

Chemical study of ancient-type *kankyo*: the ginger fermented after soaked in water

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Abstract

Ginger is a crude drug which processed by various methods. In China, ginger fermented in ceramic pot after soaked in running water was used as *kankyo* ('hot' property) until the Song dynasty. However, in modern China dried ginger ('warm' property) is used as *kankyo*, and heated ginger ('hot' property) is used as *hokyo*, while in Japan, ginger soaked in hot water or steamed is called *kankyo*. Although the processing method of *kankyo* has changed, it is unclear whether the medicinal effects of ancient *kankyo* are similar to those of modern *kankyo* or *hokyo*. Therefore, in this study we prepared ancient-type *kankyo* and compared its pungent compound levels with those of modern *kankyo*. In addition, we analyzed the color values of our produced ancient *kankyo*.

As a result, the ancient-type *kankyo* displayed a higher 6-shogaol content. Furthermore, the *kankyo* displayed similar pungent compound levels to modern *kankyo* subjected to steaming or soaking in hot water for 1 hour. While, the 6-shogaol content of modern *hokyo* subjected to heating at 180°C was higher than that of the above-mentioned *kankyo*. Thus, we consider that 1) modern Japanese *kankyo* could have similar effects to ancient Chinese *kankyo* and 2) *hokyo* has a stronger 'hot' effect than ancient *kankyo* due to its higher 6-shogaol content.

In addition, we found the *L** (brightness) and *a** (redness) values of the ginger processed longer fermentation was lower and higher, respectively. Thus, we think that the color value of *kankyo* could be used as an index for fermented ginger.

Key words ginger, processing, ancient, fermentation, shogaol.

Abbreviation MA, the ginger processed by modified ancient method.

Introduction

Processed ginger has been used in Kampo medicine since ancient times. *Kankyo* is a form of processed ginger; however, various methods have been used to produce it.¹⁾ In China, ginger that had been fermented in a ceramic pot after being soaked in running water was used as *kankyo* until the Song dynasty. However, from the middle of the Qing dynasty dried ginger came to be

exclusively used as *kankyo*. At the same time, roasted ginger was used as *hokyo* or *kokukyo*. In the current Chinese Pharmacopoeia,²⁾ dried ginger is called *kankyo* (*ganjiang* in Chinese), and roasted ginger is called *hokyo* (*paojiang* in Chinese).

By the way, in Kampo medicines, each crude drugs have pharmacological natures, i.e., cold, cool, hot, warm, or neutral.³⁾ The natures of ancient-type *kankyo* and roasted ginger (*hokyo*) is considered to strong 'hot', while, that of dried ginger is 'warm'.¹⁾ Crude drugs with warm and hot natures can warm the body,⁴⁾ heal metabolic conditions, and activate the immune system.³⁾

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Thus we found the ginger which has strong 'hot' properties had been changed ancient-type *kankyo* to *hokyo*. However it is unclear whether the medicinal effects of ancient *kankyo* are similar to those of *hokyo*. In addition, the properties of ancient Chinese *kankyo* have not been scientifically investigated.

While in Japan, ginger that had been dried with lime after being steamed was originally used as *kankyo*. Then, the practice of using lime was stopped in the Meiji era. In the 16th Japanese Pharmacopoeia,⁵⁾ *kankyo* is described as ginger that has been soaked in hot water or steamed before being dried. Those gingers have been said to expect hot effect. However the differences of medicinal effects between Chinese ancient-type *kankyo* and Japanese modern *kankyo* have not been clear.

Therefore, in this study we prepared *kankyo* using a modified version of the ancient method and analyzed the concentrations of its pungent compounds (6-gingerol and 6-shogaol) as well as its color values. We also compared the pungent compound concentrations of the abovementioned *kankyo* with those of modern Japanese *kankyo* and Chinese *hokyo*.

