Korean J. Food Sci. An.
Vol. 35, No. 3, pp. 307~314(2015)
DOI http://dx.doi.org/10.5851/kosfa.2015.35.3.307

ARTICLE

Effect of Dietary Fiber Extracted from *Algelica keiskei* Koidz on the Quality Characteristics of Chicken Patties

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Abstract

In this study, we evaluated the effects of dietary fiber extracted from *Algelica keiskei* Koidz on the chemical composition, cooking characteristics, and sensory properties of chicken patties. The chicken patties with *Algelica keiskei* Koidz dietary fiber had significantly higher moisture and ash content, and yellowness than the control sample ($p<0.05$). Energy value, cooking loss, reduction in diameter, reduction in thickness, lightness, redness, hardness, cohesiveness, gumminess, and chewiness of the control samples was significantly higher than chicken patties with *Algelica keiskei* Koidz dietary fiber ($p<0.05$). The sensory evaluation indicated that the greatest overall acceptability in chicken patties was achieved at *Algelica keiskei* Koidz dietary fiber levels of 1% and 2%. Chicken patties supplemented with 2% *Algelica keiskei* Koidz dietary fiber had improved quality characteristics.

Keywords: *Algelica keiskei*, chicken patties, dietary fiber, quality properties

Received July 10, 2014; Revised December 11, 2014; Accepted December 12, 2014

Introduction

The patty is very popular among the meat products worldwide, mainly due to price, flavor, and convenience (Choi *et al*., 2012). However, the high fat content in patties is a major healthy concern, and the meat industry is undergoing transformations caused by changes in consumer demands. For this reasons, healthier meat products based on processing is one of the most important approaches to the development of new meat-based products (Carrapiso, 2007; Choi *et al*., 2010; Kumar and Sharma, 2004; Pinero *et al*., 2008; Yang *et al*., 2007). The development of healthier meat products has the addition of various functional components. Indeed, previous research has studied added rice bran, citrus, acorn, persimmon, carrot, and lemon albedo in meat products (Chin and Ban, 2008; Choi *et al*., 2008; Eim *et al*., 2013; Kim *et al*., 2008; Sarıçoban *et al*., 2008).

The *Algelica keiskei* Koidz called *Sinsuncho*, it is mainly a native to subtropical perennial herb, belonging to the Apiaceae (Kang *et al*., 1999). *Algelica keiskei* has been used widely for its various beneficial actions. In particular, its stem and leaves have been consumed as a health food. *Algelica keiskei* contains various bioactive compounds that possess potential health benefits and their use as functional ingredients opens up new prospects for food processing, due to its numerous biologically active components including germanium, flavonoids, chalcones, coumarins, and saponins (Choi and Park, 2011; Kim and Kim, 2001). Kim and Kim (2001) reported that effects of addition of *Algelica keiskei* powder on the quality characteristics of *yukwa*. Research on using *Algelica keiskei* is limited.

Moreover, *Algelica keiskei* is an excellent source of dietary fiber, minerals, and vitamins (Kang *et al*., 1999; Lee *et al*., 2005). Dietary fiber is an important component in the human diet, not only for its nutritional properties but also for functional and technology properties (Choi *et al*., 2014). Furthermore, dietary fiber can be added to meat products to reduce the cooking loss due to its water- and fat-binding capacities (Choi *et al*., 2009). Choi *et al*. (2012) reported that dietary fiber from *Laminaria japonica* is for functional and technological properties such as

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improving cooking yield, reducing formulation cost, and enhancing texture in meat products. Additionally, some researchers have reported various sources of natural dietary fiber (Chin and Ban, 2008; Kim *et al*., 2013; Sanchez-Zapata *et al*., 2010; Yang *et al*., 2007), but a limited number of studies has reported on adding dietary fiber extracted from *Algelica keiskei* Koidz to meat products. Also, *Algelica keiskei* Koidz contained the metal ion contained can weaken the binding of meat products, due to *Algelica keiskei* Koidz may be poor the quality of meat products. For that reason, dietary fiber extracted from *Algelica keiskei* Koidz extract was applied to a meat product.

Thus, the objective of this study was to evaluate the effects of the addition of *Algelica keiskei* Koidz on the proximate composition, pH, color, energy value, cooking loss, reductions in diameter and thickness, texture profile analysis, and sensory evaluation of chicken patties.

