DEVELOPMENT OF A NEW MODEL OF DRYING SYSTEM FOR HIGH YIELD OF THE HEAVEN GRADE GINSENG

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ABSTRACT

The red ginseng is very popular as a health food. It has been manufactured with raw ginseng by the conventional method. But, the yield of the heaven grade ginseng (the best quality red ginseng) among the whole products is around 5-7%, Therefore, the yield should be improved in order to increase economic returns.

In this study, a new model of drying system was developed to improve the yield of heaven grade ginseng from 7% to 15% or more. For this system, temperature and relative humidity were controlled by the feedback control system, and a solenoid valve for steam supply and other variables were controlled by the PC.

The special features of this system developed are an image processing system for monitoring the red ginseng during the drying process in the drying chamber, and a cylindrical porous tray for holding ginseng that is rotating with the speed of 0-10rpm in the drying chamber and makes uniform drying of red ginseng possible.

Key Word : Red Ginseng, Heaven Grade Ginseng, New Model of Drying System, Raw Ginseng

INTRODUCTION

Korean ginseng is one of the typical and economical crops in Korea and it is a perennial herb, which is cultivated in the shade. Ginseng has been mainly used as a medicinal stuff. But, the demand and the interest on it has been increased by the sharp rise of the health food demand that is due to the improvement of the living standards and increase of an advanced age.

Since the raw ginseng is not stable for storage, the red ginseng and white ginseng have been processed and used for a long term storage and distribution. In this case, the red ginseng has been recognized as that its effect of medicine and the quality of long term storage were very stable.

Because the raw ginseng should be processed in a short term after harvesting from August to November, the quantity of raw ginseng is usually too large to process without problems. For the processing of the heaven grade(best quality) red ginseng, a relatively high technology is being requested, because the processing conditions and variables are complex. Also the ginseng is a most valuable crop among the agricultural products. Nevertheless, the prices of red ginseng that is the most value-added product are different as much as ten times by its crack, appearance, inside cavity, inside white and etc. Therefore, the development of an automated processing system is needed, which is based on the engineering process analysis.

The red ginseng is one of the most expensive special ones among agricultural products. For example, the prices of 600g package (ten roots of red ginseng) by the grades are as follows : $2,838 for the heaven grade; $1,419 for the earth grade; $385 for the good grade. Their price ratio is 100 : 50 : 13.6 and the price differences are significant.

The annual world total production of ginseng is 11,170M/T and 32.5% of them are produced in Korea. The red ginseng has been produced by the government monopoly system by June 1996, but the Government Monopoly in Red Ginseng Act was revised in July 1996 so that private organization can process the red ginseng.

Under this circumstance, it is very difficult to produce the best quality red ginseng by the technical problems of the red ginseng manufacturing process. The main reason of difficulty is that the mechanism of physical changes is not clearly proved, which is occurred during the manufacturing process.

The objectives of this study were to develop a pilot drying system that has a control capability for the variables of red ginseng processing, to investigate the mechanism of physical changes occurring during the manufacturing process of red ginseng using a drying system developed, and then to improve a manufacturing process for producing the best quality red ginseng.

Materials and Methods

The pilot drying system developed in this study was designed to investigate the optimum processing conditions by processing three roots of six years old raw ginseng to red ginseng per batch.

2.1 Design requirements and conditions of pilot drying system

a. Temperature and relative humidity

The initial moisture content of raw ginseng is 70-80%(w.b.) and the optimum moisture content of red ginseng which is a final product, is 12.5-13.5%(w.b.). In order to achieve such a final product, the inside temperature of drying system should be controlled from 10℃ to 120℃ such as CRT(Continuous Rising Temperature) method, and the relative humidity from 10% to 99%. In this case, the requirements of raw ginseng for red ginseng

is defined by the enforcement regulation of Korea Ginseng Industry Law. They are specified as the followings: it should be six years old and first grade, its weight be more than 100g per root, length be more than 10㎝, the ratio of diameter and length be less than 2/5, the number of legs that are more than 5㎝ long and straight.

In addition to these, since the steaming and drying systems should be operated by the electronic signal, they were coupled with computer to make those processes be automatic operation.

b. Steaming and drying chamber(Fig. 1)

The operating capacity of steaming and drying system was designed for three roots of raw ginseng per batch. In order to accommodate those, the dimension of steaming and drying chamber was designed as 350×350×350㎜ based on the size of six years old and first grade raw ginseng.

