DEVELOPMENT OF RED-PEPPER CRUSHER

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ABSTRACT

Red pepper powder is produced from dried red pepper through milling process with roller mill. Traditional Roller mill is convenient for crushing wax and fiber parts in red pepper. However, some metallics are produced by the friction of two rollers when it operates without feeding of red peppers. In order to reduce this metallic problems created in the roller mill in the process of red pepper, a new roller mill mechanism which enables two roller to apart when red pepper is not fed between two rollers was introduced. Adjustment of clearance between two rollers was able to conducted by the current difference between idling and crushing process. Two types of roller surface, grove and flat, and two different roller mills, cast iron and Ti coating, are tested and compared in this experiment.

1. INTRODUCTION

Red pepper has been one of the most important vegetables in KOREA. Now, cultivation area is estimated at 80,000~90,000ha and annual average red-pepper consumption per capita 2.5kg. Most red-pepper is used as crushed powder for the traditional fermented food such as Kimchi and Gochujang and the sauce of cooking.

The crushing process of dried red-pepper was conducted by Jolgu with hand-working and electronic motor until 1960's. After that, the crusher with a pair of roller, made by iron, was developed to improve crushing rate and to reduce manpower. Traditional roller mill is convenient for crushing wax and fiber parts in red pepper. However, some metallics are produced by the friction of two rollers when it operates without feeding of red peppers. To reduce metallic materials found in powder, we developed new type crusher which can apart two rollers when red pepper is not fed.

2. MATERIALS AND METHODS

A. MATERIALS

(1) Red-pepper

The dried red-pepper, Dabok produced at Seosan, Chungnam in 1998, was used for the experiments. The characteristics of the red-pepper are shown in Table 1.

Table. 1 Characteristics of red-pepper

Variety	Length(mm)	Diameter(mm)	Weight(g)	M.C.(w.b.%)
Dabok	110.5	18.5	3.11	13.4

(2) Chromaticity of red-pepper

The Hunter value of dried red-pepper was measured with chroma meter (Minolta CR-200).

Table. 2 Hunter value of red-pepper

Item	Hunter value		
	L	A	b
Pericarp (exterior)	36.82	18.77	7.03
Pericarp (interior)	38.09	16.79	9.26
Placenta	57.32	27.66	34.18
Seed	64.05	10.23	32.17

(3) Crushing roller

This study used cast-iron roller and Ti-coating roller made by coating Ti on cast-iron roller. Table 3 shows chemical composition of cast-iron roller.

Table. 3 Chemical composition of cast-iron roller

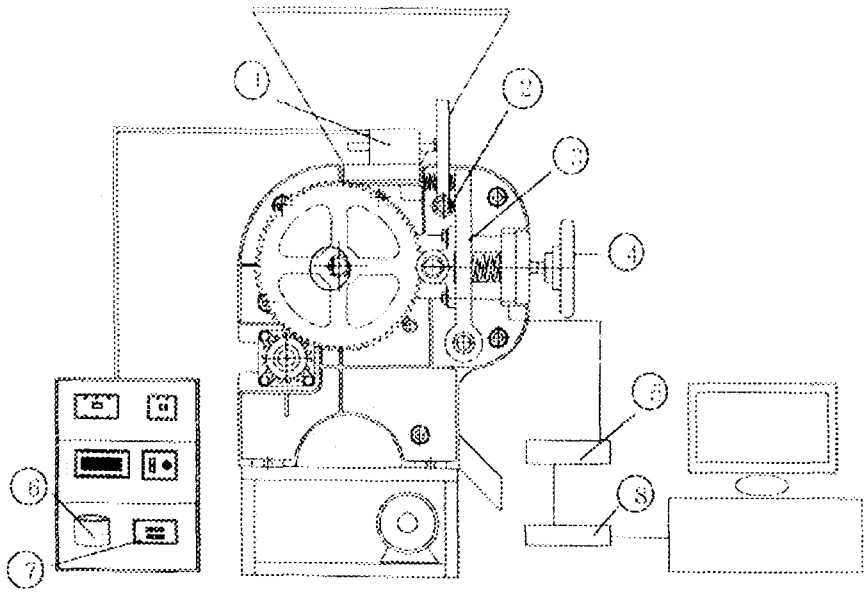
Item	Chemical composition (%)								
	Fe	C	Si	Mn	S	P	Ni	Cr	Pb
Roller	93.05	3.30	1.89	0.34	0.016	0.015	0.01	0.02	0.015