Materials and Methods

Preparation and processing of *Algelica keiskei* Koidz dietary fiber extract

The *Algelica keiskei* Koidz was purchased from a market in Gwangingu, Seoul, Korea. It was ground using a blender (KA-2610, Jworld Tech, Korea) for 30 s. The *Algelica keiskei* Koidz powder (dietary fiber content: 4.23%, digestible carbohydrates content: 54.34%, moisture content: 7.93%, protein content: 16.54%, fat content: 5.03%, ash content: 11.93%) was gelatinized with 0.6% termamyl (heat stable alpha-amylase) at 95°C for 1 h to remove starch, followed by filtration. The residue was washed three times with four volumes of hot water (100 °C) and allowed to equilibrate to room temperature (20 °C, 6 h). The residue was dried (55°C) overnight in an air oven and then ground using a blender (KA-2610, Jworld Tech, Korea) for one minute and passed through a 35-mesh sieve (particle size of <0.5 mm). *Algelica keiskei* Koidz dietary fiber (dietary fiber: 55.48%, moisture content: 7.82%, protein content: 12.28%, ash content: 12.67%) was then placed in polyethylene bags, vacuum packaged using a vacuum packaging system (FJ-500XL, Fujee Tech, Korea) and stored at -4°C until used for product manufacture. The pH, lightness, redness, and yellowness values of *Algelica keiskei* Koidz dietary fiber was 5.37, 63.95, -6.79, and 18.65.

Chicken patties preparation and processing

Fresh chicken breast muscle (*M. pectoralis major*) in broilers (Arbor Acre strain, 5 wk of age, approximately 1.5-2.0 kg live weight) and pork back fat (moisture 12.51%, fat 86.54%) were purchased from a local processor at 48 h postmortem. Chicken breast muscles and pork back fat were initially ground through an 8-mm plate, and then secondly ground through a 3-mm plate. Each batch of samples consisted of five chicken patties, which differed in composition with respect to the addition of *Algelica keiskei* Koidz dietary fiber levels (0, 1, 2, 3 and 4%). The chicken patties were produced according to the following traditional recipe (Choi *et al*., 2012). The ground meat (60%), pork back fat (20%), and ice water (10%) mixed with ingredients (1.5% sodium chloride, 0.2% sodium tripolyphosphate, 2.5% garlic powder, 2.5% onion powder, 0.8% ginger powder, 1.5% isolated soy protein and 1.0% sugar) were added. The mix was kneaded for 15 min at 4°C by hand and the chicken patty mixtures were divided into five equal portions. The first batch was used as a control and the *Algelica keiskei* Koidz dietary fiber was no added. The other batches were supplemented with various levels (1, 2, 3 and 4%) of *Algelica keiskei* Koidz dietary fiber. Each portion was kneaded for an additional 15 min to obtain homogeneous mixtures. The mixtures were stored in a cold room (4°C) for 1 d, and then shaped using a household hamburger mold (PM 10/13 Burger press, AB Services Food Machinery, Coventry, England; diameter: 100 mm, thickness: 20 mm) into meat products that were approximately 100 mm in diameter and 20 mm thick with a weight of about 100 g before cooking. The chicken patty processing was carried out in each treatment (each chicken patty 8 kg batch). An electric grill (CG20, USA) was used to cook the meat. Patties were cooked on a preheated electric grill at a grill surface temperature of 150°C and were cooked for 3 min on one side and for 3 min on the opposite side until the targeted core temperature reached 75°C. The core temperature of the chicken patties was monitored with a digital thermometer (Tes-1305, Tes Electrical Corp., Taiwan) equipped with a data logger (RS-232, Tes Electrical Corp., Taiwan) by inserting an iron constantan thermocouple. All analyses were performed three times for each chicken patty formulation.

Proximate composition

The compositional properties of the chicken patties were determined using an AOAC (2000). Moisture content (950.46B) was determined by weight loss after 12 h of drying at 105°C in a drying oven (SW-90D, Sang Woo Scienctific Co., Korea). Fat content (960.69) was determined by the Soxhlet method with a solvent extraction system (Soxtec® Avanti 2050 Auto System, Foss Tecator AB, Sweden) and protein content (981.10) was determined by the Kjeldahl method with an automatic Kjeldahl nitrogen analyzer (Kjeltec® 2300Analyzer Unit, Foss Tecator AB, Sweden). Ash was determined according to the AOAC method 920.153 (muffle furnace). Carbohydrate contents were calculated by the difference.

