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Effect of Oyster Mushroom (*Pleurotus ostreatus*) Powder on Bread Quality

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Abstract

Breads were prepared from wheat flour supplemented with oyster mushroom (*Pleurotus ostreatus*) powder, and effects of the supplementation of oyster mushroom powder on dough rheology and bread quality were examined. The initial pasting temperature in viscoamylograph increased, but peak and final viscosities decreased with the increased amount of oyster mushroom powder. The gradual increase of water absorption, dough development time and mixing tolerance index, and decrease of dough stability with the increased amount of oyster mushroom powder were obtained by farinographs. The supplementation of oyster mushroom powder had an effect on the bread making, resulting in an increase of loaf weight and a decrease of loaf volume. The rough and coarse crumb texture with dark color was observed with the increased amount of oyster mushroom powder. The firmness of bread crumb containing oyster mushroom powder was increased during storage periods. Sensory evaluation revealed that the addition of 1% oyster mushroom powder could be supplemented to make an acceptable quality of bread.

Key words: oyster mushroom powder, dough rheology, farinograph, bread quality, firmness

INTRODUCTION

The oyster mushroom (*Pleurotus ostreatus*), one of most popular mushrooms in Korea, has been used as a good food source because it contains high quantities of protein, vitamins and minerals. It is considered as a healthy and palatable food containing low content of fat and high content of minerals, proteins and dietary fibers (1-3). In addition, the physiological effects of oyster mushroom such as hypocholesterolemic, antiatherogenic, anticancer, antioxidant, and antibacterial effects (4-8) have been reported by many researchers.

Large quantities of oyster mushroom are produced in Korea for all year round. The consumption of oyster mushroom, however, is limited because fresh mushroom is very perishable due to its high moisture content and various enzymes. Therefore, the development of processed foods with oyster mushroom containing physiologically active compounds could be the best way to increase the consumption of oyster mushroom.

The present investigation was undertaken to replace a part of the wheat flour by oyster mushroom for bread making. The effect of replacement of wheat flour with oyster mushroom powder on rheological properties of dough was studied in this study. Baking qualities and sensory characteristics of bread prepared from oyster mushroom powder were also evaluated.

MATERIALS AND METHODS

Materials

Fresh oyster mushrooms purchased from a local market were dried using an air forced drying oven set at 40°C for 2 days, ground with a blender (Daewoo Corp., Model: KMF-360, Seoul, Korea) to pass through a 150 μm sieve, and stored in a freezer set at -20°C until use. Wheat flour for bread making, yeast, yeast food, nonfat dry milk, salt, sucrose, and butter were purchased from a local market. Wheat flour contained 13.39% water, 14.62% crude protein, 1.03% crude fat, and 0.84% ash (9).

Physicochemical analysis

Oyster mushroom powder was analyzed for moisture, crude fat, crude protein, and ash contents using AOAC method (10). The nitrogen factor used for crude protein calculation was 4.38 (11). The pasting properties of samples were determined with a Brabender viscoamylograph Type VA-1B with a 700-cmg cartridge. A suspension of 12% dry weight wheat flour and composite flours in 450 mL distilled water was heated from 30°C

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to 95°C at 1.5°C/min, held at 95°C for 30 min and cooled to 50°C at 1.5°C/min. Pasting temperature, peak viscosity, final viscosity and setback were obtained from a viscoamylogram. The farinographic characteristics were determined with Brabender farinograph (Model 810-106, Brabender, Duisburg, Germany) according to AACC method 54~21 (12). Three hundred grams of flour were mixed at the optimum water absorption. Water absorption (amount of water required to attain dough consistency of 500 BU), dough development time (time to reach maxmum dough consistency), dough stability (difference in min between arrival and departure time) and mixing tolerance index (difference in BU between height at peak and peak+5 min) were obtained from farinograms.

