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Effect of Strawberry Puree on the Physicochemical Properties of *Kochujang*

-Research Note-

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Abstract

Quality characteristics of *kochujang* prepared with strawberry puree (10, 20, and 30% on the total weight basis) were investigated after 30 and 300 days of storage. The moisture content of strawberry *kochujang* at 300 days was considerably higher than that of strawberry *kochujang* at 30 days and increasing strawberry content from 0 to 30% significantly increased moisture content of *kochujang* progressively ($p<0.05$). Water activity and titratable acidity also showed similar trends, but pH showed the reverse trend with the highest value in control at 30 days and the lowest value in 30% strawberry *kochujang* at 300 days. As the strawberry puree content increased, amino-nitrogen content consistently and correspondingly decreased. Amino-nitrogen content at 300 days was higher than that of strawberry *kochujang* at 30 days. Soluble solids content also showed a similar trend, but soluble solid content at 300 days was considerably lower than that of strawberry *kochujang* at 30 days. Reduction in soluble solids content with increasing strawberry concentration was more evident at 30 days than at 300 day.

Key words: strawberry, puree, *kochujang*, physicochemical properties

INTRODUCTION

Kochujang, a fermented hot pepper-soybean paste, has been used for a long time along with other fermented traditional Korean condiments such as soybean paste and soy sauce. The hot, sweet, and savory tastes of *kochujang* originate from digestion of ingredients such as soybean, starch, and red pepper (1-4). There is growing interest in *kochujang*, due to its effects on body weight and blood-pressure reductions and high poly-γ-glutamate content. It also contains more vitamin B_1, B_2, C, and folic acid than *doenjang* (soybean paste) or *ganjang* (soy sauce) (3). The quality of *kochujang* usually depends on the microorganisms which control the aging process, ratio of raw materials, and fermentation time. Recent studies have mainly focused on intervening in the aging process by adding chitosan (1), sake cake (5), natural preservatives (6), and alcohol (7). In addition, to improve the functionality of *kochujang*, there have been various attempts increase the bioactive components by adding kiwifruit (8), *Lycium chinense* fruit (9), sea tangle and chitosan (10), and apple and persimmon (11).

Fruits and vegetables are known to strongly contribute to reduced risks of diseases such as cancer, heart attack, and stroke (12). This fact is attributed to the large amounts of antioxidants they contain. There is increasing interest in the benefits of the strawberry including increased plasma antioxidant capacity in humans (13), antioxidant activity for low density lipoproteins (14), and anti-carcinogenic activity against human and mouse cancer cells (15,16). Strawberry fruit also have high ascorbic acid concentrations which have protective roles against reactive oxygen species (17). As major contributors to the total phenolic contents, as well as important to fruit color, anthocyanins also have potent antioxidant properties (18) and reduce oxidative stress-induces neurotoxicity (19). Strawberry is reported to serve as one of our most important dietary sources of phenolic compounds (20,21).

In this study strawberry puree was added at different concentrations to improve the functional properties of *kochujang* and changes in physicochemical characteristics at 30 and 300 days were investigated.

MATERIALS AND METHODS

Materials

Kochujang pre-mixture was obtained from Poorun Foods Co., Ltd., which was prepared by blending wheat powder (22%), wheat grain (20%), salt (10.5%), and purified water (47.5%). Wheat flour was first steamed with pressure after spraying the warm water and blended with ground wheat grain (inoculated with 0.05% spore suspension of *Aspergillus oryzae* starter and incubated at 35~40°C for 48~52 hr) in uniform sizes and salt, then stored in a fermentation tank for 1 month. Corn syrup

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(100% corn starch, TS Co., Ltd., Incheon, Korea), red pepper powder, mixed condiments (contained 38% red pepper powder, 15% salt, 7% garlic, and 4% onion), and spirits (Haitai Company, Seoul, Korea) were also obtained from Poorun Foods Co., Ltd. Fresh strawberry was obtained from a local market, which were cultivated at Koryeong (Gyeongbuk, Korea), washed with tap water, and drained. Strawberries were pureed using a hand blender and simmered at 80°C for 15 min.

Kochujang preparation

Kochujang was prepared using the commercially manufacturing practice by Poorun Foods Co., Ltd. Aged *kochujang* pre-mixture and 30% corn syrup were pasteurized at 70°C while blending 8% mixed condiments, 8.6% red pepper powder, 3% spirits, and different amounts of strawberry puree (0, 10, 20, and 30%). The mixtures were then cooled to 40～45°C, placed in a pot, and aged for 300 days at room temperature (23～24°C).

pH and titratable acidity measurement

Five g of sample was quantified to 100 mL with distilled water and filtered. Ten mL of filtrate were titrated by 0.1 N silver nitrate for determination of sodium chloride. Five grams of sample mixed with 45 mL distilled water were prepared to measure the pH of strawberry *kochujang* with a pH meter (PMK210, Radiometer, France) at room temperature. The titratable acid was determined as the titration volume in mL of 0.1 N NaOH needed to bring the pH to 5.3 after homogenization.