Caloric content

Total calorie estimates (kcal) for patties were calculated on the basis of a 100 g portion using Atwater values for fat (9 kcal/g), protein (4.02 kcal/g), and carbohydrate (3.87 kcal/g) (Mansour and Khalil, 1999).

pH

The pH values of chicken patties were measured in a homogenate (Ultra-Turrax T25, Janke & Kunkel, Germany) prepared with 5 g of sample and distilled water (20 mL) using a pH meter (Model 340, Mettler-Toledo GmbH, Switzerland). The pH meter calibrated with standard 4.00, 7.02, and 10.05 pH buffers (VWR Scientific Products) at a temperature of 20±1°C. All determinations were performed in triplicate.

Color evaluation

The color of each cooked and uncooked chicken patty was determined using a colorimeter (Minolta Chroma meter CR-210, Minolta Co., Japan; illuminate C, calibrated with a white plate, L^*=+97.83, a^*=-0.43, b^*= +1.98). Six measurements for each of five replicates were taken. The temperature of each sample at the time (25±1°C) of lightness (CIE L^*-value), redness (a^*-value), and yellowness (b^*-value) values were recorded.

Cooking loss

All patties were cooked on a preheated electric grill (CG20, USA) at a grill surface temperature of 150°C and were cooked for 3 min on one side and for 3 min on the opposite side until the targeted core temperature reached 75°C. Cooking loss was determined by calculating the weight differences before and after cooking as follows:

Cooking loss (%) = [(weight of raw chicken patty (g) – weight of cooked chicken patty (g)) / weight of chicken patty (g)] × 100

Reductions in diameter and thickness

To measure the diameter and thickness of the same locations before and after a cooking, two points per patty were marked. After each patty was cooked, it was cooled down to room temperature. The diameter and thickness of the raw and cooked patties were recorded using vernier calipers (530-122, Mitutoyo, Japan) and calculated using the following expression. All determinations were performed in triplicate.

Reduction in diameter (%) = [(raw chicken patty diameter – cooked chicken patty diameter) / raw chicken patty diameter] × 100

Reduction in thickness (%) = [(raw chicken patty thickness – cooked chicken patty thickness) / raw chicken patty thickness] × 100

Texture profile analysis (TPA)

Texture profile analysis (TPA) was performed at room temperature with a texture analyzer (TA-XT2*i*, Stable Micro Systems Ltd., England). Chicken patty samples were taken from the central portion of each meat patty. Prior to analysis, samples were allowed to equilibrate to room temperature (20°C, 3 h). Samples were taken from the central portion of each meat patty. The conditions of texture analysis were as follows: pre-test speed 2.0 mm/s, post-test speed 5.0 mm/s, maximum load 2 kg, head speed 2.0 mm/s, distance 8.0 mm, force 5 g. The calculation of texture profile analysis values was obtained by graphing a curve using force and time plots. Values for hardness (kg), springiness, cohesiveness, gumminess (kg), and chewiness (kg) were determined as described by Bourne (1978).

Sensory evaluation

The sensory evaluations were performed in triplicate on each sample by sensory panelist. A trained twelve-member panel consisting of researchers from the department of Food Sciences and Biotechnology of Animal Resources at Konkuk University in Korea was used to evaluate the chicken patties. Training of panelists was performed according to sensory evaluation procedure (Meilgaard *et al*., 1999). Each chicken patty was evaluated in terms of color, flavor, juiciness, tenderness, and overall acceptability. Chicken patties were cooked to a core temperature of 75 °C, cooled to 20°C, cut into quarters [size: 50 (width) × 50 (length) × 20 (height) mm], and served to the panelists randomly. Each sample was coded with a randomly selected 3-digit number. Sensory evaluations were performed under fluorescent lighting. Panelists were instructed to cleanse their palates between samples using warm water

(30°C). The color (1 = extremely undesirable, 10 = extremely desirable), flavor (1 = extremely undesirable, 10 = extremely desirable), tenderness (1 = extremely tough, 10 = extremely tender), juiciness (1 = extremely dry, 10 = extremely juicy), and overall acceptability (1 = extremely undesirable, 10 = extremely desirable) of the cooked samples were evaluated using a 10-point descriptive scale. This analysis was conducted using the hedonic test described by Choi *et al*. (2008).

