EFFECT OF *LAMINARIA JAPONICA* POWDER LEVELS ON THE PHYSICO-CHEMICAL AND SENSORY CHARACTERISTICS OF LOW-FAT PORK PATTIES

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***Abstract*— the effects of low fat and the addition of *Laminaria japonica* powder on the chemical composition, cooking characteristics and sensory properties of low-fat pork patties were evaluated. Low-fat pork patties containing *Laminaria japonica* powder had significantly higher moisture, ash, carbohydrate content, yellowness, and springiness than the control sample. Protein and fat content, energy value, cooking loss, reduction in diameter, reduction in thickness, hardness, gumminess, and chewiness of the regular-fat (20%) control samples were significantly higher than low-fat pork patties containing *Laminaria japonica* powder. The sensory evaluations indicated that the greatest overall acceptability in low-fat pork patties was attained at a *Laminaria japonica* concentration of 1 or 3%. Pork patties with fat contents reduced from 20% to 10% and supplemented with 1 or 3% *Laminaria japonica* powder had improved quality characteristics that were similar to the control patties containing a fat content of 20%.**

***Index Terms*— Laminaria japonica*, low-fat, pork patties, dietary fiber, quality properties.**

I. INTRODUCTION

Laminaria japonica is a common seafood in Korea and many other Asia countries (Kim, Kim, & Yoo, 2008), and it has been used as a drug in traditional Korean medicine for over a thousand years (Park, Cho, Kim, Kim, & Kim, 2008). Laminaria is the most important economic seaweed cultured in Korea, and it is widely consumed as a marine vegetable. Laminaria 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 biological activities including anticoagulant, antithrombotic, antitumor, antiviral, anti-complement and anti-inflammatory activities(Bang, Shin, Chung, & Kim, 2006). The meat industry is constantly undergoing transformations, driven among other factors by changes in consumer demands. Health concerns about fat consumption and changes in consumer's preferences have led to extensive research on low-fat meat products (Choi et al., 2010; Pinero et al., 2008). Therefore, the objective of this study was to evaluate the effects of low-fat and the addition of *Laminaria japonica* powder on the physico-chemical and sensory evaluation of low-fat patties.

II. MATERIALS AND METHODS

*A. **Preparation and processing of Laminaria japonica powder***

The *Laminaria japonica* was grinded using a blender for one minute and passed though a 35-mesh sieve. The *Laminaria japonica* was then placed in polyethylene bags, vacuum packaged using a vacuum packaging system and stored at -4 ℃ until used for product manufacture.

*B. **Pork patties preparation and processing***

Fresh pork ham and pork back fat were purchased from a local processor. All subcutaneous and intramuscular fat and visible connective tissue were removed from fresh ham muscle. Lean materials and pork back fat were initially ground through an 8-mm plate. Each batch of samples consisted of five pork patties, which differed in composition with respect to fat level (10% or 20%) and the addition of *Laminaria japonica* powder. The pork patties were produced according to the following traditional recipe. Lean meat mixed with ingredients (1.5% salt, 0.15% sodium tripolyphosphate, 3.0% garlic powder, 3.0% onion powder, 0.7% ginger powder, 1.5% isolated soy protein, and 0.8% sugar) were added. The mix was kneaded for 15 min at 4˚C by hand and the pork patty mixtures were divided into five equal portions. The first batch was used as a control and the fat content was adjusted to 20% by the addition of back fat. The second batch was used as treatment-C and the fat content was adjusted to 10% by the addition of back fat. The other batches were supplemented with various levels (1, 3, and 5%) of *Laminaria japonica* powder and the fat content was adjusted to 10% with the addition of back fat. 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 day, and then shaped using a household hamburger mold into meat products that were approximately 100 mm in diameter and 15 mm thick with a weight of about 90 g before cooking. 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.

*C. **Proximate composition***

The compositional properties of the pork patties were determined using an AOAC (2000).

*D. **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).

*E. **Cooking loss***

Cooking loss was determined by calculating the weight differences before and after cooking.

*F. **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 and calculated using the following expression.

*G. **Texture profile analysis***

Texture profile analysis was performed at room temperature with a texture analyzer. Pork patty samples were taken from the central portion of each meat patty.

*H. **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 pork patties.