Moisture content and water activity measurement

The moisture content was determined using a convection oven at 105°C overnight (22). Water activity of each sample was measured using a water activity meter (TH-500, Novasina, Swiss).

Amino-nitrogen measurement

Kochujang (5 g) was well mixed with 250 mL of distilled water and filtered (23). Twenty mL of neutral formalin (pH 8.3) was added to the mixture as above, and the pH was again adjusted to 8.4 with 0.05 N NaOH. The final titrated volume was used to calculate the amino-nitrogen content. The distilled water was used as the blank test.

NaCl and soluble solids content measurement

NaCl content was determined by the Mohr method (24). Five grams of *kochujang* pre-mixture were homogenized with 250 mL distilled water and filtered. Ten mL of filtrate were titrated with 0.1 N silver nitrate after adding 1 mL of 2% K_2CrO_4 solution. Soluble solids content was determined at room temperature with a refractometer (PR-301, Atago Co., Tokyo, Japan).

Statistical analysis

Duncan's multiple range test was used to compare the differences of means among treatment groups. Differences between means were tested at the 5% level of significance. All measurements were done in triplicate.

RESULTS AND DISCUSSION

pH and titratable acidity

Changes in pH and titratable acidity of strawberry *kochujang* at different concentrations are shown in Fig. 1. In general, pH decreased while titratable acidity increased due to organic acid produced by microorganisms during the storage of *kochujang*. A significant reduction ($p<0.05$) in pH with increasing strawberry concentrations was clear and the pH of strawberry *kochujang* at 300 days was considerably lower than that of strawberry *kochujang* at 30 days. pH difference in the same

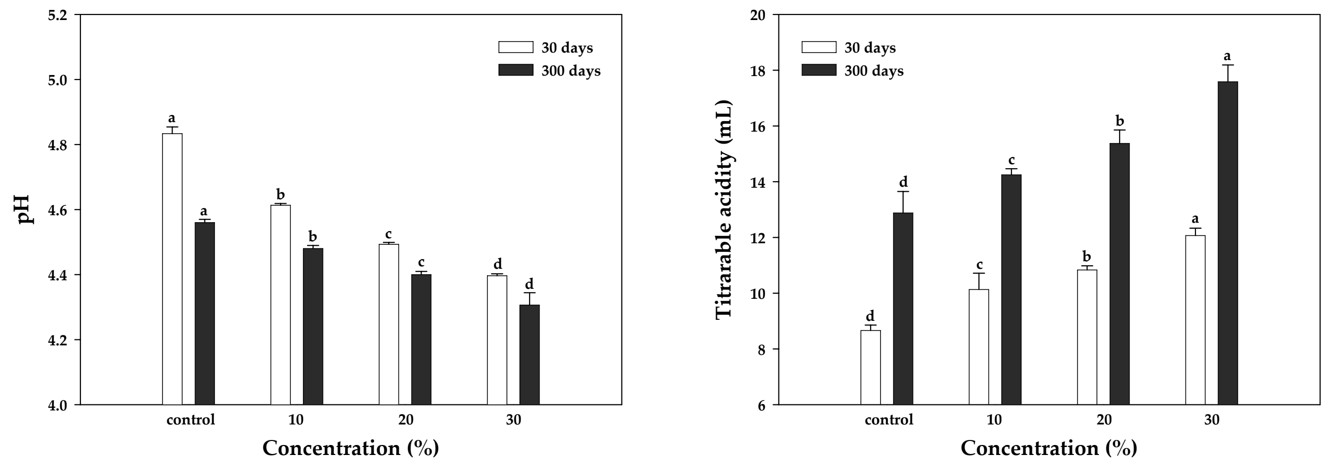

Fig. 1. Changes in pH and titratable acidity as affected by concentration of strawberry puree. Any two means in the same storage period with the same letter are not significantly different by Duncan's multiple range test ($p<0.05$).