Statistical analysis

All tests were done at least three times for each experimental condition and mean values are reported. An analysis of variance was performed on all the variables using the general linear model (GLM) procedure of the SAS (Statistical Analysis Systems Institute, 2008) statistical package. Duncan's multiple range test ($p<0.05$) was used to determine the differences between treatment means. The statistical analysis for each parameter combines the data from three batches.

Results and Discussion

Proximate composition and energy value

The proximate compositions and energy values of the chicken patties formulated with different *Algelica keiskei* Koidz dietary fiber levels are shown in Table 1. The moisture content of chicken patties with *Algelica keiskei* Koidz dietary fiber was higher than the control ($p<0.05$); the chicken patty moisture content increased as the content of *Algelica keiskei* Koidz dietary fiber was increased gradually. The protein contents of chicken patties with added *Algelica keiskei* Koidz dietary fiber were slightly higher than the control, but did not differ significantly among the treatments ($p>0.05$). For this reason, the protein contents (12.28%) of *Algelica keiskei* Koidz dietary fiber had relatively small compared to the protein content of chicken patties, did not indicate a significant statistical difference between control and treatments. The fat content of the control was the highest ($p<0.05$). Increasing levels of *Algelica keiskei* Koidz dietary fiber decreased the fat content of chicken patties ($p<0.05$), due to the relatively increased moisture contents of the chicken patties. The ash contents of chicken patties with added *Algelica keiskei* Koidz dietary fiber were higher than the control ($p<0.05$), due to the *Algelica keiskei* Koidz dietary fiber having an ash content of 12.67%. These results were consistent with those obtained by Choi *et al*. (2012) for the addition of *Laminaria japonica* to reduced-fat chicken patties, and by Desmond *et al*. (1998) for the addition of oat fiber to low-fat beef burgers. These studies showed similarly that natural-source dietary fiber increased the moisture content of meat products. Choi *et al*. (2008) indicated that rice bran, as a source of dietary fiber, increased the moisture content and the ash content of ground chicken meat products. Similar results were obtained by Turhan *et al*. (2005) for beef burgers with hazelnut pellicle added. Choi *et al*. (1999) reported that the moisture and ash content of bread increased with the addition of *Angelica keiskei* Koidz flour.

The highest energy value observed for the control sample was 257.27 kcal/100 g ($p<0.05$; Table 1). The energy values for the chicken patties with added *Algelica keiskei* Koidz dietary fiber ranged from 235.60 to 257.31 kcal/100 g. According to Choi *et al*. (2012), the energy values of the patties were affected by the fat content because the energy value of fat content is 9 kcal/ 100 g. In this study, the energy value observed similar trend as affected by the fat content. Turhan *et al*. (2005) reported that the energy values of beef burgers with added hazelnut pellicle were significantly lower than those of the control due to the decreased fat content. Cengiz and Gokoglu (2005) indicated that frankfurters with reduced fat and added fat replacer with citrus fiber and soy protein concentrate had lower energy values.

Table 1. Proximate composition and energy values of chicken patties formulated with various levels of dietary fiber from *Algelica keiskei* Koidz

Parameters	Dietary fiber levels from *Algelica keiskei* (%)				
	0	1	2	3	4
Moisture content (%)	57.99±0.83[c]	60.03±0.76[b]	60.58±0.66[b]	60.85±0.45[ab]	61.15±0.29[a]
Protein content (%)	16.08±0.62	16.90±0.94	16.59±0.39	16.90±0.52	16.59±0.31
Fat content (%)	19.88±0.77[a]	19.39±0.20[ab]	18.42±0.57[b]	18.26±0.49[b]	18.75±0.41[b]
Ash content (%)	2.24±0.14[d]	2.50±0.05[c]	2.82±0.13[b]	2.87±0.11[b]	3.47±0.05[a]
Evergy value (kcal/100 g)	257.31±4.85[a]	247.02±5.64[b]	238.63±5.12[c]	236.61±3.89[c]	235.60±5.02[c]

All values are mean±standard deviation of three replicates.