Materials and Methods

Ginger material: Fresh ginger (breed name: *Sanshu*) was purchased from Sakata Nobuo Store Co., Kochi, Japan (2011).

Reagents: The 6-gingerol (purity: 98%) was purchased from Nacalai Tesque, Ltd., and the 6-shogaol (purity: more than 98%) was from Wako Pure Chemical Industries, Ltd. All chemicals were of analytical grade, and the chromatographic solvents were of high-performance liquid chromatography (HPLC) grade.

Preparation method: The ancient method used to produce *kankyo* was described in the medicinal literature 'Shennongbencaojingjizhu',⁶⁾ which was published before the year 500, as follows: fresh ginger is soaked in water for 3 days, before being peeled and then soaked in running water for a further 6 days. Next, the ginger is peeled again, dried in the sun, and placed in a ceramic pot for fermenting.

In this study, we used fresh ginger and processed it in

the laboratory. The fresh ginger was cleaned, and then 70 g ginger samples were processed using one of the following six methods:

(1) Modified version of ancient processing method (MA-type)

Ginger was soaked in water for 3 days, peeled, and then soaked in water for a further 6 days. The soaking water was changed every day. Then, the ginger was sliced into 5- to 7-mm-thick sections and dried at 40°C for 6 hours. Next, the pieces were placed in a glass bottle, before the bottle was sealed and then placed in a thermostatic oven set to 25°C for 6 days to ferment the ginger. Finally, the ginger was dried in an oven set to 40°C for two nights.

Methods (2) to (6) varied from method (1) as follows:

(2) The fermentation period was extended to 15 days. (++)fermentation)

(3) The first soaking period was extended to 6 days. (++)1st soaking)

(4) The second soaking period was extended to 9 days. (++)2nd soaking)

(5) 0.7 g of sugar was added to the glass bottle to accelerate fermentation. (+sugar)

(6) 0.2 g of yeast was added to the glass bottle to accelerate fermentation. (+yeast)

Fresh unprocessed ginger that had been dried in an oven for two nights was used as a control.

HPLC method: We used HPLC to determine the 6-gingerol and 6-shogaol contents of the processed ginger products. The HPLC was performed as described in a previous paper.⁷⁾

Color analysis: We evaluated the light reflected by powdered samples of each processed ginger product using the parameters L^* (brightness), a^* (redness), and b^* (yellowness). The color analysis was performed as described in a previous paper.⁷⁾

Results

Changes in 6-gingerol and 6-shogaol contents (Fig. 1): We assessed the levels of pungent compounds (6-gingerol and 6-shogaol) in *kankyo* samples that had been processed using various methods based on the