*Analysis method : KSD 1801-93(I.C.P), C : KSD 1804 (93)

B. Experimental equipment

(1) Construction of experimental equipment

Experimental equipment was composed of hopper, a pair of crushing roller, electronic motor, and pressure regulator and control part adjusting distance between high-speed roller and low speed roller by checking pressure of rollers.



① Solenoid ② Cam ③ Fixing frame of low speed roller
④ Pressure regulator ⑤ Amplifier ⑥ Electic sensor
⑦ Indicator ⑧ A/D converter

Fig. 1 Schematic diagram of experiment equipment

Table. 4 Specification of experimental equipment

Item		Size
Body	(L×W×H, mm)	70×80×1300
Roller	Diameter(, mm)	195
	Lenth (mm)	260
	Revolution(rpm)	H.S. roller 40, L.S. roller 20
Motor		3P. 220V, 5ps

(2) Setting the initial crushing pressure

The initial crushing pressure was set by adjusting handle controling spring tension and measured/displayed using load-cell(200kg Max.), 12bit AD converter and personal computer.

(3) Adjustment of distance between crushing rollers

Adjustment of clearance between crushing rollers was conducted by the current difference between idling and crushing processes. As the current of crushing process was higher than that of idling process, if the current used is lower than threshold current, it was considered as idling process. Then, solenoid pushed distant adjusting rod to widen distance between crushing rollers.

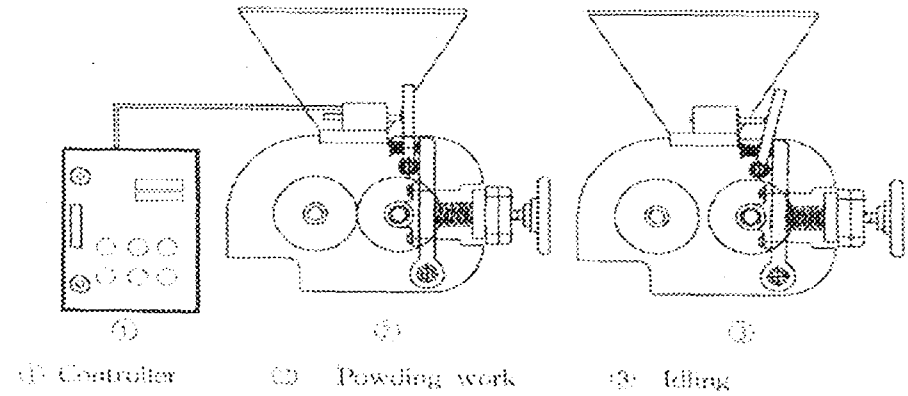


Fig. 2 Difference in clearance control part between crushing and idling work

C. METHOD

(1) Crushing experiment

This study analyzed Fe increase, particle size and working performance as comparing two types of roller surface, grove and flat, and two different roller materials, cast-iron and Ti-coating. As Ti-coating material using plasma is harder 4 - 10 times than cast iron, Ti-coating roller was used in this experiment to improve non-abrasion of roller.

(2) Analysis of Fe amount

Samples of red-pepper powder were gathered from crushing bowl made of ceramic and outlet of crusher in each cycle time. Fe amount was analyzed by method detecting heavy metals in vegetable using Inductively Coupled Plasma Emission Spectrometer.

