Using Radio Frequency Heat Treatment to Control the Insect *Rhyzopertha dominica* (F.) During Storage in Rice Seed (*Oryza sativa* L.)

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**Abstract**

*Rhyzopertha dominica* (F.) is one of the seriously stored insect in rice seed. It infested the seeds and damaged the seed at the endosperm and embryo. In addition, the infected seed may loss in their germination and viability and can not consider as the seeds. This investigation was established to evaluate the efficiency of radio-frequency heat treatment on eliminating stored insect (*Rhyzopertha dominica* (F.)) both on the surface, and inside the seeds, which decrease seed qualities at the least. The rice seeds cv. “KDML105” with 10.4% moisture content and 93% germination were treated with radio-frequency heat treatment at 27.12 MHz under the temperature of 70, 75, 80 and 85 °C for 180 seconds. The result showed that *Rhyzopertha dominica* (F.) were 100% found dead in all treatments. However, the rice seed qualities were also decreased with the increasing of the temperature used. The seed viability by tetrazolium test was decreased to 91, 82, 64 and 39% at the treated temperature of 70, 75, 80 and 85 °C, respectively. Therefore, the radio-frequency heat treatment had significantly resulted in the high efficiency in killing *Rhyzopertha dominica* (F.), however it reduced also the seed qualities. The best temperature level was at 70 °C with the remain viability as high as 91%. It concluded that radio frequency heat treatment has a good potential in controlling storage insect pest which maintain the rice seed qualities. Further study is suggested to investigate and developed more on radio-frequency post-harvest treatment to control insects in rice seed during storage.

**2 Background and Aim of the Study**

Insect pests are responsible for severe rice crop losses, by feeding directly on rice seed tissue. *Rhyzopertha dominica* (F.) is one of the most serious insects in stored rice seeds. It infests the seeds and damages the seed at endosperm and embryo. The infested seeds loss germeability and vigor heavily and cannot considering as seed. The conventional solution to this problem is the use of fumigants, which the remaining chemical residues are not friendly to environment. The interesting in radio-frequency heat treatment is increased as a new thermal method for post-harvest insect control in agricultural commodities (Tang et al., 2000). Cwiklinski and von Hörsten (1999) reported that a complete eradication of fungi on wheat seed can be reached by using electromagnetic treatment from 70 to 75 °C and treatment times of 150 to 180 seconds, referring to an initial seed moisture content of 15% (w.b.). Its application leaves no chemical residue on products, has provides acceptable product quality and has minimal impacts on the environment (Wang et al., 2003). However, for all of this reported were not reported on using radio-frequency heat treatment to control *Rhyzopertha dominica* (F.) in rice seed storage.
Therefore, the objective of this study is to evaluate the efficiency of radio-frequency heat treatments in eliminating lesser grain borer (*Rhyzopertha dominica* (F.)) both on the surface, and the inside of the rice seeds cv. KDML105, with minimum losses in seed qualities.

3 Methods

Rice crop (*Oryza sativa* L.) var. KDML105 were cultivated in Chiang Mai, Thailand. After harvested, the seeds were cleaned by laboratory aspirator and infested by 25 adults of *Rhyzopertha dominica* (F.) for each sample. The infested seeds with 10.4% initial seed moisture content, 94% seed viability and 93% germination were subjected to radio-frequency at 27.12 MHz at the temperature of 70, 75, 80 and 85 °C for 180 seconds.

The radio-frequency unit has been developed and built at the Institute of Agricultural Engineering, University of Göttingen, Germany. The whole system consists of a magnetron, a power supply and a cavity. The temperature in the inside of the container is determined by fibre optic temperature measurement.

Insect mortality assessments were taken after treatments immediately by stereomicroscope and the seed moisture content, seed viability, and seed germination were investigated following International Rules for Seed Testing (ISTA, 2004).

4 Results and Discussion

The exposure of rice seeds infested with 25 adults lesser grain borer to radio-frequency heat treatments at 70, 75, 80 and 85 °C for 180 seconds, resulted in 100% insect mortality in all treatments (Figure). The lesser grain borers were found dead both inside and outside the seeds. As the assessment was done immediately after the treatment, the insect mortality is attributed to lethal temperature resulting from dielectric heating within the seed and the insects.

The rice seed qualities decreased whereas the treatment temperature increased. Seed moisture content assayed by hot air oven method was decreased to 9.7, 9.5, 9.5 and 9.3%, and seed viability by tetrazolium test was decreased to 91, 82, 64 and 39%, respectively. Moreover, the seed germination by standard germination test were also decreased to 89, 86, 57 and 27% respectively.

The results from this experiment corresponded with the work from Wang et al. (2002) investigated process protocols to control field and storage pests in in-shell walnuts using a 27 MHz pilot scale radio frequency system, they found that after the RF heating to 55 °C and holding in hot air for at least 5 min resulted in 100% mortality of fifth-instar navel orangeworm. In addition, Wang and Tang (2004) reported the results of thermal death kinetics of targeted insects by using a 27 MHz radio frequency heat treatment, the results suggest that navel orangeworm were complete killed of 600 fifth-instar requires minimum exposures of 140, 50, 15, 6 and 1 min at 46, 48, 50, 52 and 54 °C, respectively.

Therefore, the radio-frequency heat treatment had significantly resulted in eliminating lesser grain borer (*Rhyzopertha dominica* (F.)). The temperature treatment of 70 °C was the resulted in 100% elimination of lesser grain borers while having least effect on rice seed quality, and can maintain the rice seed viability as high as 91%.
Table: The comparison of means of viability, germination and seed moisture content by several radio-frequency heat treatments.

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Seed viability (%)</th>
<th>Seed germination (%)</th>
<th>Seed moisture content (%)</th>
</tr>
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<tbody>
<tr>
<td>control</td>
<td>94&lt;sup&gt;a&lt;/sup&gt;</td>
<td>93&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.4&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>70</td>
<td>91&lt;sup&gt;b&lt;/sup&gt;</td>
<td>89&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.7&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>75</td>
<td>82&lt;sup&gt;c&lt;/sup&gt;</td>
<td>86&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.5&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>80</td>
<td>64&lt;sup&gt;d&lt;/sup&gt;</td>
<td>57&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9.5&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>85</td>
<td>39&lt;sup&gt;e&lt;/sup&gt;</td>
<td>27&lt;sup&gt;e&lt;/sup&gt;</td>
<td>9.3&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td>**</td>
<td>**</td>
<td>**</td>
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<tr>
<td>CV (%)</td>
<td>0.73</td>
<td>1.66</td>
<td>1.31</td>
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</tbody>
</table>

Figure: A, B, C and D The lesser grain borers found dead outside and inside the rice seeds.

5 Conclusion
Using radio-frequency heat treatment to control the insect *Rhyzopertha dominica* (F.) in rice seeds resulted in significantly, but varying positive effects in both insect control and seed qualities depending on the level of temperature used. The further study would investigate the level of radio-frequency heat treatment which affected to control insects in rice seed during storage.

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Reference


