Research Article
J. Ginseng Res. Vol. 34, No. 4, 282-287 (2010)
DOI:10.5142/jgr.2010.34.4.282

JGR Journal of Ginseng Research

Characterization of a Loess Module for Manufacturing Loess Red Ginseng

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An optimized manufacturing process was developed for the production of high-quality loess red ginseng using a hybrid process in which loess (yellow earth) was incorporated into the conventional ginseng manufacturing process system. We designed conventional ginseng processing facilities and prepared the loess module by baking loess that contained 42% water at 860°C for 8 h. The loess module showed excellent performance in deodorization and humidity control. The optimum steaming temperature at which maximum expansion of starch organisms occurred was 90 to 98°C.

Keywords: Loess-red ginseng, Loess module, Deodorization, Humidity, Starch

INTRODUCTION

Ginseng (*Panax ginseng* C. A. Meyer) has been used for thousands of years as a precious ingredient in Korean herbal medicine and Chinese medicine and has also been used by the general populace. Korean ginseng produced locally, in particular, has become internationally renowned for its superior medicinal properties. Korean ginseng is divided into four broad categories based on the processing method. For example, first-stage processed forms, which maintain their original form, include fresh ginseng, red ginseng, white ginseng, and Taegeuk ginseng [1]. Products that are processed in the second stage include ginseng powder products such as tablets and capsules, as well as drinks, tea, and pouch. Red ginseng, a first-stage processed product, is a SooChi herb produced using a traditional Korean pharmaceutical technique. In general, traditional processing of galenicals has the advantages of reduced toxic side effects, improved galenical effects, enhanced efficacy, easy storage, and better taste and smell [2,3]. Traditional processing methods for red ginseng include steaming water ginseng followed by drying, and numerous chemical transformation stages exist, such as saponin modification, amino acid transitions, and browning [4]. Particles that are unique to red ginseng, including ginsenosides Rg_2, Rg_3, and the Rh-group [5], are secondary products. These saponins have shown multiple pharmacological benefits such as anticancer effects [6], suppression of cancer cell growth [7], decreased blood pressure [8], neuronal cell protection and improved ability to concentrate [9,10], and antithrombotic actions [11,12]. Thus, much research has focused on applying red ginseng substances to pharmaceutical preparations or food for medicinal or health-enhancing food products with high value [13]. However, most ginseng-processing companies use basic processing methods that are highly reliant on physical processing such as drying, steaming, heating, and extraction [14,15]. Although chemical or biological processing methods [16,17] are under consideration, their application in ginseng industries is currently limited. Thus, heat-processing research is necessary to develop differ-

Received 22 Apr. 2010, **Revised** 3 Aug. 2010, **Accepted** 5 Aug. 2010

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entiated red ginseng substances.

Loess is readily available in Korea and has multiple uses because it is nontoxic. The colloid particle of loess in particular has the ability to agglutinate and absorb suspended substances, which makes it ideal for use in heavy metal elimination and deodorization [18]. Advantages of loess also include humidity control and antifungal activities, room temperature-maintaining effects, heat-radiating properties, and superior radiation of far-infrared light.

This study optimized loess red ginseng production using loess that has far-infrared light radiation, toxin absorption, and humidity-control properties. First, production methods and characteristics of the clay module for loess red ginseng production were analyzed. These preliminary data were applied to the production of loess red ginseng.

MATERIALS AND METHODS

Material

The samples were prepared from 4 year-old water ginseng harvested in Geumsan, Chungnam province in 2004, and its fine root parts were eliminated before use to maintain the shape of the water ginseng and enhance the product value. The loess used in this study was purchased from Jo-Eun Earth Co. (Hwasun, Korea) and had a particle size of 10 μm. Inorganic substances were analyzed using inductively coupled plasma luminescence (inductively coupled plasma atomic emission spectrometer; JY-38 plus, Jobin-Yvon, Longjumeau, France); the results are shown in Table 1.

