J Food Sci Nutr
Vol 11, p 160~165 (2006)

J Food Science and Nutrition

# Effect of Rice Flour Addition on Quality Properties of Functional Dumpling Skins

Eun-Raye Jeon[1], Lan-Hee Jung[2†] and Young-Hee Park[3]

[1]Department of Food Technology, Sunghwa College, Jeonnam 527-812, Korea
[2]Department of Home Economics Education, Human Ecology Research Institute, Chonnam National University, Gwangju 500-757, Korea
[3]Department of Food Science, Dongshin University, Jeonnam 520-714, Korea

## Abstract

**This study intends to present basic materials for the development and production of functional dumpling skins by making rice flour-added functional dumpling skins and analyzing the nature of its quality. The moisture content of dumpling skins increased with high addition of rice flour. The color value of dumpling skins changed little with high addition of rice flour. The hardness of dumpling skins showed significant difference in all storage periods with the addition of rice flour. For the sensory properties of dumpling skins with the addition of rice flour, where 25% and 50% rice-flour were added, dumpling skins showed a high score in overall quality for 0-day and 7-days of storage. In particular, the 50% rice-flour dumpling skin mixture indicated the highest score. For the correlation between textural and sensory properties according to the addition of rice flour, 0 day-stored dumpling skins showed a positive correlation between smoothness and moistness in the mouth feel and the overall quality ($p<0.01$) in the sensory properties. Wheat odor ($r=0.68$) and chewiness ($r=0.65$) also correlated positively with overall quality ($p<0.05$). Hardness in textural properties correlated positively with moistness ($r=0.69$) and the mouth feel ($r=0.65$) of dumpling skins ($p<0.05$). Hardness in textural properties correlated positively with adhesiveness ($r=0.99$) and chewiness ($r=0.93$, $p<0.01$). Dumpling skins stored for 7 days showed a positive correlation between hardness, chewiness, and moistness in the mouth feel and overall quality ($p<0.05$) in the sensory properties. Hardness in textural properties correlated positively with gumminess ($r=0.65$, $p<0.05$).**

**Key words:** functional dumpling skins, rice flour, quality properties

## INTRODUCTION

The economic growth caused by rapid industrialization, the pursuit of easy lifestyles, and the rapid growth of the foodservice industry have brought about an increase in the use of instant or fast food (1). As a result, the foodservice or the food processing industry has been revitalized along the spread of microwave ovens and refrigerators, resulting in the rapid increase in simple frozen foods. In particular, frozen dumpling which accounts for 50% and over of all cooked frozen food in Korea has increased in consumption in group meals as well as at home (2). Dumpling skins of frozen dumpling which accounts for a very high percentage of frozen food is mostly made from wheat flour.

Since concern for health and well-being has increased rapidly, recently, an increasing amount of consumers have turned to using healthy and functional food stuffs. Thus, some previous researches examined the characteristics of noodle-making using several convenient food stuffs. For example, the addition of barley, corn, sweet potato and potato flour by Kim et al. (3), the addition of heat-treated potato flour by Shin et al. (4), and the addition of 35~45% rice flour and 15% gelatinized waxy rice flour to 40~50% wheat flour by Park and Kim (5).

Among others, rice has rapidly decreased in consumption, but it has been reported that it contains various effective components as well as nutrients which promote physiological activity. Since rice protein reduces blood cholesterol which is a major risk factor of cardiac diseases caused by arteriosclerosis, it improves hyperlipidemia (6). Furthermore, rice, especially brown rice is rich in vitamin E or strong antioxidants such as $\gamma$-oryzanol, tocotrienol, or ferulic acid. These antioxidants inhibit the loss of membranes or lipid peroxidation, playing an important role in antiaging (7). Rice also contains protein degradable products such as angiotensin-converting enzyme inhibitors (8) and is effective in preventing diabetes (7)

†Corresponding author. E-mail: lhjung@jnu.ac.kr
Phone: +82-62-530-2523, Fax: +82-62-530-2529

and colon cancer (9). Since such physiological activities of rice have been known, product development using rice instead of flour has taken place.

Recently, several research has been undertaken in this field: to use physiologically activated substance contained in rice (10) or to develop processed food using pigmented rice such as black or red rice (11-14). But, there is little research which has examined the effects of rice flour addition on the quality of dumpling skins.

