Kasetsart J. (Nat. Sci.) 42 : 144 - 149 (2008)

Effect of Herb on Insect Growth in Brown Jasmine Rice During Storage

Safiah Saah[1]*, Supitchaya Chanthachum[1] and Jiraporn Petcharat[2]

ABSTRACT

Effects of 3 types of herb *Capsicum frutescen*s, *Curcuma longa* and *Citrus hystrix* on insect pest of brown jasmine rice packed in plastic LLDPE bag were investigated. Rice weevil, *Sitophilus oryzae* (L.) was found during 4 months period. Rice weevil population in the control sample of 137.0±4.08 adult/100g was much higher than the samples treated with *Citrus hystrix*, *Capsicum frutescen*s and *Curcuma longa* (56.0±3.27, 3.67±0.82 and 2.0±0.0 adult/100g, respectively). Total viable count (TVC) (6.84 logCFU/g) and yeast & mold (4.02 logCFU/g) of the control sample were more than herbs treated samples ((TVC≤ 4.31, yeast & mold ≤ 3.65 logCFU/g). Microbial changes of control sample steadily increased during 4 months while microbial count of herb treated samples decreased after 3 months as well as the change of rice weevil number. Color of brown jasmine rice steadily increased during 4 month storage.

Key words: insect, *Sitophilus oryzae*, brown jasmine rice, *Capsicum frutescen*s, *Curcuma longa*, *Citrus hystrix*

INTRODUCTION

Brown rice is a nutritionally valuable food source and superior to white rice. It has higher percentage of all nutrients except carbohydrate (Kester, 1951; Kenned, 1980). Thiamine and oil contents of brown rice are approximately five times that of white rice while fiber, niacin, phosphorous, potassium, iron, sodium, and riboflavin contents are approximately 2-3 times greater (Champagne and Hron, 1992). The bran layers that are milled from brown rice to obtain white rice account for the higher nutritive content of brown rice. These bran layers also have cholesterol reducing properties (Kahlon *et al*., 1989; Hegsted *et al*., 1990). However, the use of brown rice has been limited because the oil in the bran is susceptible to rancid, leading to shortened shelf-life (about three to six months) due to off-flavors. Stored brown rice can have losses in both quantity and quality. Losses occur when the brown rice is attacked by stored product insects and microorganisms (Neethirajan *et al*., 2007). Insects are not only the cause of grain damage but also becomes the source of contamination. The body parts are considered as the filth of brown rice. Major insects infesting stored rice include the rice weevil (*Sitophilus oryzae* L.), lesser grain borer (*Rhyzopertha dominica* F.) and confused flour beetle (*Tribolium confusum* J.). Insects produce heat and moisture due to their metabolic activities that can lead to the growth of microflora and the

1 Department of Food Technology, Faculty of Agro-industry, Prince of Songkla University, Songkla 90110, Thailand.
2 Department of Pest Management, Faculty of Natural Resource, Prince of Songkla University, Songkla 90110, Thailand.
* Corresponding author, e-mail: safiah055@yahoo.com

development of hotspots in rice (Neethirajan *et al*., 2007). Lucas and Riudavets (2000) reported that brown rice (not polished), white rice (infested then polished or polished then infested) were used with different polishing process intensities and different initial weevil densities. Weevil progeny were more numerous in brown than in white rice. The objective of this study was to extend shelf-life of brown rice by application of herbs: *Capsicum frutescen*s (L.), *Curcuma longa* (L.) and *Citrus hystrix* (DC.) for controlling or inhibiting insect pests in brown rice during storage.

MATERIALS AND METHODS

Herb samples preparation

Mature leaves of *C. hystrix,* fruits of *C. frutescens* and rhizomes of *C. longa* were purchased from the local Songkla plaza market. The herbs were cleaned and the rhizomes of *C. longa* were cut into small pieces before drying. Herbs were dried in an oven at 45-50°C for 12-15 h to obtain 5-7% moisture content and kept in dark bottle at room temperature (28°C).