III. RESULTS AND DISCUSSION

The proximate compositions and energy values of the low-fat pork patties formulated with different *Laminaria japonica* powder concentrations are shown in Table 1. The moisture content of pork patties containing *Laminaria japonica* powder was higher than the control (P<0.05) because the samples containing *Laminaria japonica* powder were initially formulated with more water and less fat than the control. The protein content was lower in the low-fat pork patties with *Laminaria japonica* powder than the control (P<0.05). However, protein content of low-fat pork patties samples (TC, T1, T2, and T3) were not significantly different among the treatments (P>0.05) due to protein content of *Laminaria japonica* powder was 7.85% which low-fat pork patties contain in relative a few. The fat content of the control pork patties was 22.98% and the fat content of the low-fat pork patties samples ranged from 13.71-10.52%, because fat was replaced by water in the original formula. The highest energy value observed for the control sample was 310.22 kcal/ 100 g (P<0.05). The energy values for the pork patties containing *Laminaria japonica* powder ranged from 226.10 to 212.83 kcal/ 100 g. The cooking loss and reduction in diameter and thickness of low-fat pork patties formulated with different *Laminaria japonica* powder concentrations are provided in Table 2. The results of this analysis indicated that the cooking loss of samples containing *Laminaria japonica* powder decreased significantly (P<0.05), when compared with the control. In addition, the cooking loss of the pork patties decreased as more *Laminaria japonica* powder was added (P<0.05). A reduction in fat content from 20% to 10% caused a significant increase in cooking loss relative to the low-fat control due to the fact that these samples initially had more water than the control (P<0.05). The texture attributes of the control and low-fat pork patties with or without *Laminaria japonica* powder are shown in Table 3. The regular fat pork patty (control) had the highest hardness value and as the concentration of *Laminaria japonica* powder increased the hardness increased. The low-fat pork patties containing

Laminaria japonica powder had a higher springiness than the control (*P*<0.05), and this value was the highest for the sample containing 1% *Laminaria japonica* powder (T1). The cohesiveness values were not significantly different between the control and low-fat samples with or without *Laminaria japonica* powder (*P*>0.05). Gumminess and chewiness of the control was the highest and increasing the concentration of *Laminaria japonica* powder increased the gumminess and chewiness of low-fat pork patties (*P*<0.05). The *Laminaria japonica* powder concentration was found to affect the sensory properties of low-fat pork patties, as shown in Fig. 1. The color score was the highest for the control and the color score of low-fat pork patties containing *Laminaria japonica* powder was greater than those not containing *Laminaria japonica* powder (TC) (*P*<0.05). Tenderness, juiciness, and overall acceptability scores of low-fat pork patties containing 1% and 3% *Laminaria japonica* powder were significantly higher than the control (*P*<0.05), but low-fat pork patties not containing *Laminaria japonica* powder (TC) was the lowest (*P*<0.05). Overall, the low-fat pork patties produced with 1% and 3% *Laminaria japonica* powder had the highest scores, whereas the low-fat pork patties containing 10% fat without *Laminaria japonica* powder had the lowest score.

Table 1. Proximate composition and energy values of uncooked low-fat pork patties formulation with varying *Laminaria japonica* powder levels

Treatments[1)]	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrate (%)	Energy value (kcal/100 g)
Con	49.31±0.40[c]	22.59±0.42[a]	22.98±0.91[a]	2.21±0.30[c]	2.91±0.36[c]	310.22±7.30[a]
TC	57.43±0.61[a]	20.88±0.71[b]	13.71±0.82[b]	2.31±0.16[c]	5.67±1.10[b]	230.59±4.82[b]
T1	56.18±0.71[b]	20.45±0.88[b]	12.20±0.96[c]	2.79±0.19[b]	8.38±1.37[a]	226.10±5.40[bc]
T2	56.59±0.83[ab]	19.33±0.69[b]	11.88±0.91[c]	3.19±0.41[b]	9.00±2.60[a]	221.18±1.26[c]
T3	56.29±0.26[b]	20.13±0.45[b]	10.52±0.84[d]	3.87±0.24[a]	9.19±0.77[a]	212.83±5.02[d]

All values are mean ± standard deviation of three replicates (n=30)
[a-d] Means within a column with different letters are significantly different (*P* < 0.05).
[1)]Con: pork back fat (20%) + ice water (10%), TC: pork back fat (10%) + ice water (20%), T1: pork back fat (10%) + ice water (19%) + *Laminaria japonica* powder (1%), T2: pork back fat (10%) + ice water (17%) + *Laminaria japonica* powder (3%), T3: pork back fat (10%) + ice water (15%) + *Laminaria japonica* powder (5%).