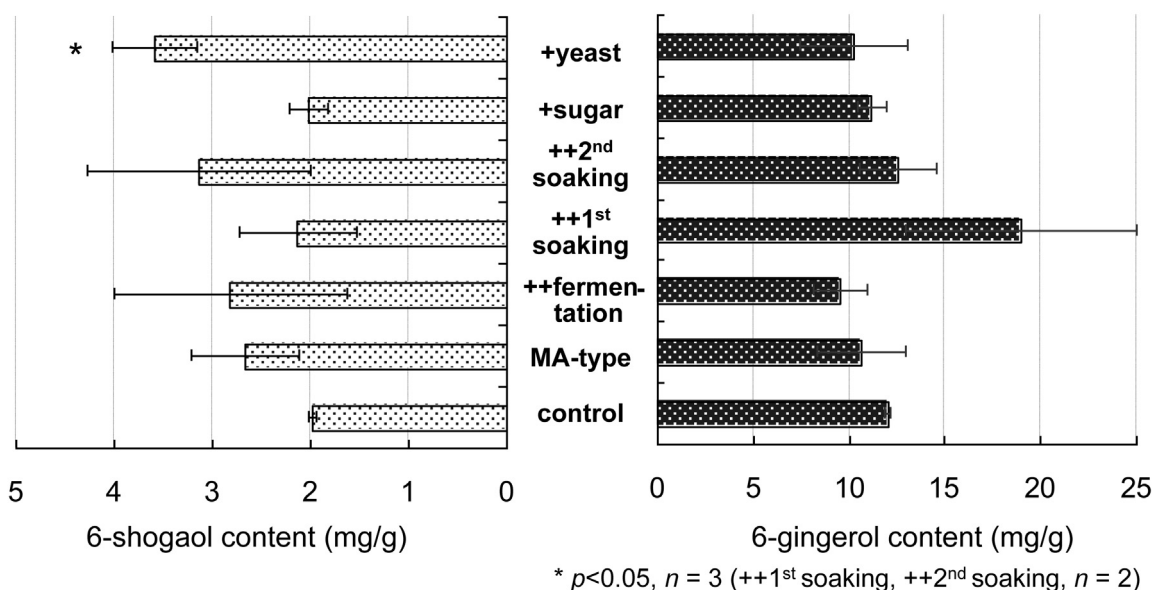


Fig. 1 The pungent compound contents of ancient-type *kankyo* produced with various methods.

MA-type indicates the ginger which processed by modified version of ancient processing method; + indicates adding yeast or sugar; and ++ means extending soaking or fermentation period.

ancient method used to produce *kankyo*. The 6-shogaol content of the MA-type *kankyo* was increased compared with that of the control. When the ginger of fermentation period or the 2nd soaking period was increased, the 6-shogaol contents of the resultant products tended to be higher than that of the MA-type *kankyo*; however, these results displayed large margins of error. In addition, adding yeast during the fermentation stage significantly increased the 6-shogaol content of the resultant product compared with the untreated control. However, none of the methods had a significant effect on the 6-gingerol content of the resultant *kankyo*.

The differences between ancient *kankyo* and modern *kankyo* or *hokyo* (Fig. 2): We compared the pungent compound concentrations of the MA-type and +yeast and *kankyo* products produced in the present study with those of modern *kankyo* and *hokyo*. We obtained the data for modern *kankyo* and *hokyo* in a previous study,⁷⁾ in which *kankyo* was produced by soaking ginger in hot water for 1 to 3 hours or steaming it for 1 to 3 hours and *hokyo* was produced by heating ginger at 180°C for 1 to 3 hours. Soaking in hot water and steaming are both used to produce modern *kankyo*. Although modern *hokyo* is produced by roasting ginger, we produced it by heating ginger at a constant temperature of 180°C.

As a result, we found that the *kankyo* produced with

the MA-type or +yeast method contained similar levels of pungent compounds to those produced by steaming ginger for 1 hour or soaking it in hot water for 1 hour. While the 6-shogaol contents of the *kankyo* products that were heated for 2 hours or steamed for ≥ 2 hours were higher than those of the MA-type and +yeast ginger products, all of these *kankyo* products exhibited similar 6-gingerol levels.

Changes in the samples' color values: We analyzed the color values of powdered samples of the *kankyo* products produced by the above-mentioned methods. Under all conditions, the a^* values of the samples were negatively correlated with their L^* values ($r = -0.83$, $p < 0.001$) (Fig. 3-A). Conversely, no correlations were observed between their b^* values and their L^* or a^* values. When we compared the samples produced using the MA-type and ++fermentation methods, we found that their L^* values decreased and their a^* values increased as fermentation progressed, regardless of their b^* values (Fig. 3-B, C).