Bread making

Bread was prepared from wheat flour and composite flours using a straight dough procedure (AACC, 10-10A) (12). The baking formula based on flour weight is presented in Table 1. The dough was prepared by adding water equivalent to the farinograph absorption value (500 BU). Then it was optimally mixed, fermented for 20 min at 30±2°C and 75% RH, divided into 3 pieces, molded and sheeted by hands, put into pans, proofed for 40 min at 30±2°C and 85% RH, and baked for 20 min at 200°C. Loaf weight was evaluated after cooling for 1 hr at room temperature. Loaf volume was determined by millet seed displacement. Specific volume (cm^3/g) was calculated by dividing loaf volume by loaf weight. Crumb texture of one-day-old bread was evaluated by visual observation (13) on a score of 1 (extremely unsatisfactory)~10 (excellent) after comparing with the control bread. The highest score was for crumb with small holes and thin cell walls, whereas the lowest score was for crumb with large holes and thick cell walls. A TA-XT2 texture analyzer (Texture Technologies Corp. Scardale, NY) equipped with a 3.7 cm diameter acrylic probe was employed for measuring the firmness of bread crumbs. Bread loaves stored at room temperature for various storage periods were sliced into 1.2 cm thickness by a bread slicing machine. Compressions were taken in the center of the slice under the following conditions: sample size 6×5×1.2 cm, pre-test speed 1 mm/min, test speed 1.7 mm/min, post-test speed 10.0 mm/min, strain 50%, and trigger force 5.0 g. Firmness was determined with five times.

Table 1. Basic baking formula for straight dough method

Ingredients	Ratio (%)
Wheat flour	100
Yeast	1.25
Yeast food	2
Nonfat dry milk	3
Salt	2
Sucrose	6
Butter	4
Water	Variable

Sensory evaluation

Sensory evaluation was conducted after cooling loaf for 1 hr at room temperature (9). The slices of bread with 6×5×1.2 cm were cut from the center of the loaf. The coded and randomized samples on a plastic dish were offered to 42 panelists in an open area without special lighting. Water was provided for mouth washing between sample testing. The color, flavour, taste, texture and overall acceptability of each loaf were evaluated using nine-point hedonic scale method in which 1 and 9 mean extremely dislike and extremely like, respectively.

Statistical analysis

All data except for pasting properties and farinograph study were recorded as means of at least triplicate measurements. Analysis of variance was used to determine the difference among treatments. When the difference was found among treatments, Duncan's multiple range test was performed at the level of significance.

RESULTS AND DISCUSSION

Physicochemical properties

The moisture, crude fat, crude protein, and ash contents (dry basis) of oyster mushroom powder were 8.95%, 2.51%, 24.75%, and 7.67%, respectively (data not shown), showing considerably higher levels of protein and ash compared to wheat flour. These values were in similar ranges to those (2.16% crude fat, 23.9% crude protein and 7.59% ash) reported by Yang et al. (3). Mushrooms are usually known to be a good protein source. However, the crude protein content of oyster mushroom powder in this study was lower than those reported by other studies (14,15). This result might be come from using different nitrogen conversion factor for getting total crude protein content. We used 4.38 as a nitrogen conversion factor based on 70% protein digestibility (11) because mushrooms contain considerable amounts of nonprotein nitrogen in cell walls and digestibility of mushroom protein is low (34~89%).

The pasting properties of wheat flour added with oyster mushroom powder by Brabender viscoamylograph are presented in Table 2. The rapid increase (63°C for control to 74.5°C for 1% supplementation) in initial pasting temperature was observed by supplementation of oyster mushroom powder, indicating that gelatinization

Table 2. Amylograph data for wheat flour-oyster mushroom powder composites[1) (12% dry weight basis)

Mushroom powder content	Pasting temp. (°C)	Peak visc. (BU)	Final visc. (BU)	Setback (BU)
0%[2)]	63.0	1,220	1,670	450
1%	74.5	1,000	1,390	390
2%	76.0	910	1,220	310
3%	77.0	870	1,140	270
4%	78.5	830	1,080	250

