Journal of Food Technology 6 (1): 34-38, 2008
ISSN: 1684-8462


# Physicochemical Properties of *Kochujang* Pre-mixture Blended with *Prunus mume* Extract During Aging

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**Abstract:** Changes in physicochemical properties of *kochujang* pre-mixture blended with *maesil* extract during aging were investigated. Wheat powder was first steamed with pressure after spraying the warm water and blended with polished wheat and salt, then stored in a fermentation tank for 2 days prior to blending with different concentrations (0, 10, 20 and 30%) of *maesil* extract. In general, pH appeared to decrease but titratable acidity increased during aging. Control showed a significantly higher pH but lower titratable acidity. Increased *maesil* extract concentration up to 40% significantly decreased the pH but increased the titratable acidity regardless of time of aging ($p<0.05$). Moisture content increased significantly with *maesil* extract content ($p<0.05$) but water activity continued to decrease with the aging time in all samples. Reducing sugar content was lower with *maesil* extract and continued to increase during aging in all samples. Gradual decrease in NaCl content was observed during aging. The amount of *maesil* extract has a negative effect on $L^*$-value but positive effect on $a^*$-value.

**Key words:** *Kochujang*, pre-mixture, *Prunus mume, maesil*, physicochemical

## INTRODUCTION

*Kochujang*, a fermented hot pepper-soybean paste, is a popular traditional condiment in Korea and used for a long time along with soybean paste and soy sauce to provide hot, sweet, savory tastes in foods. The various tastes of *kochujang* originate from raw materials, free sugars and free amino acids produced by microorganism and enzyme hydrolysis of raw materials during fermentation (Lee *et al*., 2007). *Kochujang* can be classified into two types: Traditional *kochujang* using *meju* and commercial *kochujang* using *koji* or bacterial enzymes. Generally, *meju kochujang* is made of glutinous rice, *meju*, red pepper powder and others (Yoo and Choi, 1999), which are fermented by enzymatic reactions of bacteria and yeasts and requires a long fermentation and aging period. In *koji kochujang*, *koji* which is glutinous rice inoculated with *Aspergillus oryzae*, is used instead of meju (Yoo, 2001) and fermented for 1-3 months.

In preparation of *koji kochujang* (commercial *kochujang*), *kochujang* pre-mixture (mixture of wheat powder, polished wheat, salt and purified water) is usually used. The pre-mixture is fermented for certain period of time depending on the season prior to the blending with corn syrup, red pepper powder, mixed condiments (contained 38% red pepper powder, 15% salt, 7% garlic and 4% onion) and spirits to produce the *kochujang*. The physicochemical properties of the pre-mixture will affect the total quality of *kochujang* but studies on the changes in the pre-mixture during aging have not been reported.

The purpose of this study was to investigate the changes in physicochemical properties of *kochujang* pre-mixture substituted with *Prunus mume* extract (*maesil* extract) during aging. *Maesil* extract was added in order to produce functional property-added commercial *kochujang*. The functional properties of *maesil* have been well documented (Lee *et al*., 2002; Park and Hong, 2003; Lee and Shin, 2001; Bae *et al*., 2000).

## MATERIALS AND METHODS

**Preparation of *kochujang* pre-mixture:** *Kochujang* pre-mixture was prepared by blending wheat powder (22%), polished wheat (20%), salt (10.5%) and purified water (47.5%). Wheat powder was first steamed with pressure after spraying the warm water and blended with polished wheat and salt, then stored in a fermentation tank for 2 days and then in a pot at room temperature (23.6°C) for 10 days prior to substituting with *maesil* extract. *Kochujang* pre-mixture was then blended with different concentrations (0, 10, 20 and 30%) of *maesil* extract prior to aging and experimental measurements. *Maesil* extract was purchased from Saehan *Maesil* Farm (Miryang, Gyeongnam, Korea) and the soluble solid content and pH

Table 1: Formulation of *kochujang* pre-mixture with *maesil* extract substituted

| | Pre-mixture concentration | | | |
|---|---|---|---|---|
| Materials | 0% | 10% | 20% | 30% |
| Wheat powder | 22 | 19.8 | 17.6 | 15.4 |
| Polished wheat | 20 | 18 | 16 | 14 |
| *Maesil* extract | 0 | 10 | 20 | 30 |
| Salt | 10.5 | 9.45 | 8.4 | 7.35 |
| Water | 47.5 | 42.75 | 38 | 33.25 |
| Total | 100 | 100 | 100 | 100 |