[a-d]Means within a row with different letters are significantly different ($p<0.05$).

Cooking loss and reductions in diameter and thickness

The cooking loss of chicken patties formulated with different *Algelica keiskei* Koidz dietary fiber concentrations is shown in Table 2. The cooking loss of chicken patties with *Algelica keiskei* Koidz dietary fiber was significantly lower than the control ($p<0.05$), and the cooking loss decreased as more *Algelica keiskei* Koidz dietary fiber was added ($p<0.05$). Similar results have been reported by Kim *et al*. (2013) in chicken patties formulated with the addition of dietary fiber extracted from brewer's spent grain. This result was confirmed by Choi *et al.* (2014) who reported that cooking loss in frankfurters was affected by the dietary fiber used. Choi *et al*. (2012) observed that a reduction in cooking loss of chicken patties in related with water holding capacity. Generally, cooking loss is affected by various external and internal factors; in particular, meat products with added dietary fiber showed decreased cooking loss due to improved water holding capacity and water binding capacity. The cooking loss of chicken patties during heating could be improved due to the binding and stabilizing properties of *Algelica keiskei* Koidz dietary fiber, which held the meat particles together and resisted changes in the shape of the products. Thus, the cooking loss is reduced when added to dietary fiber during heating in meat products.

The chicken patties formulated with *Algelica keiskei* Koidz dietary fiber differed significantly the reductions in diameter and thickness ($p<0.05$; Table 2). The reduction in diameter and thickness of chicken patties with *Algelica keiskei* Koidz dietary fiber was significantly lower than the control ($p<0.05$), as increasing the *Algelica keiskei* Koidz dietary fiber concentration was gradually lower the reduction in diameter and thickness of chicken patties. These results are consistent with those of Choi *et al*. (2012) who found that the reduction in diameter and thickness of pork patties with added *Laminaria japonica* powder was significantly lower those of the control without dietary fiber. Kim *et al*. (2013) reported that pork patties with increasing brewer's spent grain dietary fiber concentrations showed a tendency for decreased reductions in diameter and thickness. These results supported the findings of Turhan *et al*. (2005), who prepared beef burgers made with various concentrations of hazelnut pellicle. This most likely occurred because *Algelica keiskei* Koidz dietary fiber, which have a high water holding capacity and binding capacity. The high water holding capacity and binding capacity decreased reductions in diameter and thickness by reducing the deformation of the chicken patties during the heating.

pH and color

Table 3 shows the pH, lightness (*L**-value), redness (*a**-value), and yellowness (*b**-value) values of uncooked and

Table 2. Cooking loss and dimensional changes of chicken patties formulated with various levels of dietary fiber from *Algelica keiskei* Koidz

Parameters	Dietary fiber levels from *Algelica keiskei* (%)				
	0	1	2	3	4
Cooking loss (%)	19.49±0.67^{a}	16.31±0.78^{b}	15.89±0.86^{b}	15.35±0.69^{bc}	14.89±0.67^{c}
Reduction in diameter (%)	18.12±1.18^{a}	16.43±1.34^{b}	13.28±1.09^{c}	12.78±1.02^{c}	10.01±1.00^{d}
Reduction in thickness (%)	20.45±1.05^{a}	18.01±1.36^{b}	15.01±1.48^{c}	14.34±1.59^{cd}	13.01±0.72^{d}

All values are mean±standard deviation of three replicates.

$^{a-d}$Means within a row with different letters are significantly different ($p<0.05$).

Table 3. Comparison pH and CIE L*, a*, b* on chicken patties formulated with various levels of dietary fiber from *Algelica keiskei* Koidz