And a glass window was installed on the top side of chamber for the purpose of monitoring the various conditions of ginseng during the steaming and drying process. For monitoring these, physical eyes and/or image processing equipment may be used. Therefore, the steaming operation and the drying operation can be performed continuously within a chamber.

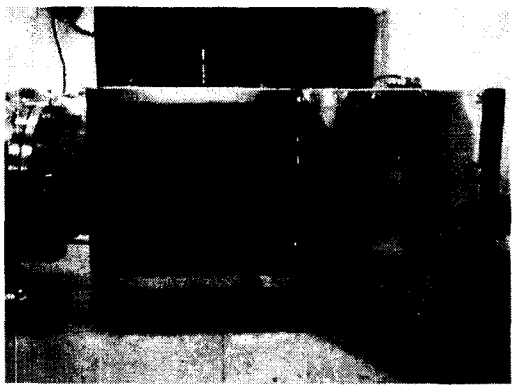

Fig. 1 Steaming and drying chamber.

c. Cylindrical porous tray

Three cylindrical porous trays were designed to achieve uniform process conditions of steaming and drying for red ginseng manufacturing, and these were installed in the chamber and rotated with the speed of 0-10rpm by the speed variable motor. The rotating system was designed as the trays were revolving and were not rotating on its axis. If these are rotating on its axis, it is not easy to maintain the shape and quality of red ginseng during processing. The size of cylindrical porous tray was designed as 300×70(R)㎜ based on that of the six years old and first grade raw ginseng.

In order to prevent the red ginseng to stick to the trays during the steaming and drying processes, the trays were coated with Teflon.

d. Electrical boiler(Fig. 2)

The moisture for steaming was supplied by an electric boiler with solenoid valve. The capacity of boiler was designed as 10ℓbased on the heat and mass balance analysis of steaming and drying processes. The boiler was designed such that it can produce pressure of maximum 7kgf/㎠ and its temperature can be measured and controlled.

An electric heater of 10㎾ was used as heat source to raise the water temperature. A solenoid valve was used for on/off functioning of steam discharge and it was controlled by a process control computer.

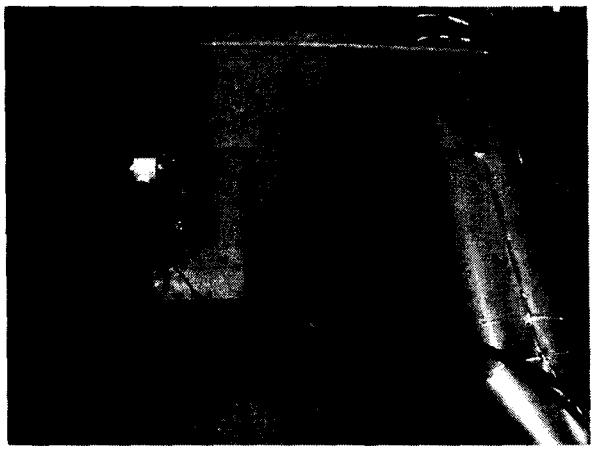

Fig. 2 Electrical boiler.

e. Other equipment

For drying process, a ventilation fan was used, which was operated by a speed variable motor. And an electric heater of 16㎾h capacity was used for steaming and drying.

2.2 Pilot system for steaming and drying

A pilot system for steaming and drying was designed by the steaming and drying algorithm and it was shown in Figure 3.