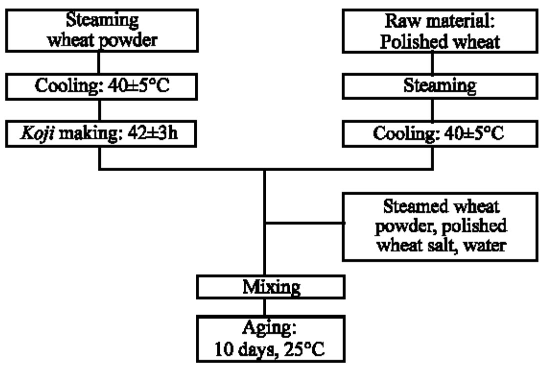


Fig. 1: Schematic diagram for the preparation of *kochujang* pre-mixture

of *maesil* extract were 68.3°Brix and 2.8, respectively. Table 1 and Fig. 1 show formulation and schematic diagram for the preparation of *kochujang* pre-mixture, respectively.

**pH and titratable acidity measurement:** Five gram of *kochujang* pre-mixture were blended with distilled water (sample: water = 1:9, w $w^{-1}$) for 1 min. The pH of the sample was determined using a pH meter (Model 340, Mettler Delta Co., Halstead, UK) at room temperature. Same sample was used to measure titratable acidity, amount of 0.1 N NaOH solution to titrate the sample beyond pH = 8.3. All measurements were done in triplicate.

**Moisture content and water activity measurement:** The moisture content was determined using convection oven at 105°C overnight. Water activity of each sample was measured using a water activity meter (TH-500, Novasina, Swiss). All measurements were done in triplicate.

**Reducing sugar and NaCl content measurement:** Reducing sugar content was determined by Somogyi method with slight modification (Lee *et al*., 1993). NaCl content was determined by Mohr method (Lee, 1990). Five grams of *kochujang* pre-mixture were homogenized with 250 mL distilled water and filtered. Ten milliliter of filtrate were titrated with 0.1 N silver nitrate after adding 1 mL of 2% $K_2CrO_4$ solution.

**Color measurement:** Color was measured using a Chromameter (model CR-200, Minolta Co., Osaka, Japan) calibrated with a calibration plate using Y = 94.2, x = 0.3131 and y = 0.3201. Color was recorded using the *CIE-L*a*b** uniform color space, where $L^*$ indicates lightness, $a^*$ indicates chromaticity on a green (-) to red (+) axis and $b^*$ chromaticity on a blue (-) to yellow (+) axis. All measurements were done in triplicate and the mean values were reported.

**Statistical analysis:** The statistical analysis was done using the SAS Statistical Analysis System for Windows v8.1.

## RESULTS AND DISCUSSION

**pH and titratable acidity:** Changes in pH and titratable acidity during aging are presented in Fig. 2 and 3, respectively. In general, pH tends to decrease but titratable acidity increases during aging of *kochujang* due to organic acids produced by microorganisms (Lee and Lee, 2006). In case of *kochujang* pre-mixture, the changes were gradual probably due to shorter aging period applied here. However, there was a distinctive difference found among samples with different concentration of *maesil* extract. Control (0% *maesil* extract-substituted *kochujang* pre-mixture) showed a significantly higher pH but lower titratable acidity. As the concentration of *maesil* extract increased up to 40% in the pre-mixture, pH decreased but titratable acidity increased significantly regardless of time of aging. This is probably due to the high amount of organic acids in *maesil* extract (Choo and Shin, 2000), whose pH was 2.8. This is in good agreement with the findings from Lee and Shin (2001) and Park and Hong (2003) who reported the decrease in pH of bread with the addition of *maesil*.

**Moisture content and water activity:** Changes in moisture content and water activity are presented in Fig. 4 and 5, respectively. Moisture content increased significantly with *maesil* extract content and the difference became larger as the aging time progressed since the moisture content of control continued to decrease with aging time. It is noted that samples with 30% *maesil* extract showed no significant changes in the moisture content while the moisture content of samples with 20% *maesil* extract decreased in the first 3 days and then increased.

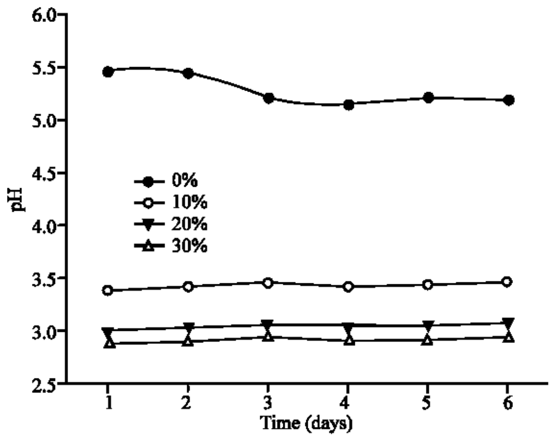


Fig. 2: Response surface contours for pH as a function of amount of *kochujang* and *maesil* extract

