

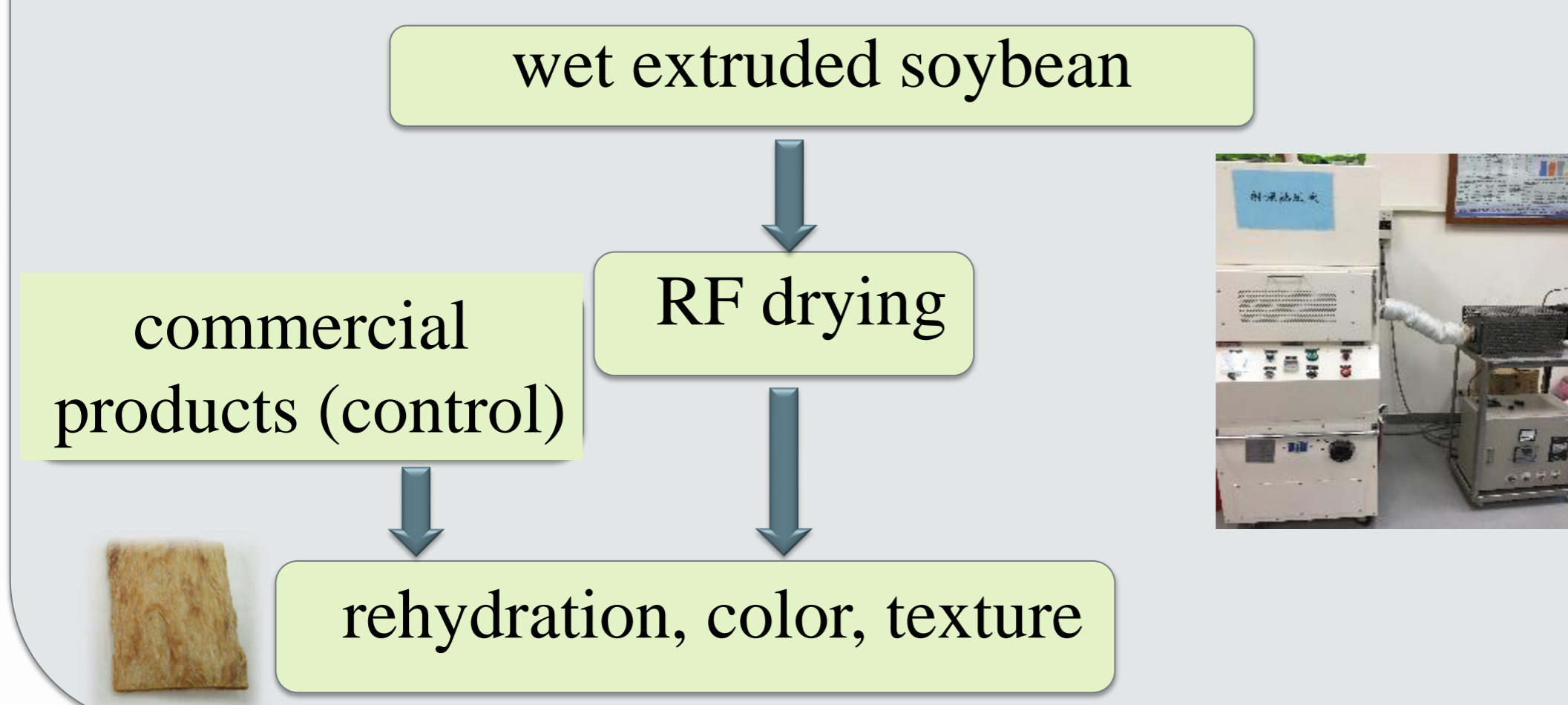
Introduction

The extruded soybean product is dried by hot air drying, in order to decrease the moisture content from 19~25% to 8% for storage. However hot air drying processing is consumption of time and energy. Radio frequency (RF) can quickly heated the extruded soybean product, then evaporated water vapor can be removed by air blowing; therefore RF can solve the heat and mass transfer problems during drying.

Objective

The objective of this study is to establish radio frequency drying the extruded soybean product in order to reduce processing time achieve the effect of time and energy saving, and then to analyze the quality of commercial and RF dried extruded soybean products.

Experimental design



Results and discussion

The results showed that the RF drying 1 kg and 2 kg extruded soybean products only required 2~6 min to decrease the moisture content from 19% to 8% (Fig. 1). Therefore, RF drying had higher drying rate and shorter drying time, and less energy consumption. The RF air drying was faster than 7~8 times of cold air drying, and the energy consumption of RF hot air drying was about 1/125 cold air drying (Table 1). The extruded soybean product by RF air drying had higher whiteness and little yellower (Table 2). Hardness, adhesion and chewing of RF dried product were higher than control, and others had no significant difference (Table 3). The rehydration ratio of the extruded soybean product by RF air drying was lower than commercial products, but the rehydration time was almost the same (Table 4).

Conclusion

RF drying wet extruded soybean product only required about 2 ~ 6 min. The RF drying process was in the constant dry period with the rate of about 55~60 g H₂O/min. Therefore it was 500 times faster than the cold air drying and less energy consumption. Therefore, RF air drying is suitable for the extruded soybean product.