The relationships between the samples' color values and pungent compound levels: We found that the color values of the *kankyo* products produced with the abovementioned methods were correlated with their 6-shogaol compound levels as follows: the a^* values of

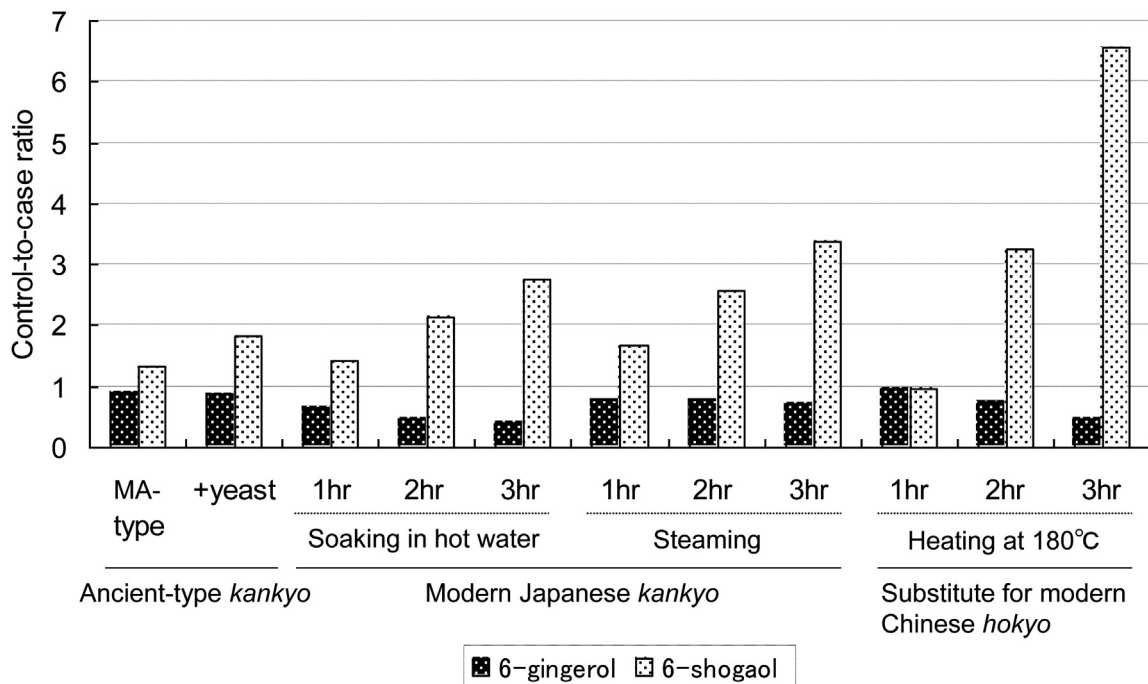


Fig. 2 Comparison between the pungent compound contents of some of ancient-type *kankyo* products and modern Japanese *kankyo* and Chinese *hokyo*.
The data for the ginger products that not belong to the ancient-type *kankyo* group were obtained in previous study.

