Studying of radio frequency on disinfestation of rice bran

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Abstract

Rice bran contains many nutrients, such as oryzanol, vitamins, lipids, dietary fiber. Vacuum-packed rice bran can prevent lipid oxidation and pest growth to extend the shelf life; however, the pest eggs in the rice may hatch once the bag opening. When temperature is above 60˚C, adults and eggs of pest in rice bran can cause death. The objective of this study was to develop the thermal process by a 40.68 MHz, 5 kW radio frequency (RF) system, which can provide more rapid and uniform heating for disinfestation of rice bran. The rice bran was packed in a 1 kg vacuum PP package, and 20 pests (*Rhyzopertha dominica*) were added in the package for mortality test. The results showed that decreasing the gap between the RF electrode plates, the RF output power increased, and rate of increasing temperature of rice bran was faster. The RF heating time increased, the temperature of the rice bran linearly increased. Moreover, loading capacity of rice bran increased, the heating rate reduced. The suitable gaps of RF electrode plates at 1, 2 and 3 packages of rice bran were 5.5, 9 and 19 cm and they required 20, 40 and 60 s heating to obtain the average temperatures over 55˚C and 100% pest mortality, respectively. Therefore, RF heating can be effectively applied for disinfestation instead of chemical fumigation due to rapidly increasing temperature of rice bran.

Introduction

Rice bran is the main processing byproducts, and it can be controlled pest infestation by a chemical fumigation. However, it will cause environmental and health. Several non-chemical alternative methods have been suggested to control insect pests in agricultural commodities, including ionizing radiation, cold storage, controlled atmospheres, microwave or radio frequency heating and combination. RF heating with good penetration and volumetric heat generation can overcome heat transfer resistance for traditional heating source. Therefore, RF heating was studied for rice bran disinfestation of rice bran.

Experimental design

1, 2 and 3kg Vacuum-packed rice bran flour
L * W * H ＝25 x 19 x (3.5, 7 and 10.5 cm)

↓

RF electrode plate gap v. s. power, temperature
RF time v. s. 20 pests (*Rhyzopertha dominica*) mortality

RF equipment

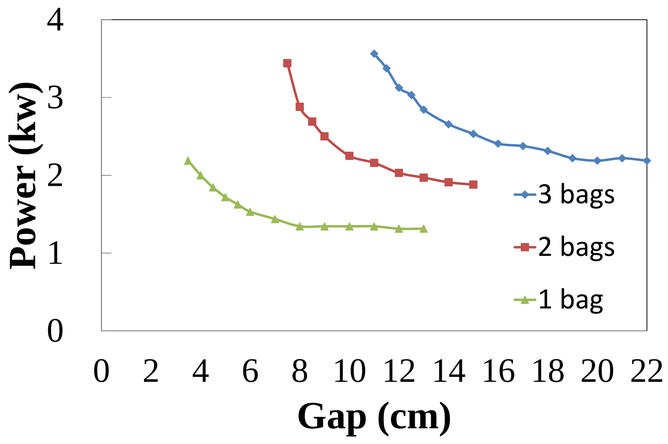

Fig. 1 Effect of rice bran loading on RF power at different electrode gaps.

Results and discussion

Increasing rice bran loading had higher RF power and the smaller RF electrode gap had higher RF output power. (Fig. 1) The temperature profiles of different vacuum-packed rice bran loading at different RF electrode gapes were shown at Fig. 2. When temperature of rice bran reached about 60˚C, and the mortalities of rice bran were 100% by RF heating and the temperature rising rates were shown in Table 1. Therefore, they only required 20 s, 40 s, and 60 s for 100% mortalities at 1 kg, 2 kg, and 3 kg rice bran loading. (Fig. 3)

Table 1 The average heating rates of different rice bran loading at different RF electrode gaps