(3) Analysis of particle size

Red-pepper powder was sorted with particle size using sieves(#12, 16 and 20). KS(Korea Standard) indicated that when the amount passing through sieve #20(0.85mm) was more than 60% of total amount, the differential ratio in peripheral velocity was appropriate.

3. RESULTS AND DISCUSSION

A. Fe increase

(1) Fe increase according to cast-iron roller types

Figure 3 shows the amount of Fe detected in red-pepper powder after crushing using ceramic material, grove roller and flat roller. The crushing condition was set with crushing pressure of 50kg/cm2 and differential ratio in roller revolution of 48%. As shown in Fig. 3, Fe amount after crushing using ceramic bowl was 26.3mg/kg, grove roller 317.6mg/kg and flat roller 381.5mg/kg. Fe amount escalated about 12 - 14 times compared to raw

material(using ceramic bowl).

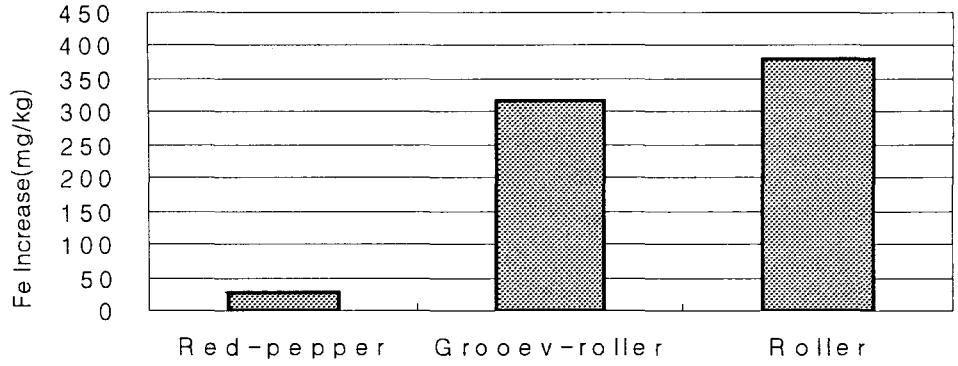


Fig. 3 Fe amount in crushing process.

(2). Fe increase according to crushing numbers

Figure 4 indicates Fe amount at prototype of cast-iron and Ti-coating rollers is continuous with crushing numbers but at conventional type gradually increased. Fe amount after the 7th crushing at conventional type was 231.43mg/kg and at prototype of cast-iron and Ti-coating rollers was 64.98mg/kg and 52.47mg/kg, respectively. This shows Fe amount at prototype is decreased to 72% and 77% compared to conventional type.

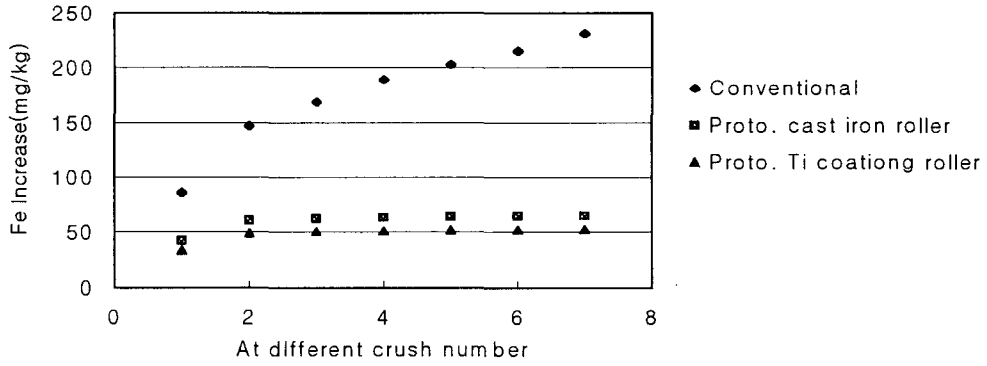


Fig. 4 Fe increase at various crushing numbers

(3) Fe increase according to differential ratio in peripheral velocity

When differential ratios in peripheral velocity were 56.6, 48, 41.7 and 27.2%, Fe amounts at prototype of cast-iron roller were 67.58, 64.98, 63.47 and 60.63mg/kg respectively and at prototype of Ti-coating roller 54.91, 52.47, 50.12 and 47.84 mg/kg. This indicated Fe amount correlated with differential ratio in peripheral velocity.