Parameters		Dietary fiber levels from *Algelica keiskei* (%)				
		0	1	2	3	4
Uncooked	pH	6.18±0.03^{a}	6.18±0.02^{a}	6.15±0.02^{b}	6.10±0.03^{c}	6.04±0.02^{d}
	*L**-value	73.00±0.83^{a}	59.16±0.29^{b}	55.13±1.27^{c}	52.89±1.06^{d}	51.82±1.29^{e}
	*a**-value	9.02±0.27^{a}	-3.33±0.17^{b}	-4.14±0.18^{c}	-4.36±0.18^{d}	-4.46±0.22^{d}
	*b**-value	11.13±0.21^{c}	13.25±0.62^{a}	12.25±0.38^{b}	11.41±0.38^{c}	11.37±0.47^{c}
Cooked	pH	6.39±0.02^{a}	6.34±0.02^{b}	6.27±0.03^{c}	6.22±0.02^{d}	6.21±0.03^{d}
	*L**-value	74.95±0.40^{a}	63.11±0.24^{b}	58.40±0.73^{c}	54.29±0.37^{d}	52.15±0.75^{e}
	*a**-value	2.11±0.06^{a}	-6.43±0.42^{b}	-6.35±0.16^{c}	-6.34±0.15^{c}	-5.66±0.33^{c}
	*b**-value	12.29±0.29^{d}	15.03±0.37^{a}	14.86±0.34^{a}	14.17±0.33^{b}	13.00±0.61^{c}

All values are mean±standard deviation of three replicates.

$^{a-d}$Means within a row with different letters are significantly different ($p<0.05$).

cooked chicken patties formulated with *Algelica keiskei* Koidz dietary fiber. The pH of the uncooked chicken patties ranged from 6.04 to 6.18, and that of cooked chicken patties ranged from 6.21 to 6.39. The highest pH for uncooked chicken patties was obtained from the control and treatment with 1% *Algelica keiskei* Koidz dietary fiber (p< 0.05), and the highest pH for cooked patties was observed in the control (p<0.05). The pH of uncooked and cooked treatments with more added *Algelica keiskei* Koidz dietary fiber tended to decrease. These results are consistent with those of Kim *et al*. (2014), who observed that pH values of gruel decreased significantly with the addition of more *Angelica keiskei*. These results are attributable to the low pH of *Algelica keiskei* Koidz dietary fiber (pH, 5.37).

The lightness, redness, and yellowness values of uncooked and cooked chicken patties with *Algelica keiskei* Koidz dietary fiber were significantly different (Table 3). The control with no *Algelica keiskei* Koidz dietary fiber had the highest lightness and redness values (p<0.05) and as the level of *Algelica keiskei* Koidz dietary fiber decreased, so did the lightness and redness values (p<0.05). The highest yellowness of the uncooked patty was treatment with 1% *Algelica keiskei* Koidz dietary fiber, and cooked were the treatments with 1% and 2% *Algelica keiskei* Koidz dietary fiber (p<0.05). Similar results were reported by Choi *et al*. (1999) when *Algelica keiskei* Koidz flour was added to bread and by Lee *et al*. (2005) for rice cake with added *Algelica keiskei* Koidz. These results were due to the effects of *Algelica keiskei* Koidz's color (CIE L*-value: 5.37, a*-value: 63.95, and b*-value: -6.79).

Texture profile analysis

The *Algelica keiskei* Koidz dietary fiber level was found to affect the texture attributes of the chicken patties (Table 4). The highest hardness, cohesiveness, gumminess, and chewiness for chicken patties were obtained from the control, with no *Algelica keiskei* Koidz dietary fiber (p< 0.05). With increasing levels of *Algelica keiskei* Koidz dietary fiber, the hardness, cohesiveness, gumminess, and chewiness of the chicken patties decreased (p<0.05). The springiness was not significantly different between the control and any of the treatments with *Algelica keiskei* Koidz dietary fiber (p>0.05). Choi *et al*. (2012) showed similar results when the studying the effects of adding *Laminaria japonica* to low-fat pork patties. These results agree with those Kim *et al*. (2013) who found that textural properties changed the effects of dietary fiber extracts from brewer's spent grain on chicken patties. Gao *et al*. (2014) reported that ground pork patties containing glutinous rice flour, corn starch, and potato starch had characteristics that were similar to those in this study. Sanchez-Zapata *et al*. (2010) indicated that hardness of pork burgers added with 5% and 10% tiger nut fiber was lower than the control with no tiger nut fiber. Crehan *et al*. (2000) observed that hardness, cohesiveness, gumminess, and chewiness of treatments with added maltodextrin were lower than the control. This result is probably because of protein and fat binding capacity is loosened, affected by the higher water holding capacity of the added dietary fiber treatments.

