Radio frequency disinfestation for American ginseng

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Abstract

The objective of this research was to study of RF heat treatment for American ginseng to obtain non-chemical disinfestation of cigarette beetle. When 2.5 kg American ginseng was put in the PP box and placed between RF electrodes with gaps of 10, 11 and 12 cm, the output RF powers were 3.56, 3.45 and 3.35 kW, respectively. The average surface temperature of American ginseng can be reach 60℃ at least 150 s RF heating, and the internal temperature was higher than the surface temperature of American ginseng. When 20 cigarette beetles were put in the 2.5 kg American ginseng, which was heated by RF with 11 cm gap for 120 s to obtain 100% mortality. The average surface, middle and bottom layer temperature had reached 57.2 ℃, 63.4 ℃, and 78.3 ℃, respectively. There were no significant differences in quality parameters (moisture, hardness, and color) between RF treatments and untreated controls. Therefore, RF heating can provide a practical, effective and environmentally friendly method for ginseng disinfestation.

Key words：Radio frequency, American ginseng, cigarette beetle, disinfestation

Introduction

American ginseng is a common Chinese herbal, and it has high economic value. When storage temperature is higher than 30℃, the eggs of cigarette beetle (*Lasioderma serricorne*) in American ginseng can be hatched to cause quality damage of ginseng. Cigarette beetle control is currently dependent on methyl bromide and phosphine fumigation, but these methods are not environmental friendly and chemical harmful. Radio frequency (RF) heating can overcome conventional heating resistance, because the polar water molecule and ionic compounds in the product can create thermal energy throughout the products by molecule vibration. In general, when temperature is above 60℃, the pest in the products will be thermal killed.

Experimental design

2.5 kg American ginseng
in PP box (L*W*H=376*265*86 mm)

↓

RF electrode gap v.s. power, temperature
RF time v.s. 20 pests (*Lasioderma serricorne*) mortality

Results and discussion

The power of RF increased with lower electrode gap during RF heating 2.5 kg American ginseng (Fig. 1). The powers of RF with gaps of 10, 11, and 12 cm were 3.56, 3.45 and 3.35 kW, respectively. The average surface temperature profiles of 2.5 kg American ginseng at these three RF gaps were shown in Fig. 2, and they required at least 150 s heating to reach 60℃. When 20 cigarette beetles were put in the 2.5 kg American ginseng, which was heated by RF with 11 cm gap for 120 s to reach 55℃ to obtain 100% mortality (Fig. 3). The bottom and internal temperatures were higher than the surface temperature of American ginseng after RF with 11 cm gap 120s heating (Table 1). The average temperatures of surface, middle and bottom layers after 120 s RF heating had reached 57.2 ℃, 63.4 ℃, and 78.3 ℃, respectively. The color values of American ginseng samples were not significantly different ($p > 0.05$) between before and after RF treatments.

Table 1. The temperature changes and RF treatment time of 2.5 kg American ginseng in the different position of PP box

RF treatment Time (s)	Temperature (℃)				Position
	T_1	T_2	T_3	Average	
0	24.5	25.1	24.7	24.77	Initial surface
120	56.3	57.1	58.2	57.20	Surface
120	62.5	63.4	64.3	63.40	Middle
120	77.7	78.2	79.1	78.33	Bottom

Table 2. Color values of untreated and RF American ginseng samples.

Treatment	L*	a*	b*
Untreated	53.9±0.4	5.2±0.5	25.6±0.2
RF heating 120 s	51.7±0.3	5.1±0.3	24.2±0.1

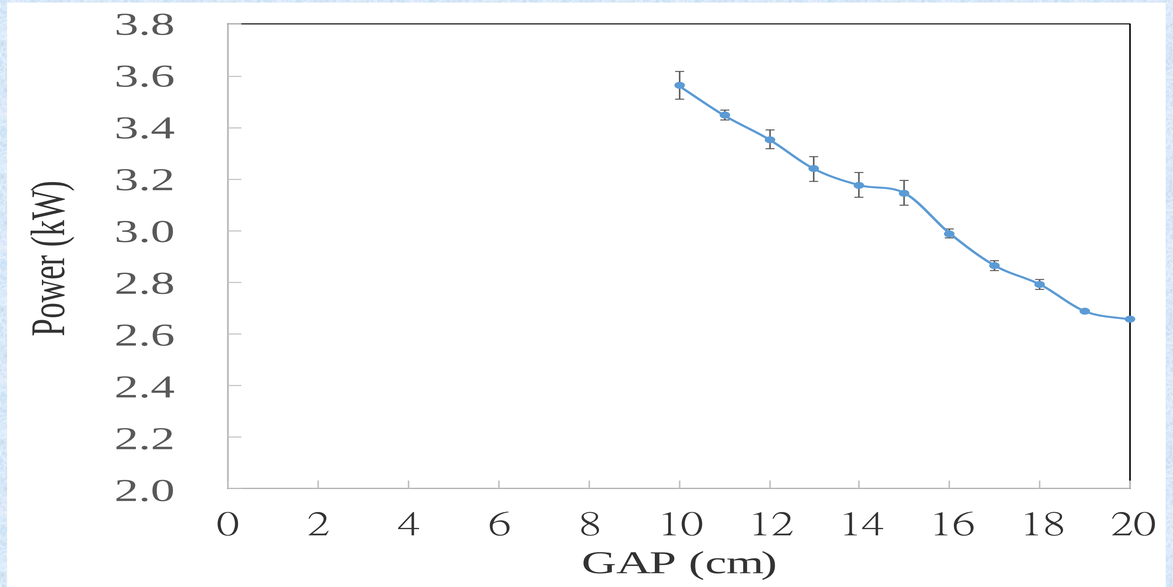

Fig. 1. Effect of different gap on the power of RF heating 2.5 kg American ginseng.(n=3)