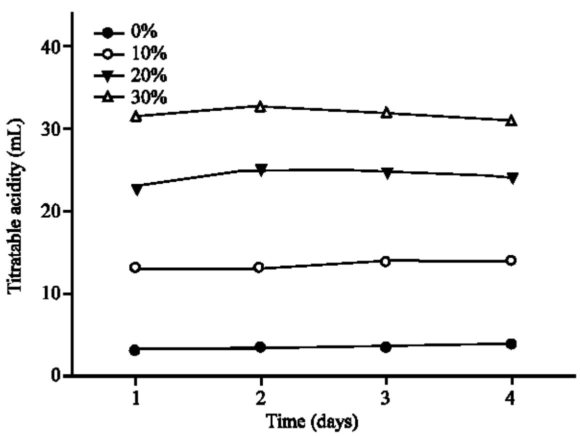


Fig. 3: Response surface contours for titratable acidity as a function of amount of *kochujang* and *maesil* extract

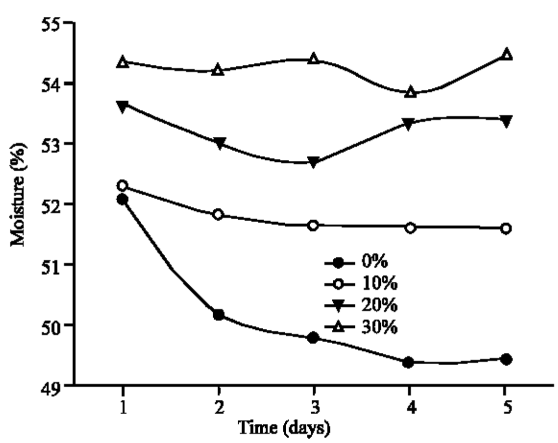


Fig. 4: Response surface contours for moisture content as a function of amount of *kochujang* and *maesil* extract

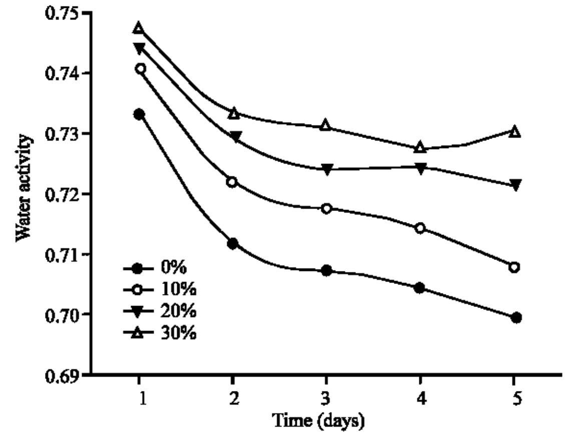


Fig. 5: Response surface contours for water activity as a function of amount of *kochujang* and *maesil* extract

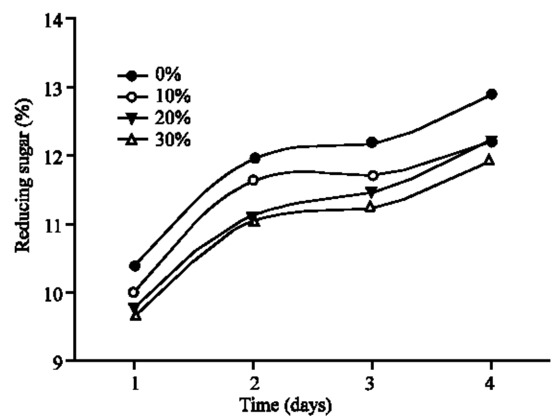


Fig. 6: Response surface contours for reducing sugar content as a function of amount of *kochujang* and *maesil* extract

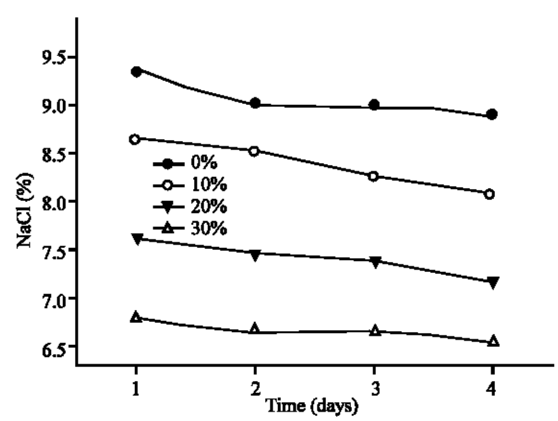


Fig. 7: Response surface contours for NaCl content as a function of amount of *kochujang* and *maesil* extract

