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Research on the Quality of Natto Made Using Water Filtered through Carbonized Okara

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The adsorbent capacity of carbonized Soybean-curd refuse (called Okara) was inspected by measuring the concentration of chloride in water. The concentration of chloride in tap water was decreased when carbonized Okara was used as a filter. Thus, the removal of chloride in the tap water was confirmed. Using the filtered water in the manufacturing process of the fermented soybeans (called Natto) produced more positive results when compared to the former method. The effect of water filtered through carbonized Okara on the quality improvement of Natto is due to the removal of chloride, thus preventing the fermenting process from being damaged by chloride. It also decreased the chloride odour that was noticeable at various stages of Natto production.

Key words: Okara, Natto, recycling, carbonized material

1. INTRODUCTION

Okara is a by-product in the manufacturing process of Soybean-curd (called Tofu). An estimated 800 ,000 t is produced every year in Japan. Some Okara is reused in other foods, but the majority is used as food for animals or handled as industrial waste. For that reason, an efficient recycling method for Okara has been sought in order to reduce environmental damage as well as the disposal cost involved.

In this study, the viability of using carbonized Okara to adsorb chloride from the water was discussed. An attempt was made to improve the quality of the Natto by using this filtered water to ferment soybeans during the manufacturing process.

2. EXPERIMENTAL

2.1 Preparation of carbonized Okara powder

The dried Okara was carbonized at 650℃ for 1 hour (the heating rate was 5.4℃/min.) using a vertical tube furnace. The carbonized Okara was then crushed with a disk mill (Kawasaki, T-100), and it was sifted through a sieve with 230 mesh. The presence of functional groups was examined by detecting absorption peaks with FT-IR (Perkin Elmer, Spectrum One) equipped with ATR accessory (Perkin Elmer, Universal ATR). The specific surface area of the carbonized Okara powder was determined by the BET method (Shimadzu-Micromeritics, FlowSorb II 2300). The surface morphology observation of the carbonized Okara powder was carried out with a scanning electron microscope (Hitachi, S-800). The crystal structure of carbonized Okara powder was determined with an X-ray diffractometer (Shimadzu, XD-610). The FT-IR and XRD tests were also performed on Okara powder made at temperatures ranging from 550 to 700℃. These served as reference points for the tests carried out on the Okara powder carbonized at 650℃.

2.2 Fermentation test of Natto using water filtered through carbonized Okara

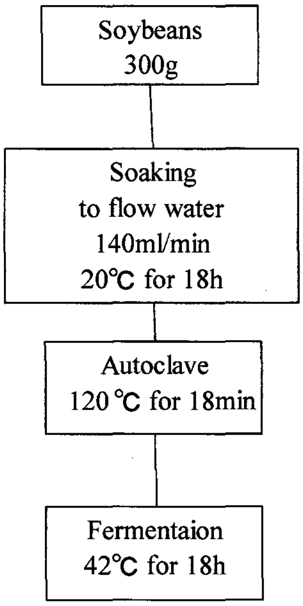

Fig. 1 The fermentation process of Natto.

Table 1. The criteria of sensory evaluation.

Attributes	Criteria and evaluation value +3	0	-3
Color	light		dark
Look	good		bad
Smell	good		bad
Viscousness	strong		weak
Hardness	soft	⇔	hard
Flavor	good		bad
Bitterness	none		bad
Smoothness	smooth		rough
Comprehensive evaluation	good		bad

Tap water filtered through carbonized Okara powder was used for the production of fermented soybeans (called Natto). Figure 1 shows the flowchart of conventional Natto production. The water was filtered through a column (ϕ =65mm, height=140mm) of carbonized Okara, and then was used during the soaking process. The water flow rate was 140 ml min^{-1} under both untreated and treated conditions, and the concentrations of chloride were detected by DPD method [1, 2]. The quality of Natto made by using water filtered through carbonized Okara powder was then estimated by sensory evaluation with 9 panelists for 9 attributes. The attributes were color, look, smell, viscousness, hardness, flavor, bitterness, smoothness, and comprehensive evaluation (or overall appeal). The criteria of this test is shown in TABLE I. It was compared to the Natto made by the conventional method of using untreated tap water.

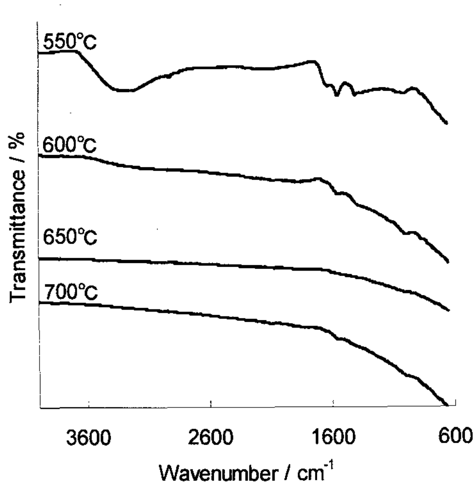

Fig. 2 The FT-IR spectra of Okara powder carbonized at various temperatures.

