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Controlled Atmosphere Storage Technique for Safe Storage of Processed Little Millet

[1]M.C. Vachanth, [1]K.M. Subbu Rathinam, [2]R. Preethi and [2]M. Loganathan

[1]PG and Research Department of Zoology,
Rajah Serfoji Govt. College (Autonomous), Thanjavur-613 005, Tamilnadu, India
[2]Indian Institute of Crop Processing Technology, Thanjavur-613 005, Tamilnadu, India

Abstract: The present study aimed to investigate the effect of various controlled atmosphere packaging (CAS) to red flour beetle, *Tribolium castaneum* in stored processed little millet. The raw and parboiled polished little millet were prepared and filled in High Density Polypropylene (HDP), Low Density Polypropylene (LDP), packs and Aluminium pouches. The adult red flour beetles were released in all the packs, flushed with combination of gases (35% CO_2, 52% N_2 and 13% O_2) and packed. The observations were made on the effect of gases and packs on the insects. The results revealed that high mortality (86%) of insects in parboiled than raw polished millet.

Key words: Modified atmosphere packaging · Stored product insect · *Tribolium castaneum* · Little millet

INTRODUCTION

Food distribution has undergone two major revolutions in the last century. However, energy crises, ecological awareness, infestation of storage insects, demand for healthy and fresh foods have created a need for a technology that allows distribution of fresh product around the years. Modified atmosphere storage technique practically, offers a possibility of meeting these requirements. In particular it plays a vital role in controlling the infestation of storage insects which is the major problem faced by the food industries[1,2].

Red flour beetle (*Tribolium castaneum*), the universal storage insect causes the main damage to stored food products. It is found in domestic or stored product premises and not in the wild. Typically, these beetles can be found not only inside infested grain products, but in cracks and crevices where grain may have spilled. They are attracted to grain with high moisture content and can cause a grey tint to the grain and produce a displeasing odor. All forms of the life cycle may be found in infested products at the same time. And thus it is a serious pest of stored grains and grain products, peas, beans, shelled nuts, dried fruits, millets, spices, chocolate, drugs, snuff, cayenne pepper, herbarium and museum specimens [3-8].

Millet is the generic name given to more than 6,000 species of wild annual grasses found throughout the world. Although its role has diminished, today millet ranks as the sixth most important cereal grain in the world. The major nutrient content of Millet was more when compare with other cereals, which contain 11% of protein (i.e. close to wheat). Millet also contains B vitamins, especially niacin, B6 and folic acid, calcium, iron, potassium, magnesium and zinc [9].

Controlled Atmosphere Storage (CAS) is also improves the product quality, freshness and increases the shelf-life of the product and adds value to the product. CAS is a process in which the normal atmosphere air inside the sealed package is replaced by a known gas or a mixture of gases. The principal factors for a successful storage are the choice of gas/gases and its effect on the product and the use of a suitable packaging material. The gases mainly used in CAS are O_2, CO_2 and N_2 [2, 10, 11].

The effect of low O_2 or CO_2 gas concentrations on insect mortality was demonstrated many years ago. A limit of about 2% O_2 has been indicating for the mortality of stored product insects so far tested. These findings provided the basis of the revived ancient method of hermetic storage [12, 13, 14]. However, the concentrations of low O_2 or high CO_2 needed for the control of different

Corresponding Author: K.M. Subbu Rathinam, P.G. & Research Department of Zoology, Rajah Serfoji Govt. College (Autonomous), Thanjavur-613 005, Tamil Nadu, India

stored product insect species differ widely [15, 16]. Significant progress has been made in recent years in using modified atmospheric gas concentrations for the control of stored product insects. Contributions in nitrogen atmospheres, high carbon dioxide concentrations or a mixture of these gases were efficient non-chemical control methods for the prevention of insect damage [17-19]. The atmospheric gas composition is one of the factors acting against on insects breeding in the grain bulk [20, 21]. Other environmental factors affecting the survival of insects found in bulk stored grain are temperature and relative humidity [22, 23]. Therefore, the efficient use of controlled atmosphere storage should require the careful consideration of data concerning these two factors, which in some cases could be modified to increase the efficacy of this control method [16,19,24-29].

Recently it has been reported that, 9% post harvest losses, due to insect and mite infestation worldwide, suggesting a need to make an over all effort to control these post harvest losses [7, 30]. The most conservative estimates for the post harvest losses in food grains in India even put at about 10%, a quantity good enough to feed at least 60 million people. Therefore, considering these storage problem raised by *Tribolium* species in processed millet and to increase its shelf life, the present study conducted for safe storage of little millet by using CAS.