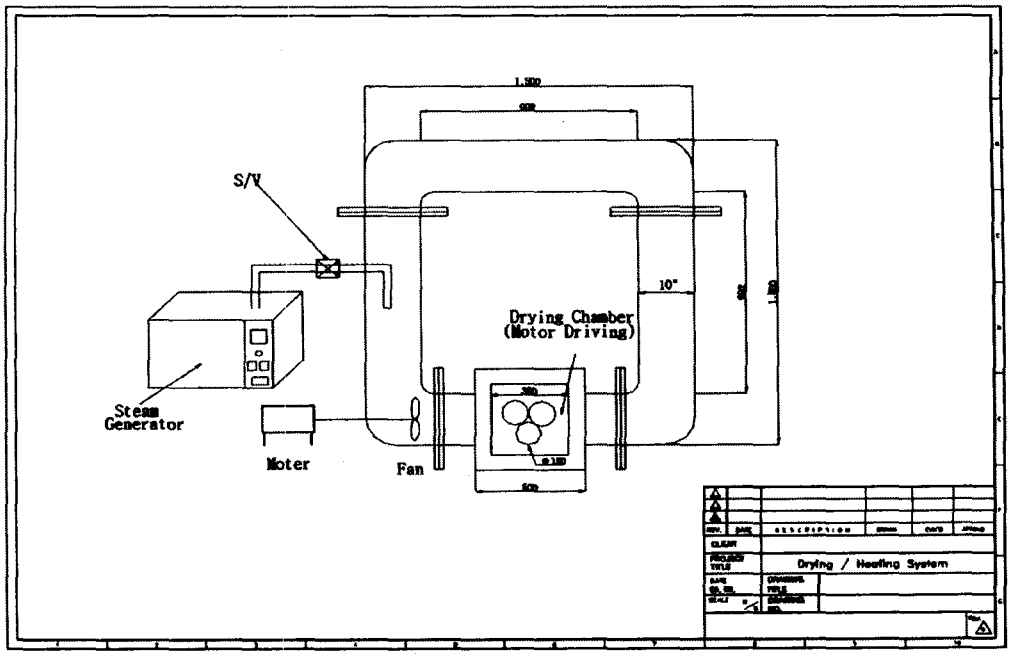

Fig. 3 A plane figure of steaming and drying system.

2.3 Control program for steaming and drying processes

A computer program was developed for more precise control of steaming and drying. It was programmed using LabWindows/CVI. The main display of this program was shown in Figure 4.

The control program developed was used for controlling the temperatures and relative humidities of boiler and heater automatically as desired. Temperatures were measured by two thermocouples and relative humidities were measured by two thermocouples equipped with wet bulb measuring system.

2.4 Processing red ginseng by the pilot system

In order to test the performance of the pilot system developed, test runs of red ginseng manufacturing were conducted. In these experiments, six years old raw ginseng was used, which was harvested in the late of February 2000. Tests were carried out three times as 4days, 10days, 17days after harvesting raw ginseng, and three roots of raw ginseng were processed at each time.

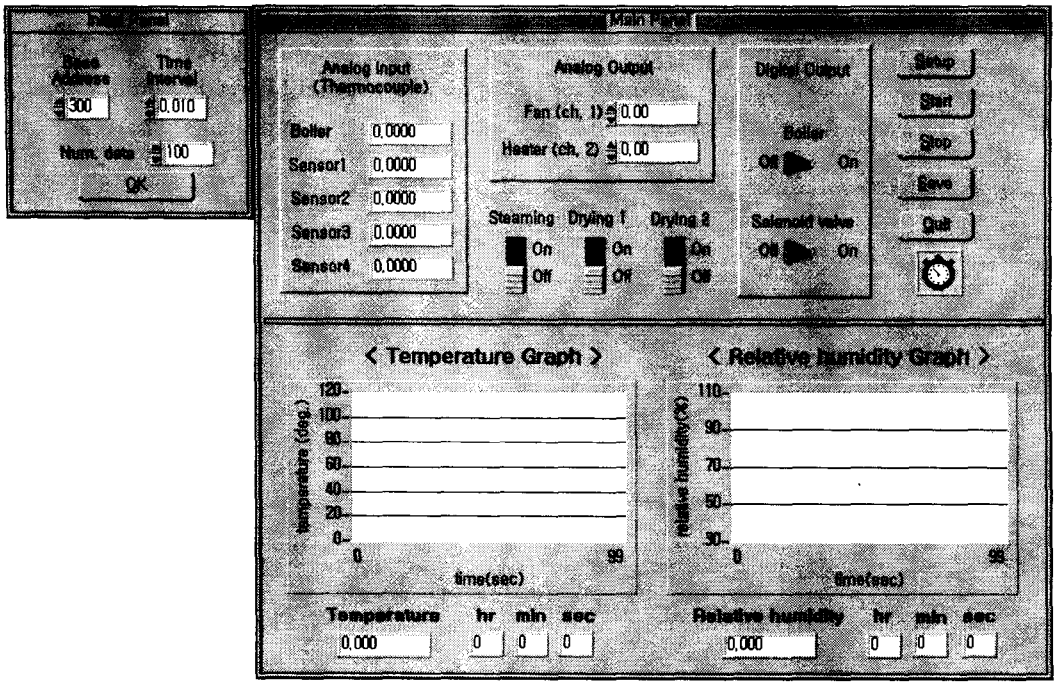

Fig. 4 A sample display of processing control program.

