) (Zeller)

The larvae of this species infest dried fruits and leave their webbing. As with the Indian meal moth, they crawl away from the food to construct pupal cocoons, but usually near the infested product. They may also migrate to other parts of the pantry or kitchen, or even elsewhere in the house.

3.2.9. Stored Nut Moth *Aphomia gularis* (Zeller)

The forewings are light yellowish brown, and the hindwings are lighter. The thorax, abdomen, and legs are of the same basic color as the forewings. This moth occurs principally in peanuts, prunes, larval food appears to be limited to seeds, flour, nuts, walnuts and dried fruits because nuts do not form its only diet.

3.3. Dried Fruit Flies

Certain flies may originate in crops while plants are still green, while other can infest at larvae stage to stored products at any time before final use.

3.3.1. Vinegar Flies *Drosophila melanogaster* Meigen

These are small, clear-winged flies with bright-red eyes and a shining black abdomen, the first three segments of which have a yellow band, and are common wherever damaged or overripe fruit and vegetable garbage accumulates. These flies are attracted to fermenting fruit waste, melons, piles of peach and apricot pits, damaged grapes, tomatoes, or other fruits. They are common in wineries and in and around tomato and fruit canneries. Cull-fruit dumps on farms and along roadsides may be seen swarm with vinegar flies.

3.3.2. Soldier Fly *Hermetia illucens* (Linnaeus)

Soldier flies are black, two-winged insects that resemble some of the four-winged mud-dauber wasps in color, size, and in the habit of flitting their wings as they walk about. The brownish, flattened and tough skin larvae or maggots, feed in accumulations of rotten fruits that are dried out, decayed and black. Sometimes, they damage honeybee colonies by feeding on wax, pollen and honey.

3.3.3. House Fly and Blow Flies

The most common fly's species are the house fly *Musca domestica* Linnaeus and several kinds of blow flies *Phaenicia coeruleiviridis* (Macquart), *Phaenicia sericata* (Meigen), and *Orthellia caesarion* (Meigen). These flies are not primary pests of the fruits, but drying fruit is sometimes subjected to contamination by these flies that come from barns, stables, or other nearby installations and may be a considerable nuisance.

4. General Notes on Inspecting Fruit and Vegetables

Before start of inspecting of fruits and vegetables, ensure to check the importing country requirements for inspection, have the correct inspection equipments, have the correct export compliance record, wear appropriate personal protective equipments, and have the current relevant instructional and reference. Inspect the inside and outside of the package for pests and contaminants (such as leaves, plant trash and soil). Different types of packaging require different handling techniques for fruits and vegetables. Do not roll pieces of produce on the inspection bench as a means of inspection. Use a magnifying lens when needed, especially for produce with sites that might harbour pests and disease (e.g., around calyces). Use higher magnification or cutting to verify anything detected during visual inspection. Examples of commodities inspected using this technique are dried apples, apricots, coconuts, currants, dates, figs, grapes, mangoes, peaches, pears, raisins, sultanas and tomatoes.

Occasional inspection of the transparent bags will reveal any insects that may help to prevent infestation of stored food products. Open inner packages, such as pun-nets, boxes or bags, to allow to properly inspect the package and produce. Inspect the inside and outside of the package, replace the plastic lining to repack produce as inspected and examine all recesses for insect pests and contaminants. If there is seen discoloration, lesions, scarring, puncture marks, stings, physical damage or rots, carefully cut open these areas to examine for internal pests. Use a conical cut, or cut small slices to progressively expose the site, to avoid damaging pest specimens. If necessary, use a hand lens to investigate possible infestations or to further identify pest or disease.

5. Stored Products Pest Treatment

The first step against insect pests is good management during production, the second is careful harvesting and preparation for market in the field, and thirdly sorting out damaged or decaying produce can limit contamination of the remaining, healthy produce. Yet, even when the greatest care is taken, sometimes produce must be treated to control insects or decay-causing organisms (Krischik, 1995; Gerald and Frank, 2005; Sarwar, 2010; 2013; Sarwar et al., 2013).

5.1. Prevention

Usually, try to purchase dried foods in quantities small enough to be used up in a relatively short period of time, and use oldest products before newer ones and opened packages before unopened ones. Before buying, inspect packages or bulk products, packages should be sealed and unbroken, look for evidence of insects, including holes in the packaging or wrapping, and also check the freshness packaging date. Items infested by insects that live within the food (beetles, flour beetles or Indian meal moth) should immediately be discarded or temperature treated to kill the insect.

Washing produce with chlorinated water can prevent decay caused by bacteria, mold and yeasts on the surface of produce. Calcium hypochlorite (powder) and sodium hypochlorite (liquid) are inexpensive and widely available. Fruits and vegetables can be washed with hypochlorite solution (25 ppm available chlorine for two minutes) then rinsed to control bacterial decay. Alternatively, these commodities can be dipped in hypochlorite solution (50 to 70

ppm available chlorine) then rinsed with tap water for control of bacteria, yeasts and molds.