Table 2. Effects of cooking loss and reduction in diameter and thickness of low-fat pork patties formulated with varying *Laminaria japonica* powder levels

Treatments[1)]	Cooking loss (%)	Reduction in diameter (%)	Reduction in thickness (%)
Con	26.52±1.75[b]	17.09±3.32[a]	18.52±1.52[b]
TC	34.64±1.57[a]	18.84±4.67[a]	20.42±1.13[a]
T1	19.01±2.67[c]	12.56±1.34[b]	14.39±1.76[c]
T2	17.86±1.50[c]	12.25±1.35[b]	14.18±1.66[cd]
T3	13.78±0.63[d]	10.04±3.80[b]	13.00±0.68[d]

All values are mean ± standard deviation of three replicates (n=30)
[a-d] Means within a column with different letters are significantly different (*P* < 0.05).
[1)]Con: pork back fat (20%) + ice water (10%), TC: pork back fat (10%) + ice water (20%), T1: pork back fat (10%) + ice water (19%) + *Laminaria japonica* powder (1%), T2: pork back fat (10%) + ice water (17%) + *Laminaria japonica* powder (3%), T3: pork back fat (10%) + ice water (15%) + *Laminaria japonica* powder (5%).

Table 3. Effects of the textural attributes of low-fat pork patties formulated with varying *Laminaria japonica* powder levels

Treatments[1)]	Hardness (N)	Springiness	Cohesiveness	Gumminess (N)	Chewiness (N)
Con	6.99±0.77[a]	0.91±0.05[c]	0.48±0.03	3.32±0.33[a]	2.94±0.32[a]
TC	4.60±0.33[c]	0.90±0.04[c]	0.47±0.04	2.10±0.19[c]	1.95±0.28[c]
T1	4.68±0.58[c]	0.98±0.07[a]	0.45±0.04	2.12±0.17[c]	2.03±0.19[c]
T2	6.03±0.54[b]	0.94±0.10[b]	0.46±0.05	2.76±0.34[b]	2.50±0.38[b]
T3	6.22±0.47[b]	0.95±0.05[ab]	0.45±0.06	2.83±0.39[b]	2.66±0.47[b]

All values are mean ± standard deviation of three replicates (n=30)

[a-c] Means within a column with different letters are significantly different (P < 0.05).
[1)]Con: pork back fat (20%) + ice water (10%), TC: pork back fat (10%) + ice water (20%), T1: pork back fat (10%) + ice water (19%) + *Laminaria japonica* powder (1%), T2: pork back fat (10%) + ice water (17%) + *Laminaria japonica* powder (3%), T3: pork back fat (10%) + ice water (15%) + *Laminaria japonica* powder (5%).

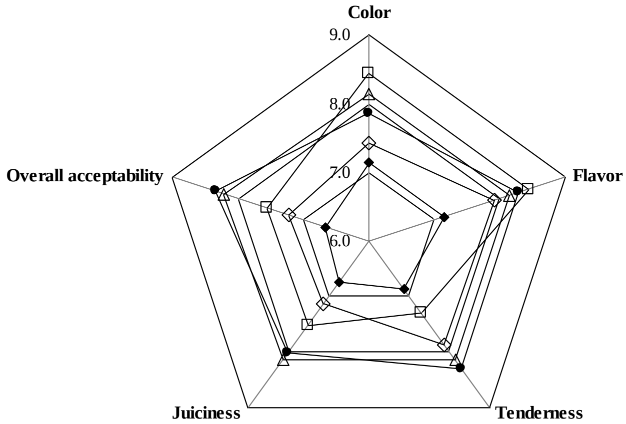

Fig. 1. Effect of sensory characteristics on cooked low-fat pork patties containing various *Laminaria japonica* powder levels

(□) Con: pork back fat (20%) + ice water (10%), (◆) TC: pork back fat (10%) + ice water (20%), (△) T1: pork back fat (10%) + ice water (19%) + *Laminaria japonica* powder (1%), (●) T2: pork back fat (10%) + ice water (17%) + *Laminaria japonica* powder (3%), (◇) T3: pork back fat (10%) + ice water (15%) + *Laminaria japonica* powder (5%).

IV. CONCLUSION

The results of this investigation indicate that fat replacers can be successfully used for the production of low-fat pork patties without any detrimental effects to the quality of the meat as perceived by the consumer. *Laminaria japonica* powder is a good source of dietary fiber and holds promise for use as a functional ingredient in meat patties. The meat patties containing *Laminaria japonica* powder had improved cooking loss, reduction in diameter and thickness, textural properties, and sensory properties. Low-fat pork patties had lower energy values than the control patties.

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