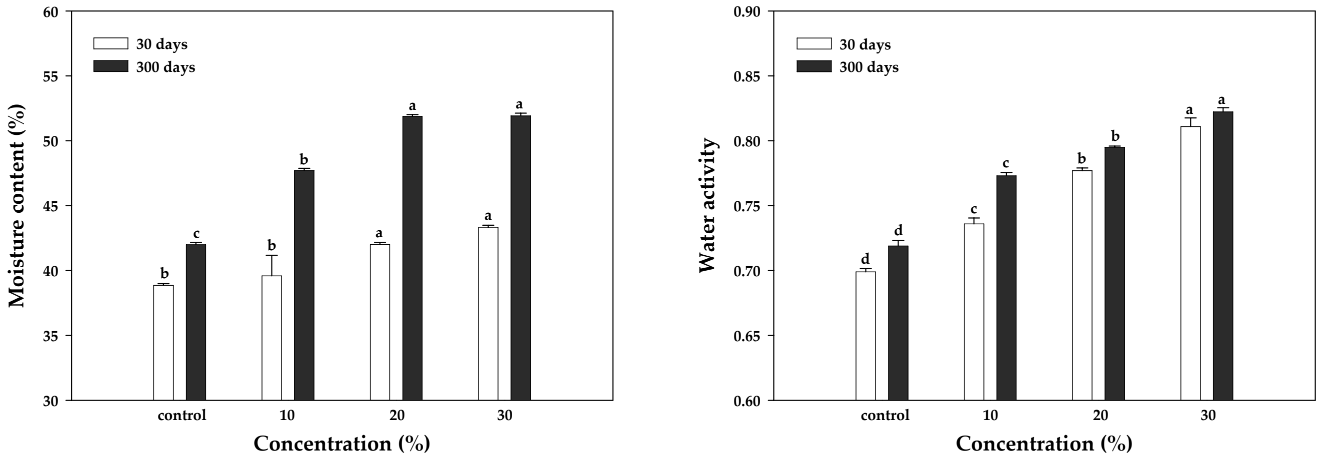

Fig. 2. Changes in moisture content and water activity as affected by concentration of strawberry puree. Any two means in the same storage period with the same letter are not significantly different by Duncan's multiple range test ($p<0.05$).

strawberry concentration became smaller with the increasing strawberry concentration. Similar results were reported by Choo and Shin with pumpkin (25) and Lee and Lee with *maesil* (26), due to the high amount of organic acid in pumpkin and *maesil*, respectively. The pHs of strawberry *kochujang* were 4.31～4.61 and these were similar to the results of Shin et al. (27) who reported an average pH of traditional *kochujang* in Cheonbuk is 4.49 and that the Korean National average is 4.60. Kim and Song (8) also reported similar results of 4.58～4.64 with kiwifruit. However, Kim and Lee (28) reported 4.65～4.78 with various condiments and Choo and Shin (25) reported 4.76 with pumpkin, which were higher than ours.

Changes in titratable acidity show that acidity of strawberry *kochujang* at 300 days was considerably higher than that of strawberry *kochujang* at 30 days in all strawberry puree concentrations. As the strawberry puree content increased, titratable acidity consistently correspondingly increased (Fig. 1). Titratable acidities of strawberry *kochujang* were 10.13～17.58 mL/g. A similar result was reported by Oh et al. (6), with natural preservatives and Lee and Lee (26) also reported 9.87～19.33 mL/g with *maesil*. Choo and Shin (25) also reported similar values with pumpkin.

Moisture content and water activity

Changes in moisture content are shown in Fig. 2. Moisture contents and water activities were significantly increased ($p<0.05$) with increasing strawberry concentration. The moisture content of strawberry *kochujang* at 300 days was also significantly higher than that of strawberry *kochujang* at 30 days. Increased moisture content was also reported by Kim and Lee (28) with garlic and onion, which was due to the free water produced by enzyme hydrolysis of macromolecules during fermentation and interference with dehydration because of the closed container (10).

Water activities were also significantly increased ($p<0.05$) with increasing strawberry concentration. Kim et al. (9) also showed similar results with *Lycium chinense* and Lee and Lee (26) with *maesil*. Interestingly, they showed water activities decreased during fermentation, in contrast, water activities of strawberry *kochujang* at 300 days was higher than that of strawberry *kochujang* at 30 days.

Amino-nitrogen content

Amino-nitrogen content represents the degree of soy protein hydrolysis by various microorganisms and also shows the amount of free amino acid, which influences the quality of soy product. The higher free amino content, the more savory taste after fermentation. The changes in amino-nitrogen content of strawberry *kochujang* are shown in Fig. 3. Amino-nitrogen content decreased significantly with increasing strawberry concentration ($p<0.05$) and amino-nitrogen of strawberry *kochujang* at 300 days was higher than that of strawberry *kochujang* at 30 days. Strawberry *kochujang* at 300 days showed 115.48～169.98 mg% of amino-nitrogen content, which was similar to the results of Park et al. (29) with various fruit juices and Kwon and Kim (10) with sea tangle and chitosan.