MATERIALS AND METHOD

The little millet was soaked for overnight at 50°C hot water, steamed for 15 minutes and then sun dried. This parboiled little millet was polished using emery polisher. The raw little millet was also polished in emery polisher. Both the processed millets were taken about 25gm each in low density polypropylene (LDP), high density polypropylene (HDP), polypropylene (PP) packs and Aluminium pouches. There were 30 packs prepared in each type of packs. From the lab culture, adult red flour beetles taken and in each pack, ten numbers were introduced. These packs were flushed with gas combination of 35% CO_2 + 52% N_2 + 13% O_2 using a gas flushing machine. These packs were stored at room temperature for further observations on survival and mortality of insects. Two packs opened every day and observed for insect mortality.

RESULTS AND DISCUSSION

The present study revealed that infestation of insects in the grain storage, especially in processed little millet. Various packaging materials (HDP, LDP, PP and ALU pouches) were used to standardize the materials, which are suitable for safe the storage.

Effect of Combination of Gas on the Mortality of Adult *T. Castaneum*

Raw Polished Little Millet: The observation on the adult mortality of *T. casteneum* in different types of packs with the combination of 35% CO_2 + 52% N_2 + 13% O_2 gas observed high in the Aluminium pouches followed by HDP and in the LDP was very less. In aluminum pouch 100% adult mortality achieved on 12th day of storage. The mortality of insect was maximum of 40 and 20 % after storage of 15 days in HDP and LDP respectively. The retention of gas concentration in the packaging material is an important factor for the mortality of insects. Earlier report showed that the concentrations of low O_2 or high CO_2 needed for the control of different stored product insect species differ widely [7].

Parboiled Little Millet: When the parboiled little millet stored in aluminium pouches with a mixture of gas 35% CO_2 + 52% N_2 + 13% O_2, the mortality of the adult *T. casteneum* was cent per cent on 5th day itself. It was observed that the mortality of adult insect was maximum of 60 and 70 per cent in LDP and HDP respectively with the above gas concentrations. Earlier report showed that the atmospheres containing upto 36% CO_2 and 15% O_2 were lethal to *T. castaneum* adult's only after 10 days of exposure [31]. The high concentrations of CO_2 affect the growth and development of insects in grain storage [19]. The retention of gas in the storage for longer period depends on the permeability or retention of packaging material.

The parboiled little millet grain will not have the rancidity and also gelatinized during the process. Therefore, the insect feeding on these grains is difficult and reduces the development of insects. The factors involved in the mortality of insects are effect of processed grain, gas concentration and type of packaging material, which can retain the gas for longer duration. The combination of above factors responsible for control of insects can be used for the safe storage of processed little millet.

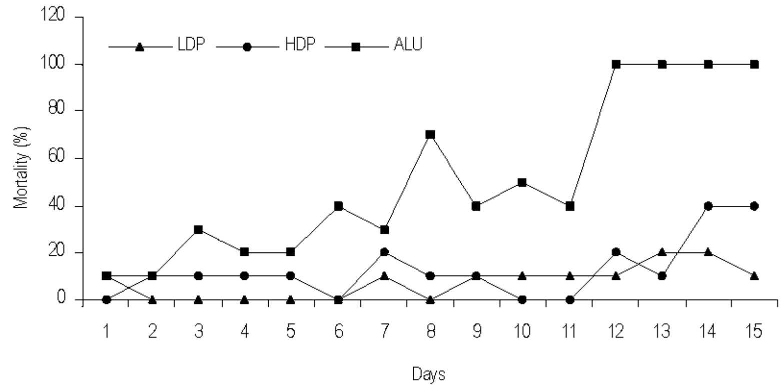

Fig. 1: Effect of gas mixture on the mortality of adult *T. castaneum* in LDP, HDP and ALU pouches packed with raw polished millet

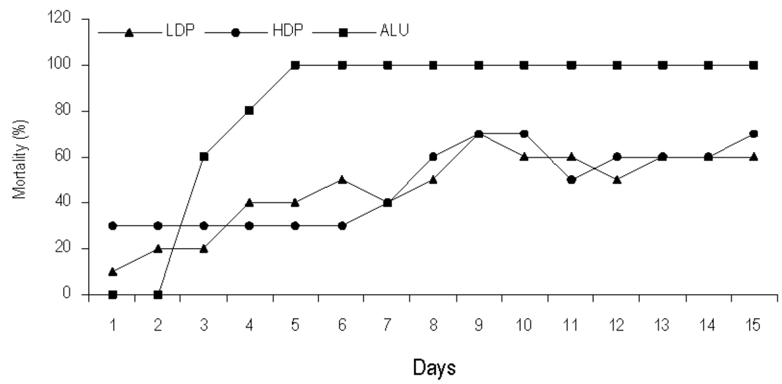

Fig. 2: Effect of gas mixture on the mortality of adult *T. castaneum* in LDP, HDP and ALU pouches packed with parboiled polished millet

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