Accordingly this experiment intends to present basic materials for the development and production of functional dumpling skins by making rice flour-added functional dumpling skins and analyzing the nature of its quality.

## MATERIALS AND METHODS

### Materials

To add rice flour to the dumpling skins, nonwaxy rice (Ilmibyeo) harvested by the Jeonnam Agricultural Research & Extension Services was used. Wheat flour made by Daehan Flour Mills Co., Ltd. was used. The proximate composition of rice flour and wheat flour were measured using AOAC (15).

### Dumpling skins preparation

Nonwaxy rice was washed five times, stored at room temperature for 12 hours, and then ground twice by a roller mill. The produced rice flour was mixed with wheat flour at 0%, 25%, and 50%. To make dumpling skins, mixed flour 100 g was sieved three times, kneaded with 60 mL of 2% salt water five-six times, and made with a round shape of 0.1 cm thick and 8.0 cm in diameter using a roller (Atlas 150 & Pastabike, Marcato S.P.A., Italy). Dumpling skins packed in a polyethylene bag (Ziploc Inc., USA) were freeze-stored (-18°C) for 0, 1, 3, 5 and 7 days, naturally thawed at room temperature (20°C) for one hour, and steamed in a steamer for 3 min to be used as samples.

### Textural properties

The moisture content of rice flour-added dumpling skins was measured using 105°C atmospheric pressure-heating drying method and color values, using color difference meters (model TC-3600, Tokyo Denshoku Co., Ltd.). Textural properties were measured using a texture analyzer (model TA-XT2, Stable Micro Systems Ltd., England). Each sample was repeatedly measured ten times by texture profile analysis (TPA) to obtain hardness, cohesiveness, springiness, gumminess and chewiness. Measurement conditions were 1) type: two bite mastication test, 2) critical diameter: 6.00 (mm), 3) load cell: 1 kg, 4) deformation: 50%, 5) table speed: 30.00 (mm/min), and 6) chart speed: 60.00 (mm/min).

### Sensory properties

Ten graduate students of the Department of Food & Nutrition were selected as the panel who trained and assessed the appearance of dumpling skins (color, smoothness, moistness), flavor (off-flavor, wheat odor), texture in the mouth (hardness, chewiness, moistness, adhesiveness) and overall quality using 15 cm line scale. Samples were cut to the $2 \times 2 \times 0.1$ $cm^3$ size after cooked and offered on white polyethylene dishes with water.

### Statistical analysis

The mean and standard deviation of data were given using SAS (Statistical Analysis System) package. The test of significance was given using ANOVA test and Duncan's multiple range test in the level of $p<0.05$. Pearson's correlation was conducted to examine the correlation in the levels of 5% and 1% between textural and sensory properties.

## RESULTS

### Proximate composition

The proximate composition of rice flour and wheat flour are shown in Table 1. Rice flour contains 8.38% moisture, 6.65% crude protein, 0.45% crude lipid and 0.47% ash, and wheat flour includes 9.36%, 14.54%, 1.21% and 0.27%, respectively.

### Moisture content

The moisture content of rice flour-added dumpling skins is shown in Table 2. The moisture contents of 0 day-stored dumpling skins were 42.90~48.00%, suggesting higher moisture content with higher addition of rice flour.

### Color values

The color value of rice flour-added dumpling skins is shown in Table 3. While the L value of 0% rice flour-added dumpling skins gradually decreased with the storage period, those of 25% and 50% rice flour-added dumpling skins were not greatly changed, suggesting that the addition of rice flour to dumpling skins had little effect on lightness according to the storage period. Also, the a and b values of the storage period were the lowest in 50% rice flour-added dumpling skins.