Steaming and drying systems

Fig. 1 shows the heat-processing system for red ginseng using the loess module. The steaming and drying machines were made of stainless steel 304. The steaming machine had an internal size of 400 (W)×400 (L)×400 (H) mm and a shelf size of 300×300×50 mm×2 decks. The drying machine system was 400×400×500 mm with a shelf size of 300×300×50 mm×2 decks. The amount of water ginseng as a percentage of each system's space volume was 14.1% and 11.3% in steaming and drying, respectively.

Production of the loess module

Production of the loess module used in the ginseng heat-treatment processes included water addition at loess volumes from 42% to 54% at 2% intervals and two cycles of maturation for 1 day to 2 days at high temperature to prevent splitting. Then, the loess dough was placed in a mold module (37×30×1.5 cm) to allow the dough to form. The loess dried at room temperature

Table 1. The chemical composition of the loess

	Chemical components									
	SiO_2	Al_2O_3	MgO	CaO	TiO_2	MnO	Na_2O	Fe_2O_3	P_2O_5	Other
Content (%)	55.9±0.2	23.1±0.1	8.5±0.3	1.4±0.9	1.2±0.5	0.2±0.1	0.1±0.2	0.1±0.4	0.1±0.4	9.5±0.9

The data expressed as means±SD of three determinations.

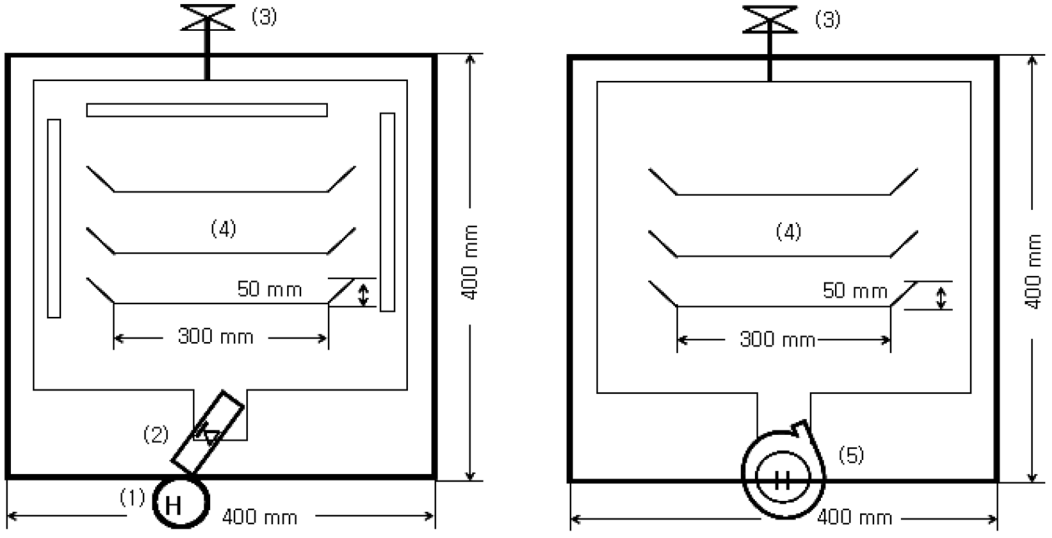

Fig. 1. Schematic of the steaming and drying cabinets for fresh ginseng. (1) Heater, (2) heating coil, (3) gate valve, (4) shelf, (5) heating fan blower.

for about 10 days and at 860°C for 8 h prior to use. The dry contraction differences of the loess module were determined using the following equation: Dry contraction difference rates (%)=(length after forming–length after baking)/(length after baking)×100.

Characterization of the loess module

The absorption and dehydration properties of the loess module were analyzed using an incubator at a constant heating temperature of 50°C and comparative humidity values of 90% and 20%. The loess module tester (5×5×1 cm) was weighed and then the loess module was enclosed to prevent air exposure so that only specific areas were exposed to air. The exposure area was calculated after a certain time. The absorption and dehydration effects (g-H_2O/m^2) were studied over 27 h. The deodorizing ability of the loess module was analyzed using a detector (Gastec Co., Kanagawa, Japan) in the sample port of the loess module container (4×4×1 cm), and 100 mL was sampled. The concentration of absorbed ammonia gas was measured as a function of time. A 3LA detector (3M Corporation, St. Paul, MN, USA) was used to measure ammonia gas concentrations in the ranges of 2.5–200 and 10–1,000 ppm.