5.2. Detection

Before any control methods can be applied, the source of the infestation must be found. The physical presence of the insects is the most obvious means of detecting areas of infestation and also looks for old cast skins left by flour beetles. The presence of webbing is an easy means to detect items infested by Indian meal moth. This always requires looking into all cracks and crevices where food debris may be, and checking inside containers of cereal, beans, peas, flour, dried fruits, and other similar foods. Pet foods and birdseed may be a source of infestation. Also, a sealed container may be infested on the inside and be loose enough for an insect to escape. There are other several ways to become aware of a stored product infestation, when a small beetle is found in susceptible food; it is a product that is a sure sign of a problem. It is also common to find stored product beetles on counters and in cupboards, and in some cases, the beetles are attracted to light and may be found around windows. The Indian meal moths may be found flying around kitchens and other rooms. As caterpillars move away from infested food to pupate, they can be found on walls and ceilings in rooms adjacent to infestations. When examining food packages, only caterpillars may not be found, but silk webbing inside infested packages may be present.

5.3. Pest Elimination

The source of a stored product pest infestation in a home is usually confined to areas where foods are stored. The entire infestation may be within a single cabinet or single box of foodstuffs. When food is found that is infested, just throw it away and after the infested materials are removed, the contents of drawers and cupboards in the area should be removed and thoroughly vacuumed. A spray treatment can now be applied to all cracks and crevices in the area and items can be replaced once the product is completely dry. Control of storage insects in dried fruits and vegetables can be achieved by freezing, cold storage (less than 5 ^{o}C or 41 ^{o}F), heat treatments, or the exclusion of oxygen (0.5% or lower) using nitrogen. Packaging in insect-proof containers is needed to prevent subsequent insect infestation (Barkai-Golan and Phillips, 1991).

5.4. Insecticides

Generally, insecticide sprays are not recommended for controlling insects in stored food, however, residual sprays of 2% chlordane, 2% malathion, 1% diazinon, or 0.5% lindane because of their low mammalian toxicity are generally effective when applied on shelf surfaces, and thoroughly treating all cracks and crevices.

6. Storage Environment

An ideal storage area for dried food is cool, dark, and dry conditions, so, the cooler the storage area, the longer the shelf life. Dark areas are ideal because light fades fruits and vegetables and decrease their vitamin A and C contents. The storage area need not be fancy, a dark, unheated closet or drawer works fine. Metal containers have the advantage of keeping their contents in darkness. Glass or plastic containers can be covered with a cardboard box, a barrel, or black plastic to keep light out. Many peoples store dried foods in the refrigerator or freezer, which keeps quality of product high. Postharvest heating using hot water or hot forced-air to kill or weaken pathogens can be used as a method for decay control in fresh fruits and vegetables.

The cold winter reduces ability of dried fruits insects to survive and to build up to large numbers in spring and early summer, so, freezing of the host can greatly reduce survival of pests. Dried fruit beetle prefers ripe and overripe fruits, as fruits dry these become less favorable, and when drying is complete the beetle finds them unsuitable. In contrast to the raisin moth, it prefers partially dried products. Thus, fruits folded in paper trays provide more protection from insects than the opened one. Normally, dried fruits have moisture contents above 10 percent level and insects find dried fruits attractive down to a moisture content of 10 percent, therefore, fruits should be dried to a level where insects could not exist on them.

7. Conclusion

Because dried fruits and vegetables can be kept for years and without refrigeration, these are ideal for customers who cannot get to the grocery store often or those who want to bump up the nutrition of the meals they already enjoy. Moths, beetles and flies are important pests of dried fruits, but of particular importance are the larvae of certain pyralid moths and the larvae and adults of nitidulid beetles. Some insect species infest fruits before it is harvested or while it is drying on trays. Others infest fruit principally or even entirely after it is completely dry and in storage or in packages. Because of the diverse feeding habits and mobility of pests such as beetles and moths, their controls must be taken place over a larger area of the home. Keep food storage areas clean, do not allow crumbs or spilled food to accumulate, remove and discard old, unused products and inspect the remainder. When it is known a stored product problem is present, be sure to examine all susceptible food as there could be more than one infested sources. When inspecting them, look at the

top surface of products with a flashlight or pour the package contents onto a cookie sheet. When there are older food products and it is not sure if these are infested, the products can be placed in the freezer at 0 degrees for at least 4 days or in shallow cookie sheets or pans in an oven at 130 degrees for at least 30 minutes. The low or high temperatures can kill any eggs or insects that may be present. If insects are infesting ornaments or decorations made with plant products or seeds, place the items in a freezer for at least four days. As a precaution against re-infestation, includes storing of susceptible foods in sealable glass, metal, or heavy plastic containers. As a routine precaution, materials suspected of having insects can be treated by freezing or heating after purchase.

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