1 kg rice bran		2 kg rice bran		3 kg rice bran	
Gap (cm)	Average heating rate (˚C/min)	Gap (cm)	Average heating rate (˚C/min)	Gap (cm)	Average heating rate (˚C/min)
5.5	90	9	67.2	19	42.6
6	69.6	10	59.4	20	32.4
6.5	69.6	11	55.8	21	34.8

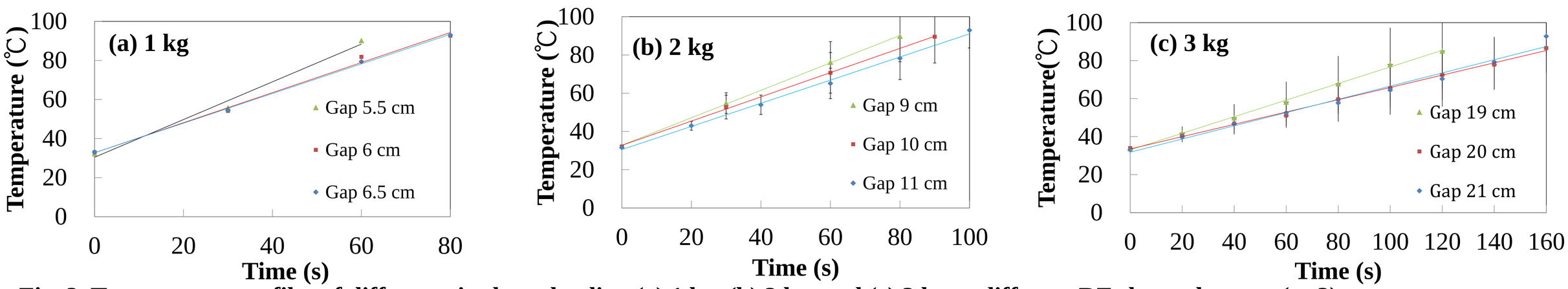

Fig. 2 Temperature profiles of different rice bran loading (a) 1 kg, (b) 2 kg, and (c) 3 kg at different RF electrode gaps. (n=3)

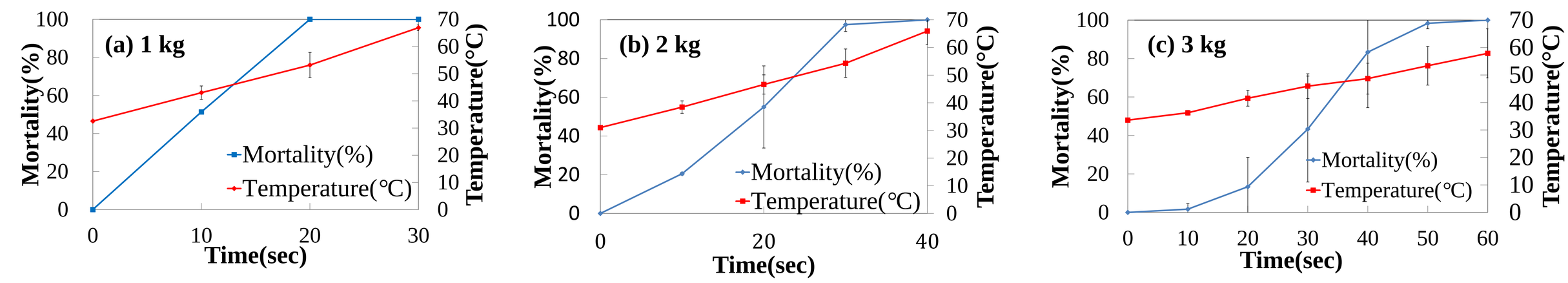

Fig. 3 Temperature profiles and mortality of of different rice bran loading (a) 1 kg at gap 5.5 cm, (b) 2 kg at gap 9 cm, and (c) 3 kg at gap 19 cm. (n=3)

Conclusions

Different loading of vacuum packed rice bran for 1 kg, 2 kg, and 3 kg obtained 100% mortality at 20 s, 40 s, and 60 s RF heating, respectively, and their average temperatures were about 60˚C.

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