Sensory properties

The sensory properties of the control and chicken patties with *Algelica keiskei* Koidz dietary fiber are shown in Table 5. The control had the greatest color score (p<0.05), and none of the treatments with *Algelica keiskei* Koidz dietary fiber showed a significant difference (p>0.05). The flavor and tenderness scores were not significantly different between the control and samples with *Algelica keiskei* Koidz dietary fiber (p>0.05). The chicken patties containing *Algelica keiskei* Koidz dietary fiber had a higher juiciness score than the control (p<0.05); this score was highest for the treatments with 2% and 3% *Algelica keiskei* Koidz dietary fiber (p<0.05). Indeed, the overall acceptability scores of the treatments with 1% and 2% *Algelica keiskei* Koidz dietary fiber were the highest (p>0.05). Similar

Table 4. Comparison textural properties on chicken patties formulated with various levels of dietary fiber from *Algelica keiskei* Koidz

Parameters	Dietary fiber levels from *Algelica keiskei* (%)				
	0	1	2	3	4
Hardness (kg)	0.40±0.05^{a}	0.37±0.05^{b}	0.35±0.04^{bc}	0.33±0.04^{cd}	0.31±0.04^{d}
Springiness	0.92±0.13	0.92±0.07	0.92±0.12	0.90±0.11	0.87±0.11
Cohesiveness	0.54±0.07^{a}	0.46±0.03^{b}	0.43±0.07^{b}	0.43±0.04^{b}	0.44±0.04^{b}
Gumminess (kg)	0.22±0.05^{a}	0.17±0.02^{b}	0.15±0.03^{bc}	0.14±0.03^{c}	0.14±0.02^{c}
Chewiness (kg)	0.20±0.04^{a}	0.15±0.02^{b}	0.14±0.03^{bc}	0.13±0.03^{c}	0.12±0.03^{c}

All values are mean±standard deviation of three replicates.
$^{a-d}$Means within a row with different letters are significantly different (p<0.05).

Table 5. Sensory properties of chicken patties formulated with various levels of dietary fiber from *Algelica keiskei* Koidz

Parameters	Dietary fiber levels from *Algelica keiskei* (%)				
	0	1	2	3	4
Color	8.23±0.59[a]	7.78±0.89[b]	7.65±0.83[b]	7.61±0.68[b]	7.55±0.65[b]
Flavor	7.89±0.87	7.96±0.57	7.94±0.77	7.81±0.91	7.63±0.81
Tenderness	7.81±0.40	7.88±0.53	8.19±0.66	8.13±0.72	7.81±0.54
Juiciness	7.56±0.51[c]	7.75±0.58[bc]	8.41±0.60[a]	8.44±0.89[a]	7.88±0.64[b]
Overall acceptability	7.56±0.51[b]	8.19±0.54[a]	8.13±0.50[a]	8.00±0.73[ab]	7.56±0.75[b]

All values are mean±standard deviation of three replicates.
[a-c]Means within a row with different letters are significantly different (p<0.05).

results were obtained by Choi *et al*. (2008), who examined the effects of rice bran fiber on the quality characteristics of *ttokgalbi*, and by Turhan *et al*. (2005), who observed the sensory properties affected by adding hazelnut pellicle to beef burger patties. Choi *et al*. (1999) reported that bread with added *Algelica keiskei* Koidz flour had a lower color score than the control, and Lee *et al*. (2005) observed that rice cake with 2% *Algelica keiskei* Koidz powder showed the best overall acceptability score. Generally, meat products manufactured with the addition of dietary fiber showed lower color scores, affected by the color of the dietary fiber sources, but overall acceptability increased due to improved tenderness and juiciness scores.

Conclusions

The results of this investigation indicated that *Algelica keiskei* Koidz is a potentially useful dietary fiber source that can be used as a functional ingredient in chicken patties. The chicken patties with increasing amounts of added *Algelica keiskei* Koidz dietary fiber levels had improved cooking loss, reductions in diameter and thickness, and textural properties. The overall acceptability of the treatments with 1% and 2% added *Algelica keiskei* Koidz dietary fiber showed the highest scores. Thus, the addition of 2% *Algelica keiskei* Koidz dietary fiber improved the physical properties and overall acceptability of chicken patties.

Acknowledgements

This research was supported High Value-added Food Technology Development Program (2014-314068-3) by the Ministry of Agriculture, Food and Rural Affairs (Republic of Korea).

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