Like Fe, in same differential ratios in roller revolution, Ti amounts at prototype of cast-iron roller were 2.22, 2.14, 1.98 and 1.83 mg/kg respectively and at prototype of Ti-coating roller 12.93, 10.92, 8.79 and 6.70 mg/kg.

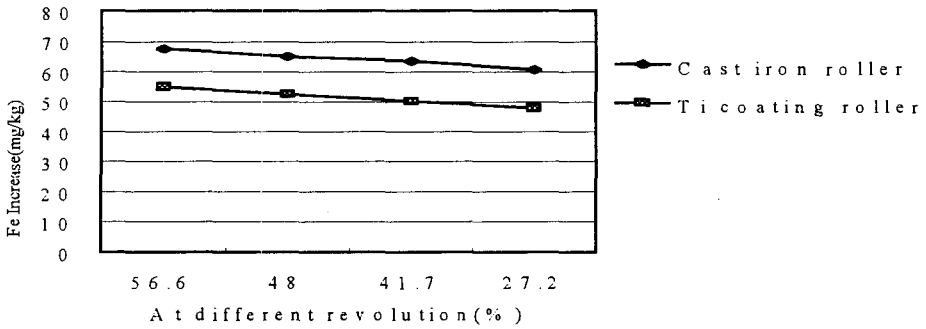


Fig. 5 Fe amount at different revolution ratio.

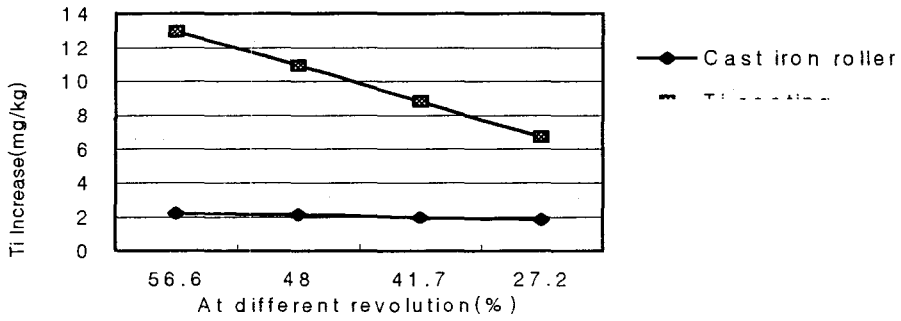


Fig. 6 Ti amount at different revolution ratio.

B. Distribution of particle size

In differential ratio in peripheral velocity of 56.6, 48, 41.7, 27.7%, the ratios passing through sieve #20(0.85mm) at prototype of cast-iron roller were 68.14, 63.28, 59.11 and 54.97% and at prototype of Ti-coating roller 65.45, 61.56, 56.89 and 51.32%.

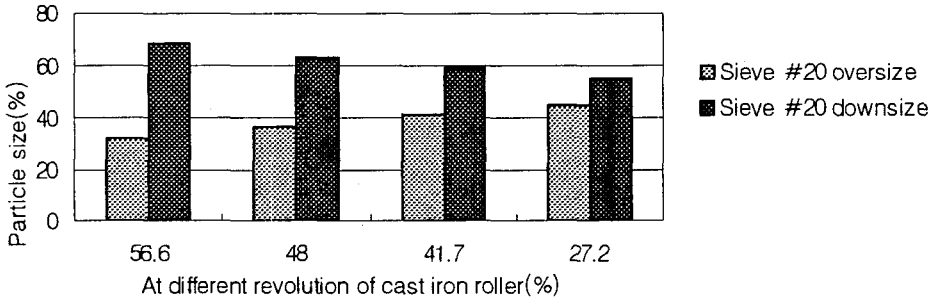


Fig. 7 Particle size according to different ratio in roller revolution at cast-iron roller