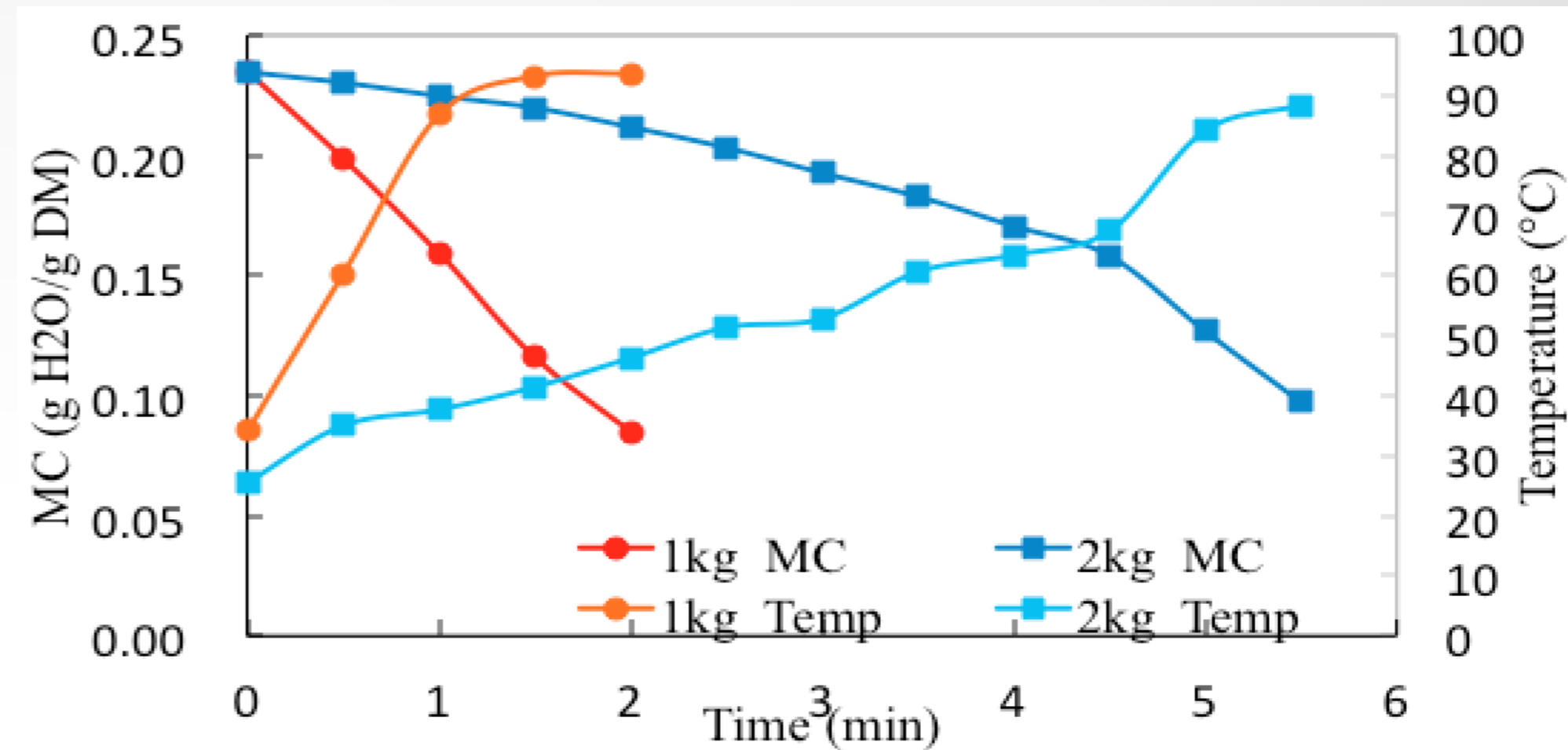


Fig. 1. The drying and temperature curves of 1 & 2 kg of wet extruded soybean product during RF drying with 18 cm electrode gap.

Table 1. The drying rate, the drying time, and the total energy consumption for different amount of extruded soybean products dried by RF and cool air drying

Drying Method	Drying rate (g H ₂ O/min)	Drying time (min)	Energy (kWh)
RF drying with 18 cm gap			
1 kg RF	61.80	2	0.14
2 kg RF	36.92	5.5	0.44
0.5kg Air drying	0.1225	420	17.72

Table 2. Color analysis of commercial and RF dried extruded soybean products

Drying Method	L*	a*	b*
1kg Gap 18cm	62.01±0.03 ^b	6.41±0.01 ^a	30.62±0.03 ^a
2kg Gap 18cm	63.32±0.05 ^a	4.91±0.04 ^c	30.18±0.09 ^b
Control	56.12±0.15 ^c	6.17±0.04 ^b	27.80±0.04 ^c

Values are expressed as mean ± SD (n=3). Values with different letters in the same column are significantly different (p < 0.05).

Table 3. Values of texture profile analysis (TPA) of commercial and RF dried extruded soybean products

TPA	RF dried product	Control
hardness (g)	219.44±18.24*	128.421±59.534
adhesiveness (g.sec)	-0.457±0.277	-0.779±0.578*
springiness	0.912±0.052	0.996±0.106
cohesiveness	0.805±0.033	0.812±0.030
gumminess (g)	176.145±19.430*	108.816±50.900
chewiness (g)	157.492±17.984*	75.767±41.285
resilience	0.420±0.044	0.472±0.038

Values are expressed as mean ± SD (n=3).

Means with * in the same row are significantly different (p < 0.05).

Table 4. The rehydration efficiency of commercial and RF-dried extruded soybean products

Rehydration	RF drying	Control
25°C water 50 min	2.56±0.109 ^b	3.25±0.292 ^b
25°C water 50 min and boiling 30 min	3.81±0.076 ^a	4.40±0.401 ^{a*}
Direct boiling 30 min	3.65±0.253 ^a	4.20±0.237 ^{a*}

Values are expressed as mean ± SD (n=3). Means with * in the same row are significantly different (p < 0.05). Values with different letters in the same column are significantly different (p < 0.05).