NaCl and soluble solids content

Changes in NaCl content are presented in Fig. 4. NaCl content of strawberry *kochujang* at 300 days was considerably higher than that of strawberry *kochujang* at 30 days in all samples where strawberry concentration changed from 10 to 30%. The NaCl content significantly

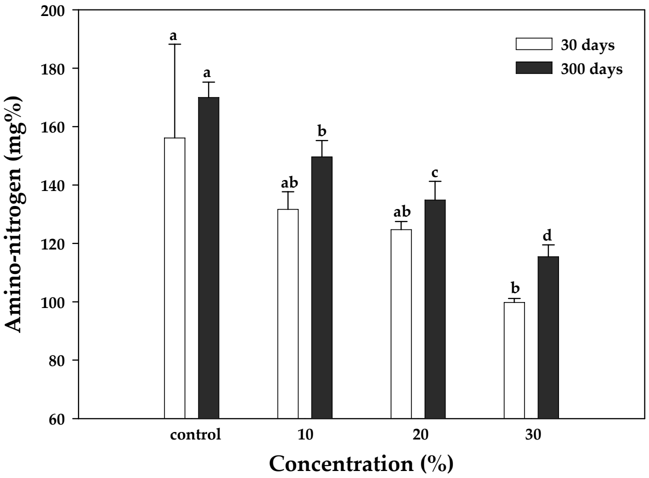

Fig. 3. Changes in amino-nitrogen content as affected by concentration of strawberry puree. Any two means in the same storage period with the same letter are not significantly different by Duncan's multiple range test ($p<0.05$).

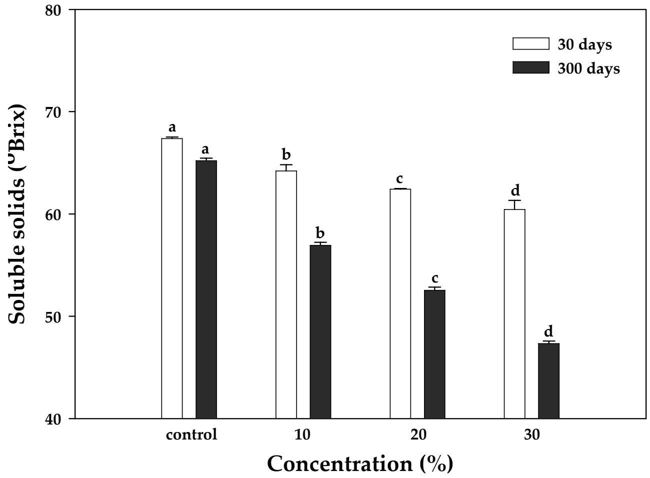

Fig. 5. Changes in soluble solids content as affected by concentration of strawberry puree. Any two means in the same storage period with the same letter are not significantly different by Duncan's multiple range test ($p<0.05$).

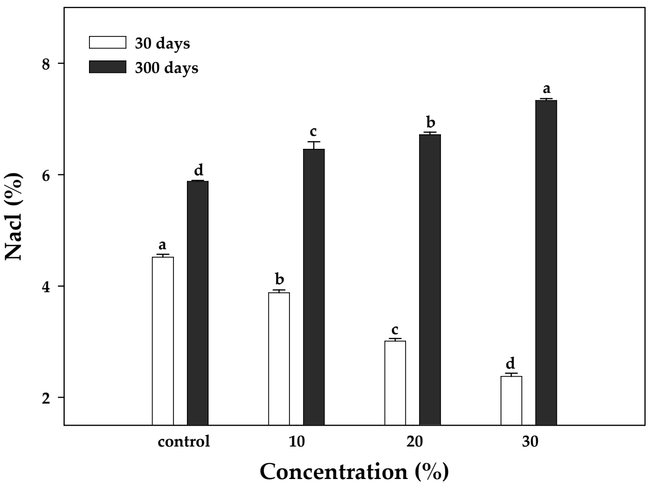

Fig. 4. Changes in NaCl content as affected by concentration of strawberry puree. Any two means in the same storage period with the same letter are not significantly different by Duncan's multiple range test ($p<0.05$).

decreased with increasing strawberry concentration at 30 days from 4.52% for control to 2.38% for 30% sample ($p<0.05$). On the contrary, NaCl content significantly increased with increasing strawberry concentration at 300 days from 5.88% for control to 7.33% for 30% sample ($p<0.05$). Previous reports also indicated that NaCl content increased during fermentation in *Lycium chinense kochujang* (9) and *maesil kochujang* (26). The NaCl contents obtained for strawberry *kochujang* were lower than those reported for *kochujang* made with sea tangle and chitosan (10) and *Lycium chinense* (9). Those values ranged 8.66～9.13% and 10.18～10.75%, respectively.

The changes in soluble solids are shown in Fig. 5. As the strawberry puree content increased, soluble solid content consistently correspondingly decreased. Soluble solid content at 300 days was considerably lower than that of strawberry *kochujang* at 30 days for all samples. Reduction in soluble solids content was more pronounced at 30 days than at 300 day. At 30 days, soluble solids content significantly decreased from 67.37% for control to 60.43% for the 30% sample; at 300 days, soluble solids content significantly decreased from 65.20% for control to 47.33% for 30% sample ($p<0.05$).

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