**Table 1.** Proximate composition of rice flour and wheat flour (%)

| Sample | Moisture | Crude protein (N×6.25) | Crude lipid | Ash |
|---|---|---|---|---|
| Rice flour | 8.38 | 6.65 | 0.45 | 0.47 |
| Wheat flour | 9.36 | 14.54 | 1.21 | 0.27 |

**Table 2.** The effect of rice flour addition on the moisture contents of dumpling skins during storage period at -18°C (%)

| Storage period (days) | Added rice flour | | |
|---|---|---|---|
| | 0% | 25% | 50% |
| 0 | 42.90±0.14[1)c2)] | 45.55±0.91[b] | 48.00±0.28[a] |
| 1 | 42.05±0.42[c] | 44.15±0.21[b] | 47.30±0.00[a] |
| 3 | 42.60±1.27[c] | 44.75±0.07[b] | 47.55±0.63[a] |
| 5 | 42.75±0.49[c] | 44.35±0.49[b] | 47.05±0.77[a] |
| 7 | 39.80±2.19[c] | 44.10±0.42[b] | 45.70±0.28[a] |

[1)]Mean±standard deviation.
[2)]Values with different superscripts within the same row are significantly by Duncan's multiple range test at $p<0.05$.

### Textural properties

The textural properties of rice flour-added dumpling skins are shown in Table 4. Hardness significantly decreased in all storage periods with the addition of rice flour. It also suggests that springiness, gumminess, and chewiness decreased.

### Sensory properties

The sensory properties of 0 day-stored rice flour-added dumpling skins are shown in Table 5. Dumpling skins of 25% and 50% addition showed higher scores in overall quality, compared to 0% rice flour-added one. Dumpling skins of 50% addition showed the highest score in color, smoothness, chewiness and overall quality. Dumpling skins of 25% addition showed the lowest score in off-flavor and wheat odor, and hardness and the highest score in moistness in appearance, texture and adhesiveness.

**Table 3.** The effect of rice flour addition on the color value of dumpling skins during storage period at -18°C

| Added rice flour | Storage periods (days) | L | a | b |
|---|---|---|---|---|
| 0% | 0 | 58.15±2.47[1)a2)] | 9.80±0.14[a] | 9.80±0.14[a] |
| 25% | | 55.70±1.55[c] | 9.45±0.21[b] | 9.45±0.21[b] |
| 50% | | 57.05±0.77[b] | 6.60±0.14[c] | 6.60±0.14[c] |
| 0% | 1 | 58.25±1.90[b] | -0.40±0.28[a] | 9.70±0.56[a] |
| 25% | | 57.90±1.20[c] | -1.10±0.00[b] | 9.15±0.21[b] |
| 50% | | 58.85±0.91[a] | -1.55±0.35[c] | 7.40±0.84[c] |
| 0% | 3 | 56.50±1.41[b] | 0.30±0.42[a] | 8.90±1.27[a] |
| 25% | | 56.15±2.61[c] | -0.05±0.77[b] | 8.35±0.49[b] |
| 50% | | 56.75±0.49[a] | -1.10±0.28[c] | 6.60±0.84[c] |
| 0% | 5 | 55.85±2.75[c] | 0.45±0.49[a] | 9.15±0.91[a] |
| 25% | | 56.10±2.82[b] | 0.15±0.35[b] | 8.30±0.70[b] |
| 50% | | 57.95±0.21[a] | 0.10±0.00[b] | 6.20±0.14[c] |
| 0% | 7 | 54.75±2.19[c] | 0.20±0.42[a] | 8.95±0.91[a] |
| 25% | | 55.60±2.82[b] | 0.10±0.28[b] | 8.25±0.07[b] |
| 50% | | 57.55±0.49[a] | -0.45±0.49[c] | 6.15±0.21[c] |

L: degree of lightness, a: degree of redness (+ redness − greenness), b: degree of yellowness (+ yellowness − blueness).
[1)]Mean±standard deviation.
[2)]Values with different superscripts within the same column are significantly by Duncan's multiple range test at $p<0.05$.

The sensory properties of 7 days-stored rice flour-added dumpling skins are shown in Table 6. Like 0 day-stored one, 25% and 50% rice flour-added dumpling skins showed high scores in overall quality. Dumpling skins of 25% and 50% addition were low in hardness and high in moistness in the appearance, chewiness and moistness in the mouth feel, adhesiveness, and overall quality.