Rice sample

One hundred kilograms of brown jasmine rice were purchased from the local farm in Pattalung province. They were dehulled by local machine and these samples were free of insect infestation. The rice was weighed and then packed into plastic (LLDPE) bag, each bag contained 100 g of rice mixed with 2g of herbs. The bags were placed at room temperature (28°C) for four months. Triplicate samples (100g of rice) were withdrawn for analysis at an initial period and every month interval for 4 months. Storage trials were designed as completely randomized with 4×5 factorial in completely randomized design. The factor A was herb treatments: C. *frutescen*s, C. *longa*, C. *hystrix* and control (no herb). Factor B was storage times (0-4 months). Samples were analyzed for species of insect, insect population, microbe and color.

Detection of species and population of insect pest

Triplicate samples (100g of rice) were taken at each period to investigate insect infestation. Insect species and their population were obtained by counting under microscope. Each treatment was run in triplicates and the data were presented in terms of the mean±SD.

Microbiological analysis

Total viable count (TVC) and yeast & mold occuring in the brown jasmine rice were determined according to the method of A.O.A.C (1999).

Color analysis

The color (L* a* b*) of brown jasmine rice was determined by Hunter lab model color Flex from America (A.O.A.C., 1999).

Statistical analysis

All experimental data were analysed by variance (ANOVA) using SPSS program for Window Version 14 and mean values were compared with Duncan multiple range test (DMRT).

RESULT AND DISCUSSION

Detection of species and population of insect pest

The study revealed that the insect attacking brown jasmine rice during storage was rice weevils, *Sitophilus oryzae* (L.). The emerged adults came from eggs contaminating the original grains since harvesting period. The rice weevil is one of the most serious stored grain pests worldwide. It has originated in India and now has been spread worldwide. Both adults and larvae feed on whole grains. Besides rice, they also attack wheat, corn, barley and sorghum.

The changes of rice weevil population in brown jasmine rice occurred even in the bags containing different kind of herbs (Figure 1). The numbers of adult weevil increased from zero at the beginning of the experiment and they seemed to decrease in accordance with the to storing period (1-4 months) (Figure 1). The analysis of variance revealed significant differences between the treatments ($p<0.05$) in all treatments except the control. The resulted showed that numbers of adult weevil in bags treated with *C. longa, C. frutescens, C. hystrix* and control (no herb) were 2.0±0.0, 3.67±0.82, 56.0±3.27 and 137.0±4.08 adult/100g after 4 months, respectively. However, the numbers of adult weevil in brown jasmine rice mixed with *C. longa* and *C. frutescens* did not significantly differ during storage (1-4 months). The herbs had the same effect on mortality of insect. *C. longa* showed more effect on mortality of insect than *C. frutescens* and *C. hystrix*. The results showed that *C. longa* gave the best insecticidal effect on *S. oryzae*. The insecticidal effect was due to volatile oil component of herbs. The major components (~60%) of the turmeric extracted oil were identified as turmerone and ar-turmerone (Helen *et al*., 1982; Gopalan *et al*., 2000). According to Jilani and Saxena (1990) the extract of *C. longa* L. had insecticidal, repellent and antifeeding activities against some stored-product insects (Su *et al*., 1982), such as *Tribolium castaneum* Herbst (Chowdhury *et al*., 2000). The insect repellent and antifeeding constituents in *C. longa* are turmerone, ar-turmerone and curcuminoids (Lee *et al*., 2001; Chowdhury *et al*., 2000). Capsaicin and dihydrocapsaicin have been reported from *C. frutescens* (Cichewicz *et al*., 1996). Limonene is a major component of *Citrus spp*. essential oils (Ezeonu *et al*., 2001). The present results agreed with those reported by Karr and Coats (1988), in the sense that limonene had high toxic fumigant activity against rice weevils.

Microbiological analysis

Microbiological changes of TVC and yeast and mold count of brown jasmine rice with herbs during storage decreased in accordance with