Results and Discussion

3.1 Performance of the pilot system

When the pilot system was operated, it took ten minutes for raising temperature of airflow from 10℃ to 120℃ and three minutes for relative humidity from 10% to 97%, which are operating ranges of the system. For the boiler, it took twelve minutes thirty seconds for heating water from 18℃ to 99℃ under the ambient temperature of 18℃.

During the processes of test run, the steaming process for red ginseng was successfully conducted, and the drying temperatures of the first drying period and the second drying period were properly maintained as designed.

3.2 Results of red ginseng manufacturing by the pilot system

The processing results of red ginseng showed that three roots among nine roots processed had external cracks and inside white. The ones without external defects also had inside cavity and inside white.

After inspecting the physical quality, the constituents of crude saponin were analyzed using analytical TLC(Thin Layer Chromatography, Merck) plate. The standard sample of saponin used was purchased from The Korea Ginseng & Tobacco Research Institute.

As Figure 5 showed, the constituents of crude saponin of red ginseng processed by the pilot system were almost same as those of the standard. According to this result, as far as the quality of constituent of red ginseng processed concerned, it would be concluded that the function of the pilot steaming and drying system was accomplished and conformable to the design objectives.

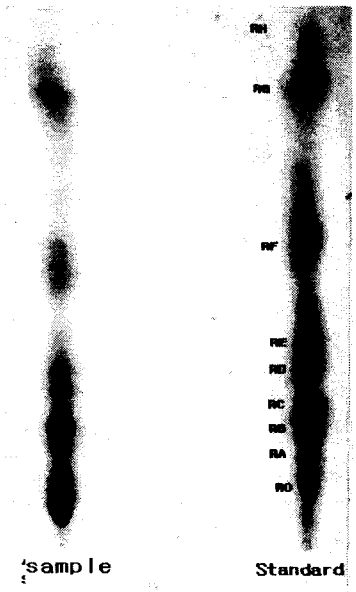

Fig. 5 Comparison of the test results of the constituents of crude saponin of red ginseng processed with the standard sample of saponin.

Conclusions

The objectives of this study were to develop a pilot drying system that has a control capability for the variables of red ginseng processing, to investigate the mechanism of physical changes occurring during the manufacturing process of red ginseng using a drying system developed, and then to develop a manufacturing process for producing the best quality red ginseng.

From this study the following conclusions would be obtained :

1) The operating capacity of steaming and drying system was designed for three roots of raw ginseng per batch. In order to accommodate those, the dimension of steaming and drying chamber was designed as 350×350×350㎜ based on the six years old and first grade raw ginseng.

2) A glass window was installed on the top side of chamber for the purpose of monitoring the various conditions of ginseng during the steaming and drying process. For monitoring these, physical eyes and/or image processing equipment may be used. Therefore, the steaming operation and the drying operation can be performed

continuously within a chamber.

3) Three cylindrical porous trays were designed to achieve uniform process conditions of steaming and drying for red ginseng manufacturing, and these were installed in the chamber and rotated with the speed of 0-10rpm by the speed variable motor. In order to prevent the red ginseng to stick to the trays during the steaming and drying processes, the trays were coated with Teflon.

4) A computer program was developed for more precise control of steaming and drying processes. The control program developed was used for controlling the temperatures and relative humidities of boiler and heater automatically as desired.

5) During the processes of test runs, the steaming process for red ginseng was successfully conducted, and the drying temperatures of the first drying period and the second drying period were properly maintained as designed.

6) So far as the test runs concerned, the physical quality of red ginseng was not reached acceptable level. But, the quality of constituent of red ginseng processed was acceptable. Therefore, a further study would be needed for obtaining the optimum operating conditions of pilot system in order to achieve the acceptable level of physical quality.

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