**Table 4.** The effect of rice flour addition on the textural characteristics of dumpling skins during storage period at -18°C

| Added rice flour | Storage periods (days) | Hardness | Cohesiveness | Springiness | Gumminess | Chewiness |
|---|---|---|---|---|---|---|
| 0% | 0 | 637±96[1)b2)] | 0.61±0.02[a] | 0.74±0.14[a] | 391±58[b] | 287±87[b] |
| 25% | | 671±109[a] | 0.60±0.01[a] | 0.73±0.10[a] | 404±71[a] | 322±79[a] |
| 50% | | 477±74[c] | 0.58±0.01[b] | 0.71±0.12[b] | 279±44[c] | 238±68[c] |
| 0% | 1 | 1189±118[a] | 0.58±0.03[b] | 0.88±0.03[a] | 670±83[a] | 537±119[a] |
| 25% | | 811±51[b] | 0.60±0.09[a] | 0.79±0.11[b] | 493±36[b] | 435±24[b] |
| 50% | | 612±87[c] | 0.55±0.02[c] | 0.79±0.08[b] | 341±54[c] | 258±24[c] |
| 0% | 3 | 1147±120[a] | 0.60±0.02[a] | 0.88±0.04[a] | 690±57[a] | 618±54[a] |
| 25% | | 1016±130[b] | 0.60±0.03[a] | 0.84±0.04[b] | 612±83[b] | 515±76[b] |
| 50% | | 892±32[c] | 0.55±0.02[b] | 0.78±0.09[c] | 497±19[c] | 390±39[c] |
| 0% | 5 | 1197±159[a] | 0.59±0.02[a] | 0.88±0.04[a] | 705±85[a] | 627±93[a] |
| 25% | | 799±62[b] | 0.56±0.02[b] | 0.86±0.04[a] | 449±43[b] | 391±41[b] |
| 50% | | 712±69[c] | 0.58±0.03[a] | 0.86±0.02[a] | 418±43[c] | 351±43[c] |
| 0% | 7 | 1138±166[a] | 0.57±0.03[a] | 0.89±0.04[a] | 655±74[a] | 587±83[a] |
| 25% | | 882±118[b] | 0.54±0.03[b] | 0.81±0.05[b] | 481±72[b] | 393±68[b] |
| 50% | | 824±40[c] | 0.57±0.01[a] | 0.80±0.07[b] | 458±29[c] | 381±40[c] |

[1)]Mean±standard deviation.
[2)]Values with different superscripts within the same column are significantly by Duncan's multiple range test at $p<0.05$.

**Table 5.** The effect of rice flour addition on the sensory properties of dumpling skins stored for 0 day at -18°C

| Sensory properties | | Added rice flour | | |
|---|---|---|---|---|
| | | 0% | 25% | 50% |
| Surface | Color | 4.20±1.5[1)c2)] | 6.60±3.39[b] | 13.20±1.53[a] |
| | Smoothness | 6.90±3.99[c] | 10.80±2.52[b] | 12.00±3.99[a] |
| | Moistness (appearance) | 10.50±4.29[c] | 12.30±2.61[a] | 11.70±3.57[b] |
| Flavor | Off-flavor | 6.00±2.68[a] | 1.80±0.08[b] | 2.40±0.09[c] |
| | Wheat odor | 5.70±1.77[a] | 2.40±0.73[b] | 3.60±1.41[c] |
| Texture | Hardness | 7.20±2.02[a] | 2.40±0.89[c] | 3.90±0.99[b] |
| | Chewiness | 8.40±2.09[c] | 12.30±2.97[b] | 12.60±2.34[a] |
| | Moistness (mouth feel) | 9.00±1.72[b] | 12.60±2.34[a] | 12.30±2.97[a] |
| | Adhesiveness | 6.30±1.68[c] | 10.80±3.78[a] | 10.50±4.29[b] |
| Overall quality | | 9.00±2.43[b] | 12.90±1.44[a] | 12.90±2.82[a] |

[1)]Mean±standard deviation.
[2)]Values with different superscripts within the same row are significantly by Duncan's multiple range test at $p<0.05$.