Measurement of the degree of swelling of ginseng starch

The degree of swelling of ginseng starch was measured based on steaming process conditions to determine the steaming completion point. The temperature was maintained between 50 and 100°C at intervals of 10°C, and the processing time was 0 h to 5 h at intervals of 1 h. The measurements for the degree of swelling of ginseng starch closely followed Scoch's protocol [19]. Starch (500 mg) was placed in a 100 mL beaker; 35 mL of distilled water was added and the mixture was heated for 30 min at each temperature interval from 40°C to 90°C. A 40 mL aliquot was centrifuged at 15,000 rpm; the supernatant was dried at 120°C in a dryer and the resulting weight was deducted from the sediment weight. The ratio of starch weight before and after reaction was calculated as a percentage. The method of separating the starch of ginseng is shown in Fig. 2.

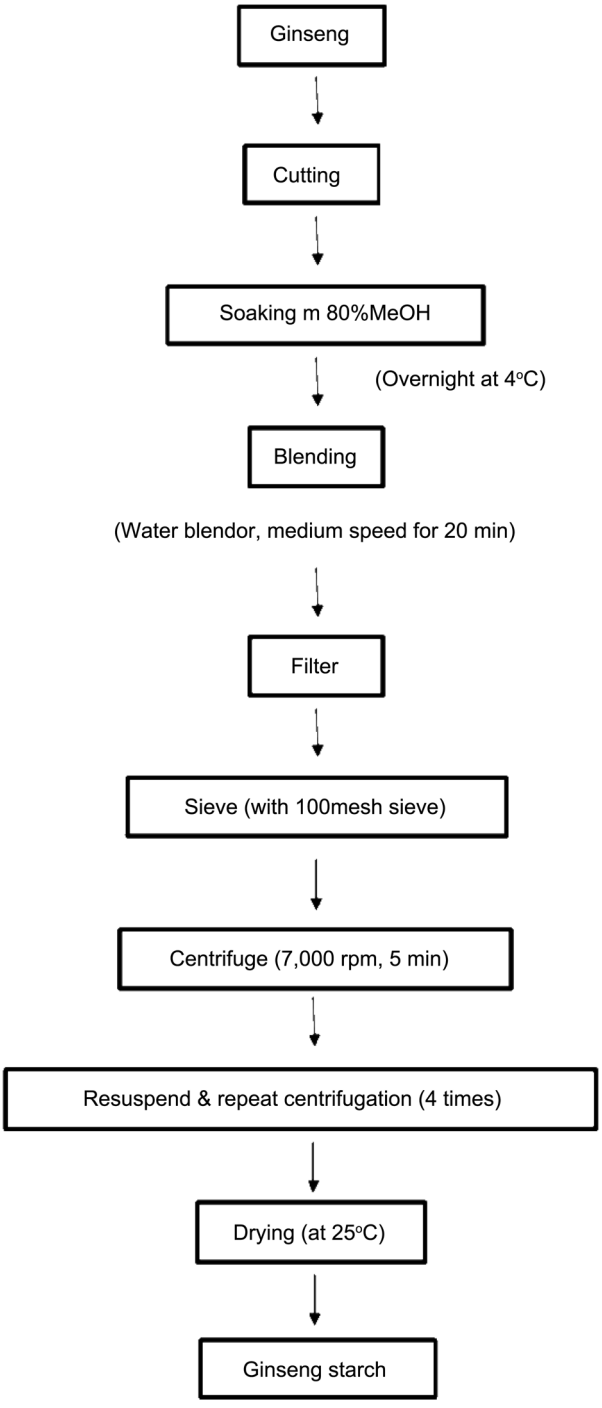

Fig. 2. Separation process for ginseng starch.