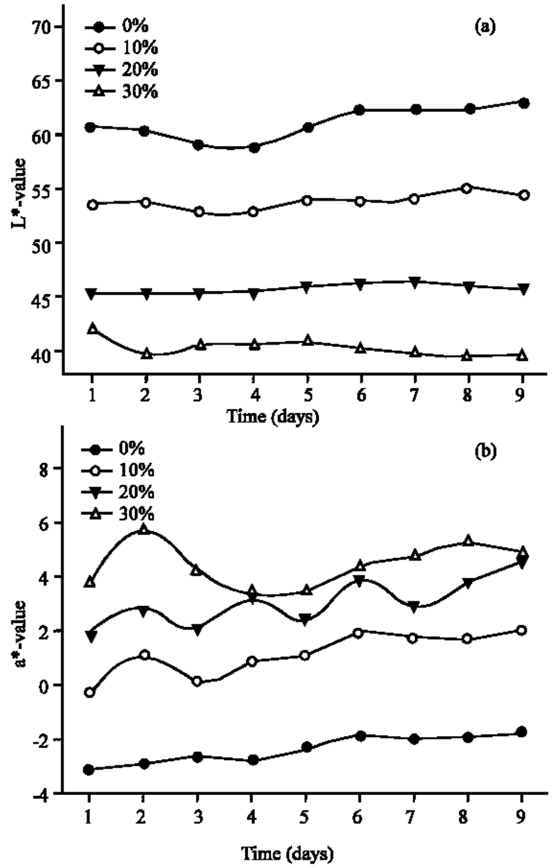


Fig. 8: Response surface contours for CIE color parameters (*L**- and *a**-values) as a function of amount of *kochujang* and *maesil* extract

Water activity continued to decrease with the aging time in all samples (Fig. 5). The decrease in the water activity may be due to the increase in mole fraction in solute by hydrolysis of protein or starch (Kim and Lee, 2001). Similar trend was observed for *kochujang* prepared with *maesil* extract. Similar results were reported for *kochujang* made with *Lycium chinense* fruit (Kim *et al*., 2003) and for *kochujang* made with chitosan and mustard (Kim and Kwon, 2001). Average water activity values ranged from 0.700-0.747 which is little bit smaller than those for Korean traditional *kochujang* (Lee and Lee, 2007).

**Reducing sugar and NaCl content:** Figure 6 and 7 present changes in reducing sugar content and NaCl content during aging, respectively. Reducing sugar content was lower with *maesil* extract and continued to increase during aging in all samples. This is due to the hydrolysis of wheat powder and polished wheat contained in the pre-mixture by amylase. Gradual decrease in NaCl content was observed during aging period (Fig. 7). With the high amount of *maesil* extract, the NaCl content was significantly low and this may contribute to produce low-sodium *kochujang* afterwards. Average NaCl content ranged from 6.53-9.35%.

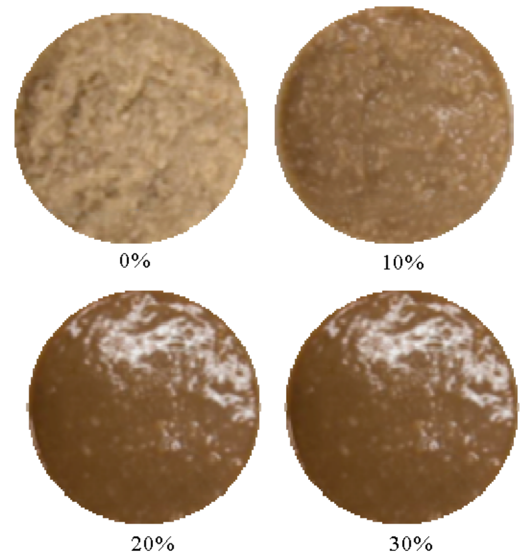


Fig. 9: Photographs taken for *kochujang* pre-mixture as influenced by *maesil* extract

**CIE color parameters:** *L**-, *a**- and *b**-values ranged 39.45-63.00, -3.00-5.28 and 12.66-18.93 (not shown), respectively (Fig. 8). The amount of *maesil* extract has a negative effect on *L**-value but positive effect on *a**-value. The *b**-values were rather fluctuated during aging and excluded in the discussion. *L**- and *a**-values gradually increased or decreased depending on the sample but no specific relationships were found between the color parameters and the amount of *maesil* extract in the sample.

Photographs taken for each pre-mixture as affected by the substitution of *maesil* extract are also presented in Fig. 9. Apparently they showed a distinctive color difference and the color became darker and more shiny with a higher amount of *maesil* extract in the sample.

## ACKNOWLEDGEMENT

This research was supported by RIC program of MCIE.

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