[1)]Values represent the mean of two replicates.
[2)]Control: 100% wheat flour.

of starch within wheat flour was retarded by oyster mushroom powder. This result might be due to the retardation of starch swelling and gelatinization of starch granules surrounded by supplemented protein (16). For peak and final viscosities, the control (0%) had the highest values (1220 BU and 1670 BU, respectively), but decreased from 1000 and 1390 BU to 830 and 1080 for 1 and 4% additions, respectively. The setback value was also decreased from 450 BU for control to 250 BU for 4% addition of oyster mushroom powder. The decreases in peak, final viscosities and setback might be attributed to the retardation of starch swelling and dilution of wheat starch by addition of oyster mushroom powder (17).

The farinograph characteristics of wheat flour added with oyster mushroom powder are presented in Table 3. The water absorption was increased steadily from 66.0% for control to 67.1% for 4% addition of oyster mushroom powder. The increase in water absorption might be due to the increases in protein and fiber contents by supplemented oyster mushroom powder. El-Adawy (18) reported that the increase of farinograph water absorption was obtained by the addition of sesame protein isolate to wheat flour due to the increased hydration capacity of protein isolate. In addition, high dietary fiber contents (19) of oyster mushroom could contribute to the increase of water holding capacity, resulting in increase of farinograph water absorption. Dough development time was increased markedly by the addition of oyster mushroom powder, but decreased from 5.5 min for 1% addition to 3.5 min for 4% addition of the powder. Dough stability was highest in the control (40 min), but decreased sharply as the addition level increased from 1% (8.5 min) to 4% addition (4.0 min). Mixing tolerance index increased from 20 BU for control to 240 BU for 4% addition of oyster mushroom powder. Previous researchers (20,21) also reported similar farinograph characteristics on supplementation with other food materials.

Bread baking properties

The properties of bread prepared from wheat flour and oyster mushroom powder are presented in Table 4. Also, the interior crumb structures for the control and substituted breads are shown in Fig. 1. The loaf weight increased significantly with the increased addition level of oyster mushroom powder. This significant increase might be attributed to higher water absorption of oyster mushroom powder than that of wheat flour. The loaf volume was decreased progressively from 736.3 cc for control to 538.8 cc for 4% addition of oyster mushroom powder, resulting in decreasing loaf volumes by 5~30%. The specific volume also showed a similar trend to loaf volume, resulting in the decrease of its specific volume with the increase in addition level. These results could be come from the dilution of gluten protein in dough system obtained from the addition of oyster mushroom powder (22). In addition, oyster mushroom powder could cleave gluten strands during mixing, impair gas retention and change crumb texture (23). The score of crumb texture of loaves was highest in the control, and decreased with the increase of addition level of oyster mushroom powder. The control breads had smooth crumb

Table 3. Farinograph data for wheat flour-oyster mushroom powder composites[1)]

Mushroom powder content	Water absorption (%)	Dough development time (min)	Dough stability (min)	MTI[2)] (BU)
0%[3)]	66.0	11.0	40.0	20
1%	66.2	5.5	8.5	60
2%	66.4	4.5	6.5	140
3%	66.6	4.0	5.5	200
4%	67.1	3.5	4.0	240

[1)]Values represent the mean of two replicates.
[2)]MTI=Mixing tolerance index.
[3)]Control: 100% wheat flour.

Table 4. Baking data for wheat flour-oyster mushroom powder composites[1)]

Mushroom powder content	Loaf wt. (g)	Loaf vol. (cc)	Specific vol. (cc/g)	Crumb texture[2)]
0%[3)]	226.6^{d}[4)]	736.3^{a}	3.25^{a}	9.5^{a}
1%	227.7^{c}	698.8^{a}	3.07^{b}	9.0^{a}
2%	229.1^{b}	612.6^{b}	2.67^{c}	7.0^{b}
3%	229.3^{b}	575.0^{bc}	2.51^{c}	4.0^{c}
4%	230.4^{a}	538.8^{c}	2.34^{d}	2.0^{d}

[1)]Values represent the mean of triplicates.
[2)]Score of 1~10 with 10 being the highest score.
[3)]Control: 100% wheat flour.
[4)]Means within column with different letters are significantly different ($p<0.05$).