RESULTS AND DISCUSSION

Constriction rate of the loess module for moisture content

Lee [20] showed that loess is similar to normal earth, but when it is heated above 60°C, it radiates 5 to15 μm of far-infrared light, which is the most beneficial wavelength range for humans. However, loess does not participate in the pozzolanic reaction, forms cracks due to activation, and undergoes an about 6% reduction in volume due to particle aggregation after reaction with water [21]. Thus, in this experiment, we analyzed the

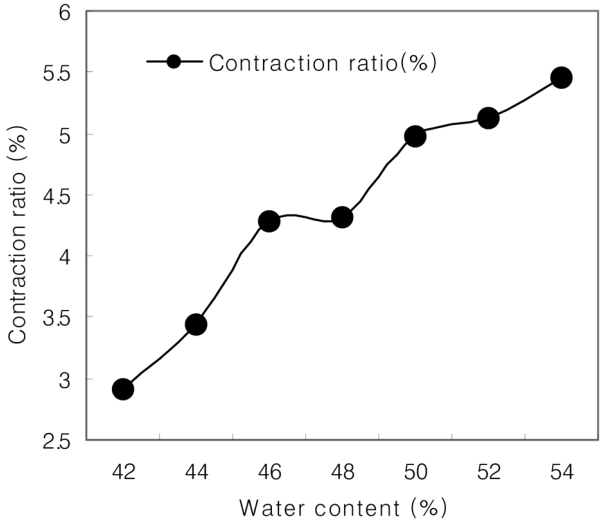

Fig. 3. Contraction ratio of the loess module with various water contents.

loess module constriction after adding water. Fig. 3 shows that lower amounts of water stabilized the loess module. Water content less than 42 to 44% produced a stable loess module, 46% water content produced severe cracks, and water content greater than 50% caused a volume constriction of greater than 5%. These results suggest that water content was the major cause of cracks in the loess module. Water in the raw material should evaporate during the drying process, leaving numerous spaces that eventually form cracks. Thus, constriction of the loess module during drying was minimized when the water content was 42%.

Moisture content control by the loess module

Loess absorbs moisture under high humidity and releases moisture under low humidity, likely because loess has a clay mineral crystal structure that allows free absorption of water and dehydration depending on moisture conditions. Thus, loess maintains a constant moisture content [22]. We analyzed the moisture control capacity of the loess module for red ginseng manufacturing. Fig. 4 shows that the highest moisture absorption capacity of the loess module was observed at 1 h (140 g-H_2O/m^2) over a 27 h period. After 2 h, the moisture absorption capacity decreased to 58 g-H_2O/m^2, and after 7 h, it decreased to 0 g-H_2O/m^2. In contrast, dehydration increased rapidly over the 27 h period (Fig. 4). After 23 h, the dehydration capacity of the loess module was 90 g-H_2O/m^2, and thereafter, the dehydration capacity slowly increased. These results suggest that the loess module designed in this study would prevent excess moisture absorption and dehydration during red ginseng manufacturing and maintain a constant moisture content.

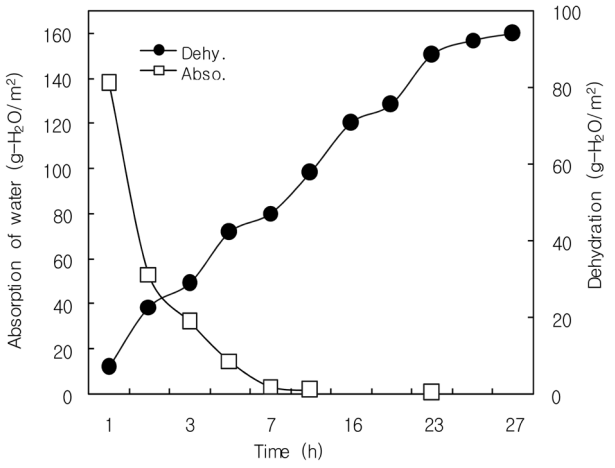

Fig. 4. Changes in absorption and dehydration in the loess module.