**Table 6.** The effect of rice flour addition on the sensory properties of dumpling skins stored for 7 days at -18°C

| Sensory properties | | Added rice flour | | |
|---|---|---|---|---|
| | | 0% | 25% | 50% |
| Surface | Color | 10.20±3.78[1)a2)] | 7.80±2.21[c] | 8.40±3.66[b] |
| | Smoothness | 12.60±3.66[a] | 9.90±3.15[c] | 11.70±2.97[b] |
| | Moistness (appearance) | 7.20±2.51[c] | 12.00±1.98[b] | 13.50±2.10[a] |
| Flavor | Off-flavor | 4.50±1.51[b] | 4.80±1.91[a] | 4.20±1.78[c] |
| | Wheat odor | 5.70±1.97[a] | 5.01±1.01[b] | 4.20±1.02[c] |
| Texture | Hardness | 8.40±2.34[a] | 4.50±1.91[b] | 3.60±1.09[c] |
| | Chewiness | 9.60±3.09[c] | 11.10±2.82[b] | 12.00±1.98[a] |
| | Moistness (mouth feel) | 6.90±1.46[c] | 10.80±2.52[b] | 11.40±3.09[a] |
| | Adhesiveness | 6.90±1.01[c] | 10.80±2.88[b] | 11.40±2.31[a] |
| Overall quality | | 8.40±3.09[c] | 11.10±2.01[b] | 12.30±2.97[a] |

[1)]Mean±standard deviation.
[2)]Values with different superscripts within the same row are significantly by Duncan's multiple range test at $p<0.05$.

**Correlation coefficients between textural and sensory properties**

The correlation between textural and sensory properties of rice flour-added dumpling skins are shown in Table 7 and 8. In the sensory properties of 0-day storage, smoothness ($r=0.79$) and moistness in the mouth feel ($r=0.81$) correlated positively with overall quality ($p<0.01$), and wheat odor ($r=0.68$) and chewiness ($r=0.65$) positively with overall quality ($p<0.05$), suggesting that the smoothness, moistness and texture of dumpling skins, contribute to the overall high quality. Hardness in textural properties correlated positively with moistness of the appearance ($r=0.69$) and the mouth feel ($r=0.65$) of dumpling skins ($p<0.05$). Hardness in textural properties correlated positively with adhesiveness ($r=0.99$) and chewiness ($r=0.93$) ($p<0.01$).

In the sensory properties of 7-days storage, hardness ($r=0.67$), chewiness ($r=0.67$), and moistness ($r=0.67$) in the mouth feel correlated positively with overall quality ($p<0.05$). Hardness in textural properties correlated positively with gumminess ($r=0.65$) ($p<0.05$).

## DISCUSSION

This study made rice flour-added functional dumpling skins and analyzed its quality. The moisture content of functional dumpling skins increased with the addition of rice flour, while color value changed little. The textural properties such as hardness, springiness, gumminess, and chewiness were reduced with moisture content which agrees with findings of Kim and Han (16) that hardness decreased with higher moisture content. This result suggests that the addition of rice flour is very effective in making soft dumpling skins. It also agrees with findings of Jung and Eun (14) that as the addition of black rice flour to flour dough increased, protein content and springiness became lower. Furthermore, when tapioca (a kind of starch) was added, springiness of dumpling skin dough somewhat increased at first, but finally decreased, which suggests the same result as

**Table 7.** Correlation coefficients between sensory and textural properties of dumpling skins stored for 0 day at -18°C