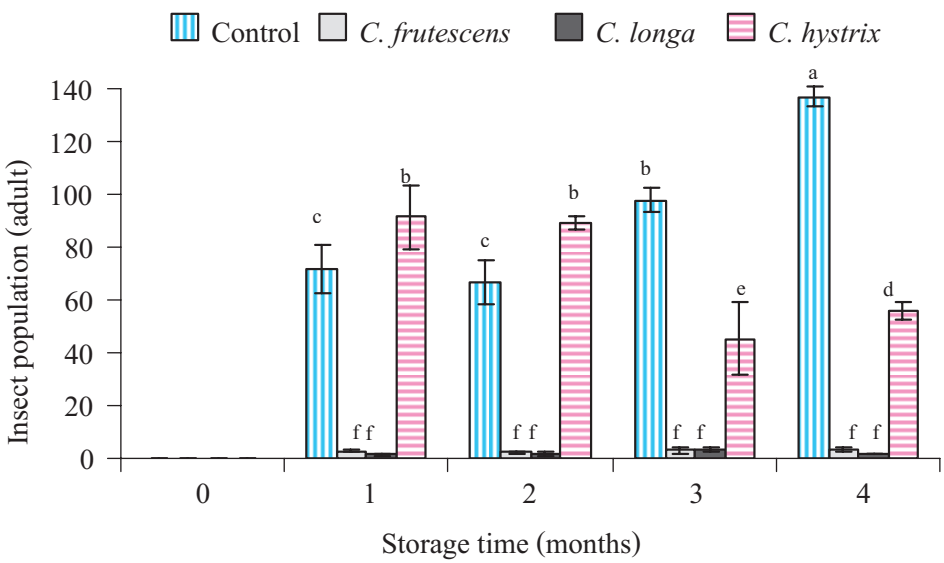

Figure 1 Effects of *C. frutescens*, *C. longa* and *C. hystrix* and storage time on *S. oryzae* population in brown jasmine rice storaged at room temperature (each value is the mean of triplicate ± SD the same letter are not significantly different as determined by DMRT ($p<0.05$)).

the storage period (4 months). As shown in Table 1, the total viable count of control sample steadily increased with storage time at room temperature (28°C), while the TVC of treated samples decreased after 3 months. After 4 months, TVC of the stored brown rice with *C. longa*, *C. frutescens*, *C. hystrix* and control were 3.87,4.20, 4.31 and 6.84 logCFU/g, respectively. Yeast and mold count in brown jasmine rice treated with both *C. longa and C. frutescens* and kept for 4 month were <10 CFU/g whereas treated with *C. hystrix* were 3.65 logCFU/g as compared with the control sample (4.02 logCFU/g). Volatile components extracted from *C. longa* dried rhizome such as turmerone, ar-turmerone and curcumin, showed fungicidal activity against *Botrytis cineria*, *Puccinia recondite* and *Pyricularia oryzae* (Kim *et al*., 2003). According to Singh *et al*. (2002) the volatile oil from *C. longa* was considered as a good antifungal material that caused complete mycelial inhibition of *Colletotrichum falcatum* (CF), *Fusarium moniliforme* (FM), *Curvularia pallescens* (CP), *Aspergillus niger* (AN) and *F. oxysporium* (FO). Sawada *et al*. (1971) reported that the essential oil from *C. longa* rhizomes could be used as antifungal for *A. niger*. The major component of *C. frutescens* extracts is capsaicin which shows the antimicrobial effect against bacteria (Cichewicz and Thorpe., 1996). Torres *et al*. (1999) found that capsaicin isolated from *Capsicum* spp. could be used for retarding the growth of *E. coli* and *P. solanacearum*. Kaffir lime leaves extracts failed to inhibit *Bacillus cereus*, *B. megaterium* and *E. coli*, (Mackeen *et al*., 1997).

Color analysis

The relationship between b* value and herb types represented yellow color of the brown rice during storage at room temperature (28°C) is shown in Figure 2. The results showed b* value of the control sample treated with *C. longa*, *C. frutescens* and *C. hystrix* to increase in accordance with the storage time from 24.30 at the beginning to 24.93, 25.35, 25.50 and 25.56 respectively. The

Table 1 Effect of *C. frutescens*, *C. longa* and *C. hystrix* and storage time on Total viable count (TVC) and yeast and mold contents of brown jasmine rice storage at room temperature.