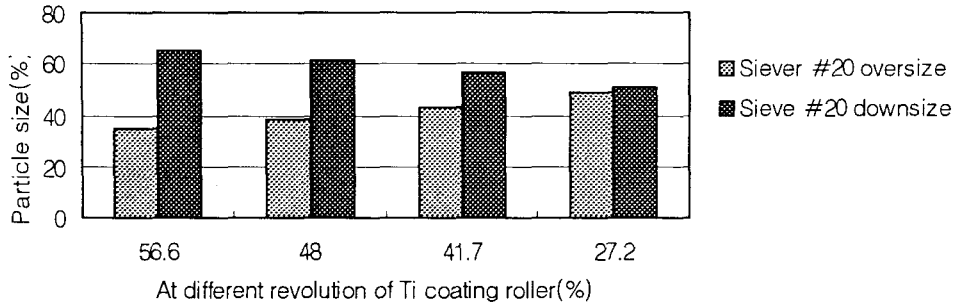


Fig. 8 Particle size according to different ratio in roller revolution at Ti-coating roller

C. Comparison of conventional type with prototype

Fe amount detected in red-pepper powder of 1kg was 237.89mg/kg at conventional type and 64.98mg/kg at prototype, which indicated Fe amount detected at prototype was decreased to 73% compared to conventional type. In the ratios passing through sieve #20, 65.64% at conventional type and 63.28% at prototype, no significant difference was found. Working performance was 64.2kg/hr at conventional type and 57.1kg/hr at prototype, which showed working performance of prototype was more effective in 11.2% than that of conventional type.

Table 5 Comparison of conventional type with prototype

Item	Fe increase (mg/kg)	Particle size (%)		Working performance (kg/hr)
		Sieve # 20 oversize	sieve #20 downsize	
Conventional Type	237.89 (100%)	34.36	65.64	57.1
Prototype	64.98 (27)	36.72	63.28	64.2

4. CONCLUSION

In order to reduce this metallic problems created in the roller mill in the process of red pepper, a new roller mill mechanism which enables two rollers to apart when red pepper is not fed between two rollers was introduced. Adjustment of clearance between two rollers was able to conduct by the current difference between idling and crushing process. Two types of roller surface, grove and flat, and two different roller mills, cast iron and Ti coating, are tested and compared in this experiment.

The result of the experiment can be summarized as follows;

1. Prototype roller mill consists of distant adjusting rod, electric current sensor, indicator

and cam that can adjust the distance between two rollers

2. More metallics were produced in the groove roller than flat roller.

3. Less iron particles was produced from Ti coating roller than iron roller by 13mg per kg of red pepper spice.

4.When the differential ratios in roller revolution were 56,6, 48 and 41.7%, iron particles amounts of cast iron and Ti roller were 67.58, 64.98, 63.47 and 54.91. 52.47, 50.12mg/kg, which indicated the more iron particles created the bigger differential ratio.

5.When the differential ratios in roller revolution were 56,6, 48 and 41.7%, the amount of red pepper spice of the cast iron and Ti roller passing sieve #20(0.85mm) were 68.28, 63.28, 59.11 and 65.45, 61.56, 56.89% which showed cast iron roller is better than Ti roller in producing high quality red pepper spice.

6. The Suitable differential ratio in roller revolution was more than 48% in considering particle size of red-pepper powder.

7. Fe amount detected in red-pepper powder was 237.89mg/kg at conventional type and 64.98mg/kg at prototype, which indicates Fe amount detected at prototype was decreased about 73%

8. The ratio passing through sieve #20 was 65.64% at prototype, which shows no significant difference between two types

9. Working performance was 64.2kg/hr at conventional type and 57.1kg/hr at prototype, which indicates prototype was more effective about 11.2% compared to conventional type.

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