| Characteristics | Sensory | | | | | | | | | | Textural | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Color | Smooth-ness | Moist-ness | Off-flavor | Wheat odor | Hard-ness | Chewi-ness | Moist-ness | Adhesi-veness | Overall quality | Hard-ness | Cohesi-veness | Springi-ness | Gummi-ness | Chewi-ness |
| Sensory | | | | | | | | | | | | | | | |
| Color | 1 | | | | | | | | | | | | | | |
| Smoothness | -0.48 | 1 | | | | | | | | | | | | | |
| Moistness (appearance) | -0.29 | 0.91 | 1 | | | | | | | | | | | | |
| Off-flavor | 0.37 | -0.08 | -0.24 | 1 | | | | | | | | | | | |
| Wheat odor | -0.18 | 0.34 | 0.43 | 0.11 | 1 | | | | | | | | | | |
| Hardness | -0.61 | 0.56 | 0.47 | -0.48 | 0.14 | 1 | | | | | | | | | |
| Chewiness | -0.49 | 0.74* | 0.73* | -0.35 | 0.42 | 0.70* | 1 | | | | | | | | |
| Moistness (mouth feel) | 0.74* | 0.68* | 0.66* | -0.35 | 0.39 | 0.53 | 0.54 | 1 | | | | | | | |
| Adhesiveness | -0.15 | 0.41 | 0.55 | -0.33 | 0.47 | 0.26 | 0.79* | 0.43 | 1 | | | | | | |
| Overall quality | -0.27 | 0.79** | 0.81** | 0.01 | 0.68* | 0.60 | 0.65* | 0.55 | 0.37 | 1 | | | | | |
| Textural | | | | | | | | | | | | | | | |
| Hardness | -0.44 | 0.62 | 0.69* | -0.37 | 0.26 | 0.06 | 0.48 | 0.65* | 0.54 | 0.28 | 1 | | | | |
| Cohesiveness | 0.52 | -0.17 | 0.20 | -0.33 | 0.20 | -0.19 | -0.12 | -0.24 | 0.04 | 0.13 | 0.03 | 1 | | | |
| Springiness | -0.36 | 0.38 | 0.37 | -0.30 | 0.02 | -0.03 | 0.38 | 0.16 | 0.23 | -0.01 | 0.62 | 0.09 | 1 | | |
| Gumminess | -0.36 | 0.58 | 0.69* | -0.41 | 0.26 | 0.02 | 0.46 | 0.60 | 0.54 | 0.27 | 0.99** | 0.16 | 0.64* | 1 | |
| Chewiness | -0.39 | 0.51 | 0.59 | -0.38 | 0.17 | -0.04 | 0.45 | 0.45 | 0.46 | 0.13 | 0.93** | 0.12 | 0.85** | 0.94** | 1 |

*$p<0.05$, **$p<0.01$.

**Table 8.** Correlation coefficients between sensory and textural properties of dumpling skins stored for 7 days at -18°C

| Characteristics | Sensory | | | | | | | | | | Textural | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Color | Smooth-ness | Moist-ness | Off-flavor | Wheat odor | Hard-ness | Chewi-ness | Moist-ness | Adhesi-veness | Overall quality | Hard-ness | Cohesi-veness | Springi-ness | Gummi-ness | Chewi-ness |
| Sensory | | | | | | | | | | | | | | | |
| Color | 1 | | | | | | | | | | | | | | |
| Smoothness | 0.35 | 1 | | | | | | | | | | | | | |
| Moistness (appearance) | 0.38 | 0.40 | 1 | | | | | | | | | | | | |
| Off-flavor | 0.01 | -0.48 | 0.37 | 1 | | | | | | | | | | | |
| Wheat odor | 0.21 | -0.12 | 0.47 | 0.61 | 1 | | | | | | | | | | |
| Hardness | 0.67* | 0.30 | 0.46 | 0.19 | 0.26 | 1 | | | | | | | | | |
| Chewiness | 0.41 | 0.34 | 0.47 | 0.00 | 0.37 | 0.65* | 1 | | | | | | | | |
| Moistness (mouth feel) | 0.66 | 0.19 | 0.60 | 0.52 | 0.73 | 0.58 | 0.64 | 1 | | | | | | | |
| Adhesiveness | 0.30 | -0.17 | 0.40 | 0.36 | 0.54 | -0.06 | 0.21 | 0.49 | 1 | | | | | | |
| Overall quality | 0.38 | -0.10 | 0.08 | 0.39 | 0.45 | 0.67* | 0.67* | 0.67* | 0.03 | 1 | | | | | |
| Textural | | | | | | | | | | | | | | | |
| Hardness | -0.02 | -0.20 | 0.00 | 0.40 | -0.40 | -0.03 | -0.25 | -0.01 | -0.02 | -0.03 | 1 | | | | |
| Cohesiveness | 0.18 | 0.13 | 0.19 | -0.02 | 0.32 | -0.01 | 0.16 | 0.02 | 0.16 | -0.45 | -0.49 | 1 | | | |
| Springiness | 0.10 | -0.27 | 0.16 | 0.48 | 0.68* | 0.23 | -0.11 | 0.27 | 0.12 | 0.28 | -0.46 | 0.48 | 1 | | |
| Gumminess | -0.63 | -0.06 | -0.23 | 0.15 | -0.45 | -0.46 | -0.55 | -0.45 | -0.42 | -0.40 | 0.65* | -0.35 | -0.38 | 1 | |
| Chewiness | 0.12 | -0.36 | 0.25 | 0.68* | 0.52 | 0.18 | -0.34 | 0.24 | 0.11 | 0.12 | -0.04 | 0.48 | 0.88* | -0.09 | 1 |