Treatment	Storage time (month)	TVC logCFU/g	Yeast and mold logCFU/g
Rice	0	5.30	3.40
Control	1	5.18	3.35
	2	6.16	3.82
	3	6.18	3.79
	4	6.84	4.02
C. frutescens	1	5.13	3.33
	2	5.07	3.30
	3	4.81	0
	4	4.20	0
C. longa	1	5.04	3.23
	2	5.11	3.23
	3	4.56	0
	4	3.87	0
C. hystrix	1	6.15	3.72
	2	6.12	3.83
	3	4.86	3.48
	4	4.31	3.65

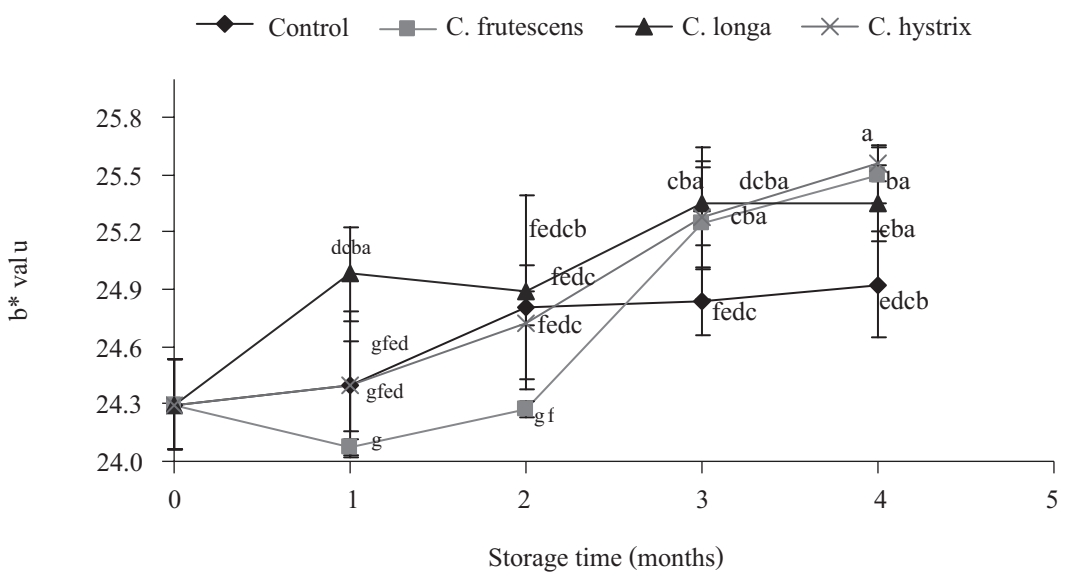

Figure 2 Effect of herbs (*C. frutescen*, *C. longa* and *C. hystrix*) and storage time on b* value of brown jasmine rice stored at room temperature. (Each value is the mean of triplicate ± SD. The same letter are not significantly different as determined by DMRT ($p<0.05$)).

results indicated that b* value of brown jasmine rice treated with herbs were higher than the control sample after 4 month storage. The increasing of b* value was due to the increase of brown rice pigments during storage. Brown pigments provided an index for evaluating the intensity of browning reaction that was caused by Maillard reaction during storage conditions (Kongkiattikajorn *et al*., 2005).

CONCLUSION

During storage at room temperature (28°C) both insects (*Sitophilus oryzae* (L.)) and microbial counts in brown jasmine rice without herbs were higher than those in brown jasmine rice mixed with herbs. Inhibition effect of *C. Longa*, on insects and microbial growth in brown jasmine rice, was better than those of *C. frutescens* and *C. hystrix* respectively during storage (4 months). *C. longa*, *C. frutescens* and *C. hystrix* could delay the damage of grains and the loss of quality of brown jasmine rice. However, the intensity of the yellow color of brown rice increased in accordance with the storage time.

LITERATURE CITED

A.O.A.C. 1999. **Official Methods of Analysis of the Association of Official Analytical Chemists**.16thed. The Association of Official Chemists, Inc.

Champagne, E.T. and R.J. Hron. 1992. Stabilizing brown rice to lipolytic hydrolysis by ethanol vapors. **Cereal Chem.** 69: 152-156.

Chowdhury, H., S. Walia and V.S. Saxena. 2000. Isolation, characterization and insect growth inhibitory activity of major turmeric constituents and their derivatives against *Schistocerca gregaria* (Forsk) and *Dysdercus koenigii* (walk). **Pest Management Science** 56: 1086-1092.

Cichewicz, R.H. and P.A. Thorpe. 1996. The antimicrobial properties of the chili peppers (*Capsicum species*) and their uses in mayan medicine. **Ethnopharmacology** 52: 61-70.