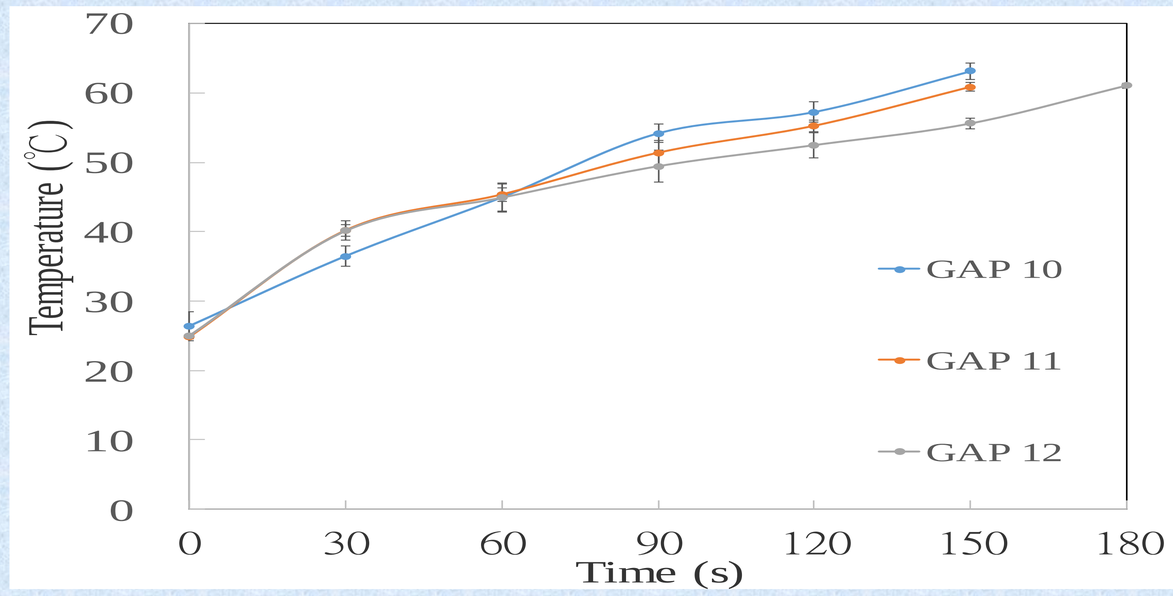

Fig. 2. The average surface temperature profiles of 2.5 kg American ginseng during RF heating with different gap. (n=3)

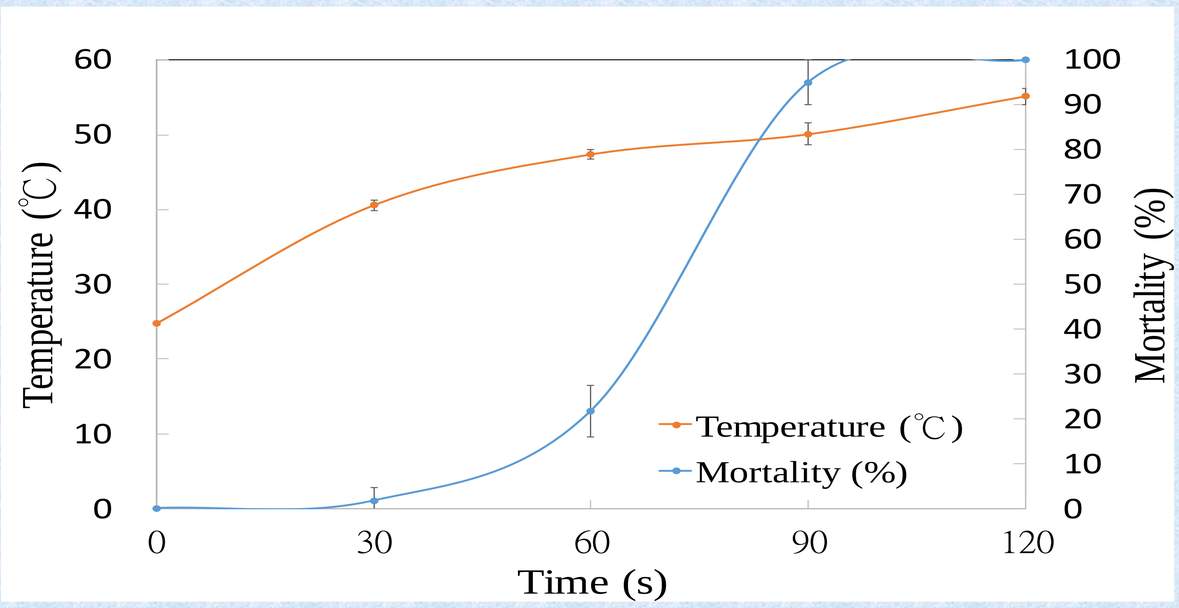

Fig. 3. Mortality of *Lasioderma serricorne* in 2.5 kg American ginseng during RF heating with 11 cm electrode gap. (n=3)

Conclusions

RF heating can rapidly increase temperature, even it may make temperature uniformity in agricultural products. It can be successfully used for postharvest insect control in agricultural products. RF treatments had no negative effects on all the measured quality parameters. RF treatment provides a practical, effective and environmentally friendly method while maintaining product quality.