*$p<0.05$, **$p<0.01$.

this study (17). Since this result may be caused by the decrease in gluten content, those with gluten sensitive enteropathy will benefit. For sensory properties, 50% rice flour-added dumpling skins showed the highest score in color, smoothness, chewiness, and overall quality. The correlation between textural properties and sensory properties suggest that the quality characteristics of dumpling skins were affected by the addition of rice flour. As we have seen, when rice flour was added to flour dumpling skins, it improved several quality char-

acteristics and raised general preference. Based on this result, there is a great potential to develop a new functional dumpling skin product.

## REFERENCES


1. Lys ES, Kwak TK. 1989. Consumer opinions on fast foods and food services—I. hamberger chain restaurants—. *Korean J Dietary Culture* 4: 229-236.
2. Pyun JW, Nam HW, Woo IA. 2001. A study on the characteristics of Mandupi differing in roasted soy flour content. *Korean J Food & Nutr* 14: 287-292.
3. Kim HS, Ahn SB, Lee KY, Lee SR. 1973. Development of composite flours and their products utilizing domestic raw materials. III. Noodle-making and cookie-making tests with composite flours. *Korean J Food Sci Technol* 5: 25-32.
4. Shin JY, Byun MW, Noh BS, Choi EH. 1991. Noodle characteristics of Jerusalem artichoke added wheat flour and improving effect of texture modifying agent. *Korean J Food Sci Technol* 23: 538-545.
5. Park WH, Kim HS. 1982. A study on the preparation of dried noodle made of composite flours utilizing rice, wheat and gelatinized waxy rice flours. *Korean J Nutr* 15: 83-90.
6. Hegsted M, Windhauser MM, Lester FB, Morris SK. 1990. Stabilized rice bran and oat bran lower cholesterol in humans. *FASEB J* 4: 368-371.
7. Lee KA, Nam YH. 2005. Physical properties of sponge cake prepared with rice flour. Spring Symposium of Korean Society of Food & Cookery Science. p 95.
8. Suzuki A, Kagawa D, Hujii A, Ochiai R, Tokimutsu I, Saito I. 2002. Short and long term effects of ferulic acid on blood pressure in spontaneously hypertensive rats. *Am J Hyper* 15: 351-357.
9. Hirose M, Hukushima S, Imaida K, Ito N, Shirai T. 1999. Modifying effects of phytic acid and gamma-oryzanol on the promotion stage of rat carcinogenesis. *Anticancer Res* 19: 3665-3670.
10. Bean MM. 1986. Rice flour. Its functional variations. *Cereal Foods World* 31: 477-481.
11. Jung DS. 2000. Quality properties of bread made of wheat flour and black rice flours mixtures. *MS thesis.* Chonnam National University.
12. Jeo JA, Jeo HJ. 2000. Quality properties of injulmi made with black rice. *Korean J Soc Food Cookery Sci* 16: 226-231.
13. Gi HJ, Lee ST, Park YG. 2000. Preparation and quality characteristics of Korean wheat noodles made of brown glutinous rice flour with and without aroma. *Korean J Food Sci Technol* 32: 799-805.
14. Jung DS, Eun JB. 2003. Rheological properties of dough added with black rice flour. *Korean J Food Sci Technol* 35: 38-43.
15. AOAC. 1990. *Official Methods of Analysis.* 15th ed. Association of official analytical chemists, Washington DC.
16. Kim KS, Han KS. 1992. Scientific study for the standardization of the preparation methods for Kyongdan (III) - for the focus on the volume of water and temperature of adding water. *J Soc Food Sci* 8: 405-410.
17. Kang KS, Kim BS. 2003. Changes of rheology on the dumpling shell by added materials. *Korean J Food Preserv* 10: 498-505.


(Received April 25, 2006; Accepted June 7, 2006)