Ezeonu, F.C., G.I. Chidume and S.C. Udedi. 2001. Insecticidal properties of volatile extracts of

orange peels. **Bioresource Technology** 76: 273-274.

Gopalan, B., M. Gota, A. Kodama and T. Hirose. 2000. Supercritical carbon dioxide extraction of turmeric (*Curcuma longa*). **Agriculture and Food Chemistry** 48: 2189-2192.

Helen, C.F.S., R. Horvat and G. Jilani. 1982. Isolation, purification and characterization of insect repellents from *Curcuma longa* L. **Agriculture and Food Chemistry** 30: 290-292.

Hegsted, M., M.M. Windhauser, S.B. Lester and S.K. Morirs. 1990. Rice bran and oat bran lower cholesterol in humans. **Federation of American Societies for Experimental Biology** 4: 368.

Jilani, G. and R.C. Saxena. 1990. Repellent and feeding deterrent effect of turmeric oil, sweet flog oil, neem oil and neem-based insecticide against lesser grain borer (Coleoptera: Bostrychidae). **Economic Entomology** 83: 629-634.

Karr, L.L. and J.R. Coats. 1988. Insecticidal properties of *d*-limonene. **Pesticide Science** 13: 287-290.

Kester, E.B. 1951. **Stabilization of Brown Rice**. U.S. Patent 2,538,007.

Kenned, B.M. 1980. Nutritional quality of rice endosperm, pp.439. In B.S. Luh, eds. **Rice: Production and Utilization**. AVI publishing Co., Westport. CT

Kahlon, T.S., R.M. Saunders, F.I. Chow, M.C. Chiu and A.A. Betschart. 1989. Influence of rice, oat, and wheat bran on plasma cholesterol in hamsters. **Federation of American Societies for Experimental Biology** 3: 958.

Kim, M.K., G.J. Choi and H.S. Lee. 2003. Fungicidal property of *Curcuma longa* L. rhizome derived *Curcuma against* phytopathogenic fungi in greenhouse. **Agriculture and Food Chemistry** 51: 1578-1581.

Kongkiattikajorn, J., L. Wiset and S. Potchanachai. 2005. Changes in lipid color of grain and pasting properties of brown rice cv. Khao Dok Mali 105 during storage. **Thai Agricultural Research** 23: 211-223.

Lee, H.S., W.K. Shin, C. Song, K.Y. Cho and Y.J. Ahn. 2001. Insecticidal activities of ar-turmerone identified *Curcuma longa* L. rhizome against *Nilaparvata lugens* (Homoptera: Delphacidae) and *Plutella xyostella* (Lepidoptera:Yponomeutidae). **Asia Pacific Entomology** 4: 181-185.

Lucas, E. and J. Riudavets. 2000. Lethal and sublethal effects of rice polishing process on *Sitophilus oryzae* (Coleoptera: Curculonidae). **Economic Entomology** 93: 1837-1841.

Mackeen, M.M., A.M. Ali, S.H. EI-Sharkawy, M.Y. Mnap, K.M. Salleh, N.H. Lajis and K. Kawazu. 1997. Antimicrobial and cytotoxic properties of some Malaysian traditional vegetable ulam. **Pharmacy** 35: 174-178.

Neethirajan, S., C. Karunakaran, D.S. Jayas and N.D.G. White. 2007. Detection techniques for stored-product insects in grain. **Food Control** 18: 157-162.

Sawada, T., J. Yamahara, S. Shimazu and T. Ohta. 1971. Evaluation of crude drugs by bioassay. III. Comparision with local variation of contents and the fungistatic action of the essential oil from the roots of *Curcuma longa*. **Shoyakugaku Zasshi** 25: 11-16.

Singh, G., O.P. Singh, and S. Mauaya. 2002. Chemical and biocidal investigations on essential oil of some Indian *Curcuma species*. **Progress in Crystal Growth and Characterization** 45: 75-81.

Su, H.C.F., R. Horvat and G. Jilani. 1982. Isolation purification and characterization of insect repellent from *Curcuma longa* L. **Agriculture and Food Chemistry** 30: 290-292.

Torres, J.M., G.A. Chavez and E.R. Chavez. 1999. Antimicrobial properties of alkamides present in flavouring plants traditionally used in Mesoamerica:affinin and capsaicin. **Ethnopharmacology** 64: 241-248.