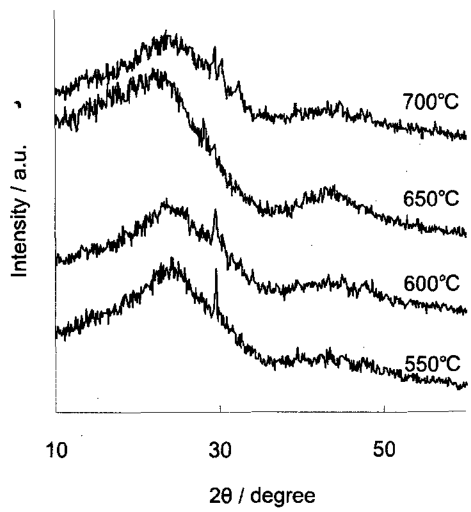

Fig. 3 The XRD patterns of Okara powder carbonized at various temperatures.

3. RESULTS AND DISCUSSIONS

3.1 Characteristics of carbonized Okara powder

The yield rate of the carbonized Okara powder at 650℃ carbonization was ca 30wt% at dried Okara. The Okara

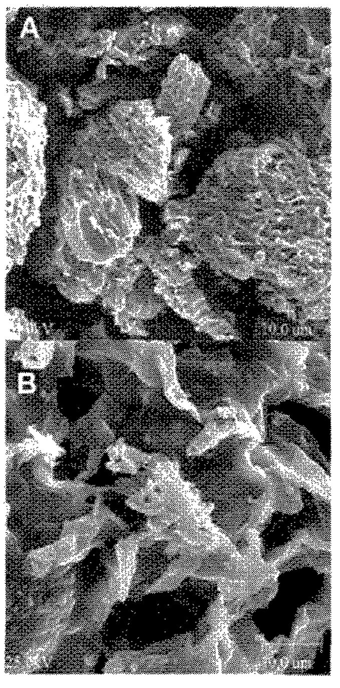

Fig. 4 SEM images of Okara powder carbonized at 650℃ (Magnification are A: 200 and B: 2,000).

contains water (75.5wt%), protein (6.1wt%), lipid (3.6wt%), carbohydrate (13.8wt%), and ash (1wt%) [3]. Figure 2 shows the FT-IR spectra of Okara powder carbonized at various temperatures. The absorption peaks caused by functional groups disappeared above 650℃. The X-ray diffraction patterns were shown in Fig.3. The broad peak near 25° observed in Okara carbonized at every temperature is considered to indicate that the crystallization of crystal with small size progressed [4]. The specific surface area of carbonized Okara powder was 3.87 m^2 g^{-1}. This value is not high compared to those of the conventional active carbon. The pores, however, proved to be dozens of micrometers in diameter, as observed with a SEM (Fig.4). Therefore, the adsorbent capacity of carbonized Okara powder has a weak point that the surface area is small, but it is superior to other materials because its larger pores allow greater water permeability.

3.2 Fermentation test of Natto using water filtered through carbonized Okara

The concentration of chloride in the tap water was 0.17 ppm. When the tap water was filtered using the carbonized Okara column, it showed a chloride removal effect; the concentration of chloride was decreased to 0.02ppm (the detection limit of DPD method). Figure 5 shows the result of sensory evaluation of Natto made using water filtered through carbonized Okara, compared to Natto made with untreated tap water. The former rated higher than the latter. The ratings of flavor, bitterness, and comprehensive evaluation were particularly high. The chloride smell that can be detected in the untreated water process suggests that chloride remains in the autoclave and is present during the fermentation process as well. The chloride in the tap water was added for the purpose of disinfecting – essentially killing or repressing bacteria. It is possible, therefore, that the chloride causes damage to the soybeans during the different stages of exposure to the tap water. These results show that the quality of Natto could be improved by using water with less chloride – water that has been filtered through carbonized Okara.

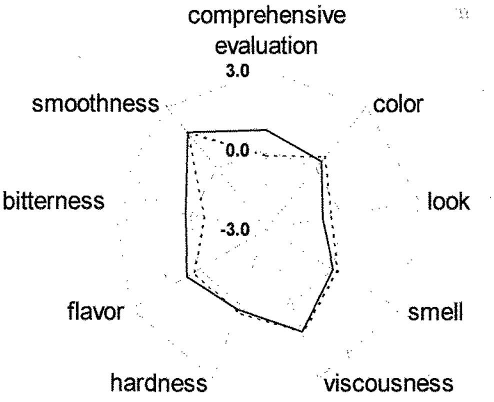

Fig. 5 The result of sensory evaluation of Natto made by using water filtered through carbonized Okara (solid line shows Natto made with treated water and broken line shows Natto made with untreated water). See Table 1.

4. CONCLUSIONS

The quality of Natto could be improved by using water subjected to carbonized Okara filtering. This paper also shows that the quality of the Natto can be improved by recycling factory waste. This, of course, contributes to environmental conservation by reducing industrial waste while also reducing the disposal costs related to this waste.

The observations in this paper come mainly from Okara material carbonized at 650℃. The specific surface area or chloride removal effect may vary at other carbonization temperatures. Further test over a wider range of temperatures may improve the performance of carbonized Okara material.

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