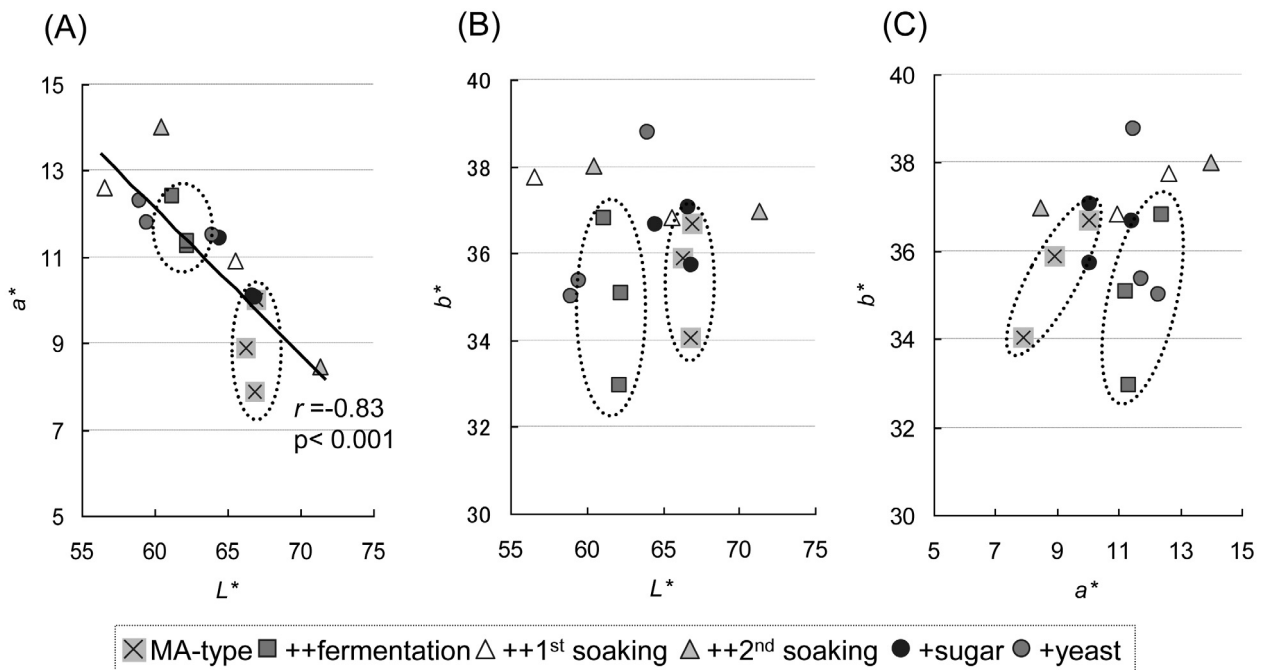


Fig. 3 The color values of powdered ancient-type *kankyo* samples.
The graphs show the relationships between the L^* (brightness) and a^* (redness) values (A), L^* and b^* (yellowness) values (B), or a^* and b^* values (C) of the powdered *kankyo* samples.
The dotted frames indicate comparison of old-type and ++fermentation.

the *kankyo* products were positively correlated with their 6-shogaol levels ($r = 0.58, p < 0.05$) (Fig. 4-A), and

their L^* values were negatively correlated with their 6-shogaol levels ($r = -0.57, p < 0.05$) (Fig. 4-B).

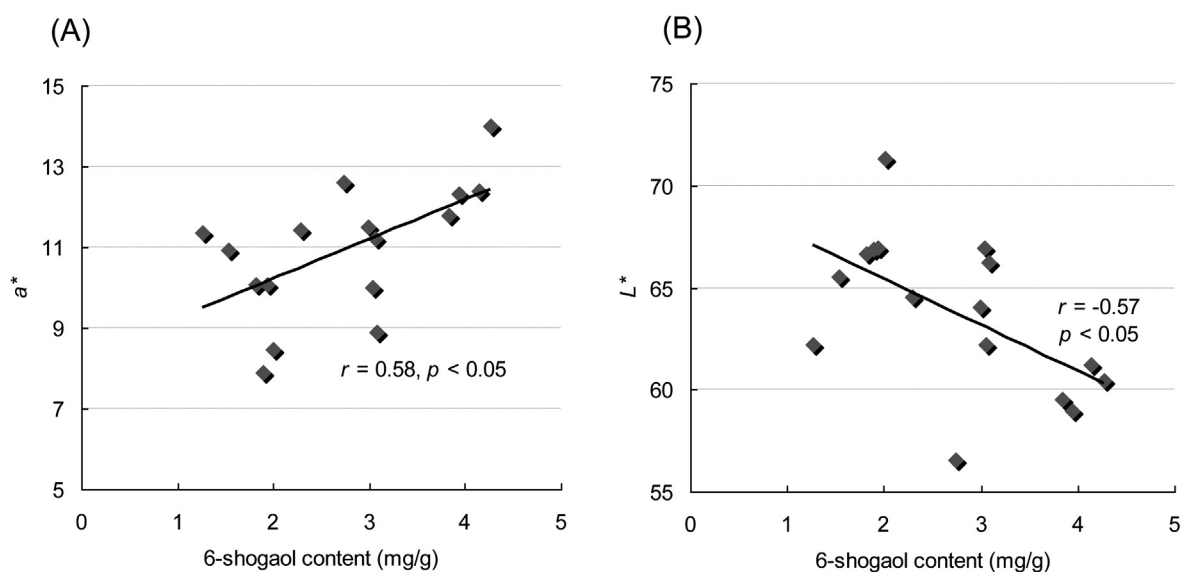


Fig. 4 The relationships between the a^* or L^* values and 6-shogaol contents of ancient-type *kankyo* products.