A B C D E

Fig. 1. Cut loaves of breads containing different levels of oyster mushroom powder (A: 0% addition; B: 1% addition; C: 2% addition; D: 3% addition; E: 4% addition).

texture with uniform and small cells, while substituted breads had more rough and coarse crumbs with relatively large cells as addition levels increased (Fig. 1). Consequently, supplementation of oyster mushroom powder caused to give more dense and coarse crumb texture.

Crumb firmness during storage

The crumb firmness of breads prepared from wheat flour and substitution with oyster mushroom powder is plotted as a function of storage periods (0~3 days) in Fig. 2. The control bread had the lowest firmness at all storage periods, indicating slower firming rate among all breads. However, breads fortified with oyster mushroom powder were significantly firmer than control bread at all substitution levels throughout storage periods. The firmnesses of control and substitute breads increased rapidly up to storage day 2 and slowed thereafter. The firmness also increased significantly with increasing substitution level, presumably due to the decreased loaf volume.

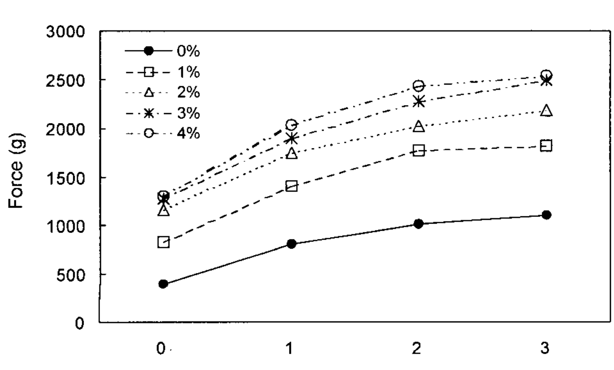

Fig. 2. Effect of the addition of oyster mushroom powder on bread crumb firmness during storage periods (0~3 days).

Sensory evaluation of bread

Table 5 shows the results of sensory evaluation for color, flavor, taste, texture and overall acceptability of the control and substituted breads. Crumb colors of oyster mushroom powder-substituted breads were significantly different from that of the control bread, resulting in becoming less acceptability as the addition level increased. Flavor scores of breads decreased with increasing the substitution level, ranging from 6.48 for control to 4.50 for 4% addition. Taste and texture scores of breads had the highest score at 1% addition, and did not significantly different from those of control bread up to 2% addition, resulting in acceptable values except for 3 and 4% additions. Overall acceptability of breads ranged from 6.70 for 1% addition to 4.56 for 4% addition, indicating that 1% addition had acceptable breads similar to those obtained from wheat flour only. However, beyond 1% addition level, the overall acceptability scores of breads decreased significantly. From the sensory evaluation results, acceptable breads up to

Table 5. Sensory evaluation score of breads made from wheat flour-oyster mushroom (*Pleurotus ostreatus*) powder composites[1)]

Mushroom powder content	Color	Flavor	Taste	Texture	Overall acceptability
0%[2)]	8.14[a3)]	6.48[a]	6.10[a]	6.00[a]	6.64[a]
1%	7.00[b]	6.26[a]	6.38[a]	6.12[a]	6.70[a]
2%	5.91[c]	5.43[b]	6.07[a]	5.55[ab]	5.93[b]
3%	4.83[d]	5.48[b]	4.95[b]	5.09[bc]	5.21[c]
4%	4.48[d]	4.50[b]	4.67[b]	4.56[c]	4.29[d]

[1)]Mean scores of nine hedonic scale (1=extremely dislike 9=extremely likes).
[2)]Control: 100% wheat flour.
[3)]Means within column with different letters are significantly different ($p<0.05$).

1% addition level of oyster mushroom powder could be produced.

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