Deodorization by the loess module

A characteristic property of loess is deodorization. Fig. 5 shows the deodorization capacity of the loess module. The removal rate of ammonia by the loess module after 20 min was 83% (Fig. 5). The removal rate of ammonia rapidly increased from 20 min to 80 min; 90% of the ammonia was removed within 60 min and 95% was removed after 140 min. These results are similar to a previous report that showed a deodorization capacity of 100% within 3 min in a refrigerator with an ultraviolet air purifier [23]. Thus, the deodorization capacity of the loess module can be used to deodorize fresh ginseng grass and earth smells and contribute to the production of high-quality red ginseng.

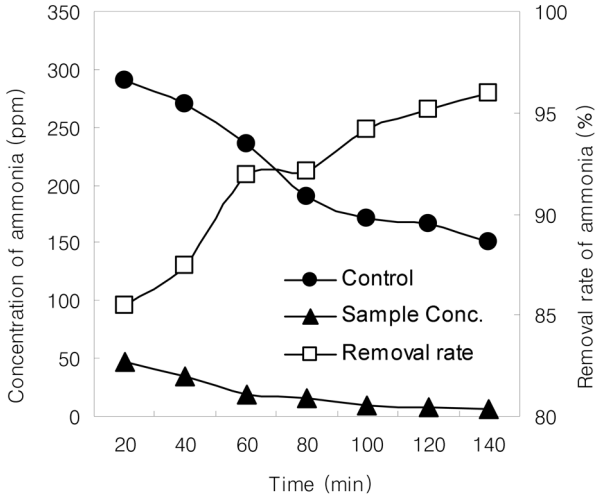

Fig. 5. Removal rate of ammonia with time in the loess module.

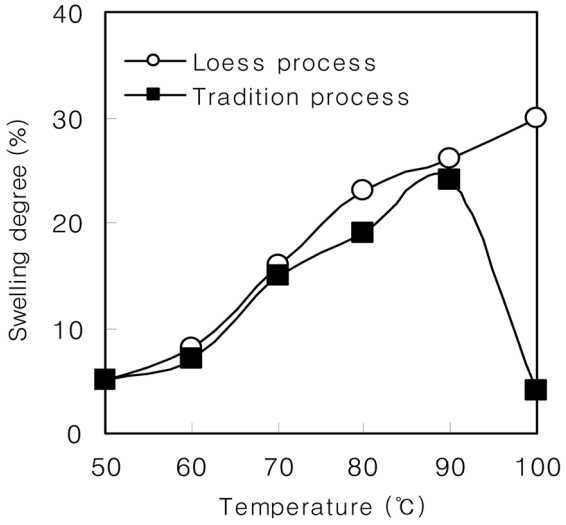

Fig. 6. Changes in the degree of swelling based on the steaming temperature.

Swelling of ginseng starch

Kim and Jo [24] reported that swelling of ginseng starch was observed at 50°C during the steaming of ginseng, and the maximum swelling of ginseng starch was observed at 55°C to 60°C because the micelle and crystal structures of ginseng starch were disrupted; thus, it turned into a gel. Amylogram data showed that ginseng starch began to gel at 61°C, and gelation was complete at 88°C [25]. Thus, in this experiment, the swelling of ginseng in the traditional red ginseng manufacturing process was compared with that in the red ginseng manufacturing process using the loess module. Ginseng was steamed at various temperatures from 50°C to 100°C, and the swelling of ginseng was determined. As shown in Fig. 6, steaming at 50 to 60°C showed no difference in swelling between the loess module and traditional manufacturing processes. However, the swelling of ginseng increased at 60°C in the traditional red ginseng manufacturing process, and the swelling rapidly disappeared above 90°C. In contrast, the swelling of ginseng disappeared above 98°C in the red ginseng manufacturing using the loess module. Thus, red ginseng manufacturing using the loess module would be preferred when the swelling of ginseng reaches a maximum at 90°C to 98°C. Our results revealed the characteristics of red ginseng swelling in the loess module during the steaming process and showed that the loess module is well suited for red ginseng manufacturing.

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