Discussion

We obtained the following findings regarding the pungent compound levels and color values of ancient *kankyo*:

1. The *kankyo* produced with the MA-type method exhibited an increased 6-shogaol concentration compared with untreated ginger. As 6-shogaol is considered to be more pungent than 6-gingerol,⁸⁾ we considered that the ancient method increases the ‘warm’ effect of 6-shogaol. This result agrees with the description of *kankyo* in the ancient medical literature, ‘*mingyibieliu*,’⁹⁾ which suggests that its essence is quite ‘hot’.

2. The method we used to produce ancient *kankyo* can be divided into 3 processes; i.e., soaking with water without peeling, peeling followed by soaking with water, and fermentation. Extending the second period of soaking or the fermentation period increased the 6-shogaol content of the product; however, the error values of these results were quite large. While extending the first period of soaking increased the 6-gingerol content of the product, it had no effect on its 6-shogaol content. We consider that this was because it caused the ginger to decay, which would have resulted in an increase in its 6-gingerol content.

3. As for adding yeast during the fermentation process, it resulted in a significant increase in the 6-shogaol content of the product, whereas adding sugar had no

effect on the 6-shogaol content of *kankyo*. Thus, we concluded that yeast is responsible for the ginger fermentation that occurs during *kankyo* production, while the sugar in ginger might inhibit fermentation.

4. The pungent compound concentrations of the ancient *kankyo* products produced with the MA-type and +yeast methods were similar to those of modern Japanese *kankyo* that had been steamed or soaked in hot water for 1 hour. Thus, modern Japanese *kankyo* products that are produced using these methods can be expected to have similar effects to ancient Chinese *kankyo*.

Meanwhile, the 6-shogaol content of ginger that had been subjected to heating at 180°C for 2 hours was higher than that of ancient *kankyo*. Therefore, we expect *hokyo*, which was first used as a substitute for ancient *kankyo* in China during the Ming dynasty, have a ‘hot’ effect due to its increased 6-shogaol content compared with ancient *kankyo*.

5. We found the L^* value of the ginger processed by ++fermentation methods was lower than, and a^* value of ++fermentation ginger was higher than, those of MA-type; i.e., the ginger became darker. Furthermore, when we compared the two values of all of ancient-type ginger, these were negatively correlated ($r = -0.83, p < 0.001$). Thus, we think that the color value of *kankyo* could be used as an index for fermented ginger. We need further study to investigate the relationship between fermented periods of ginger and the change of

color values.

We⁷⁾ previously reported that the L^* values of ginger samples that had been heated for different periods were negatively correlated with their a^* values. In addition, we found that the color change exhibited by fermented ginger was similar to that displayed by heated ginger. However, in the present study the L^* values of the heated ginger samples were positively correlated with their b^* values, and their a^* values were negatively correlated with their b^* values, whereas no such relationships were detected for fermented ginger.

6. We found that the a^* values of the *kankyo* products we produced were positively correlated with their 6-shogaol levels. In addition, the L^* values of the *kankyo* products were negatively correlated with their 6-shogaol levels. However, because we need to consider the margin of error introduced by long term processing, it is difficult to predict the 6-shogaol contents of *kankyo* products from their a^* and L^* color values.

7. In this study, we compared the pungent compound concentrations of ancient and modern *kankyo*. Further studies into the differences in the medicinal effects of these types of *kankyo* are required.

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