

Dietary Fiber in Godulbaegi (Korean Lettuce, *Ixeris sonchifolia* H.) Kimchi

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Abstract

The effect of processing conditions on the changes in the contents of dietary fiber fractions and its physical properties of Godulbaegi (Korean lettuce, *Ixeris sonchifolia* H.) was determined during preparation and fermentation for kimchi. Water holding capacity (WHC) and oil adsorption capacity (OAC) were also checked on the subject of freeze dried powder from different stages of the kimchi processing. Neutral detergent fiber (NDF) content in young samples (leaf and root) decreased with prolonged soaking and fermentation period. Every young samples had a higher level in NDF than in ripe samples. Noticeable decrease in acid detergent fiber (ADF) without a change in ripe roots was showed after fermentation (4° C, 60 days). The water holding capacity of freeze dried young plants ranged from 5.78ml/g for roots to 6.31ml/g for leaves. Soaking and fermentation resulted in decreasing WHC and about 50% of WHC (raw leaves) was lowered after kimchi fermentation (4° C, 40 days). OAC of all samples were lower than WHC in same samples significantly and those were also decreased after soaking and fermentation as WHC.

Key words : Godulbaegi (Korean lettuce, *Ixeris sonchifolia* H.) kimchi, dietary fiber, water holding capacity (WHC), oil adsorption capacity (OAC)

INTRODUCTION

Godulbaegi (*Ixeris sonchifolia* H.) is known as a ubiquitous wild plant used for foodstuffs in the southern province of Korea. Its young sprouts is cooked as the blanched and seasoned with sesame oil for a characteristic side dish in Spring. In Korean folk remedy, sun dried Godulbaegi has been recommended as the stomachic, diuretic and antifebrile. Due to its particular flavor and bitter taste for human consumption, raw or uncooked Godulbaegi as salad base seldom occurs. Therefore simple processes such as soaking and fermenting were tried by Korean in order to modify the composition and availability of nutrients. Those processes also improve the taste and/or flavor, and modify the plant cell wall material which may have important physiological effects (1). Some potential health benefits are attributable to consumption of foods high in dietary fiber in fermented vegetable products

(kimchi) ; e.g. lowering of serum cholesterol, improvement of glycemic response and possibly reducing colon cancer (2). Although some studies have been conducted on the use of Godulbaegi as a food, most of them were focused on its fiber contents (3-6) and pharmaco-chemical effect (7) using fresh Godulbaegi leaves rather than its dietary fiber changes during processing. Only one published report concerned the food values of Godulbaegi kimchi (8) through free amino acid determination. With increasing consumer's interest in fiber-rich foods, and the demand for more nutrient data, there is a need for information on both the total dietary fiber content and its profile of the varieties of wild plants consumed since each dietary fiber components exert a different physiological effect. Our objective was to determine and compare dietary fiber patterns in raw, soaked and fermented Godulbaegi kimchi. It was also studied the WHC and OAC of freeze dried Godulbaegi kimchi powder because it has a significant physiological effect.

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MATERIALS AND METHODS

Samples and sample preparation

Fresh Godulbaegi samples cultivated within Suncheon area were purchased from a local retail outlets in September (young samples) and November (ripe samples). Samples were separated by size, and divided into leaves and roots prior to trimming. Trimmed samples were freeze-dried and then ground to pass 80mesh screen. Freeze dried fresh samples were stored in the hermetic sample containers for further analyses. Godulbaegi kimchi preparation procedure was made from Korean traditional recipe. 6kg of fresh samples were soaked in 10L of 5% brine solution and then allowed to reduce bitter taste at room temperature for 24 hours. This soaking period was selected to achieve the least bitter taste and moderate salty taste from the preliminary experiments. The Godulbaegi samples were drained and rinsed with tap water. 4kg of rinsed Godulbaegi samples were mixed with kimchi ingredients (anchovy sauce 540ml, red pepper powder 250g, sucrose 100g, chopped garlic 200g, and chopped ginger 50g). Prepared kimchi mixture were divided into 200g units and stored in bottle at 4°C for fermentation. Following fermentation period, all ingredients were removed from kimchi samples and then freeze-dried as described above for further experiments.

Analytical procedures

Moisture, lipid, protein ($N \times 6.25$) and ash were determined by the procedures of AOAC (9). The method of Van Soest and Wine (10) was used to determine NDF using neutral detergent solution. Those solution were prepared by dissolving sodium lauryl sulfate 30 g, EDTA 18.61g, sodium borate decahydrate 6.81g, and disodium hydrogen phosphate 4.56g in 500ml of distilled water. And then 2-ethoxyethanol (10ml) was added followed by addition of subsequent distilled water to make up the volume of 1L. ADF was measured on the basis of AOAC (9) method using acid detergent solution (20g cetyl trimethyl ammonium bromide/L of 1N H₂SO₄).

Water holding capacity(WHC) and oil adsorption capacity(OAC)

WHC were measured on freeze-dried powder of Godulbaegi samples according to a procedure described by Lin and Humbeart (11). The procedure for OAC test was similar to those described for WHC. 1g samples of freeze-dried powder were mixed with 6ml soybean oil. This slurry was treated as outlined in previous paper (11). Results were expressed as ml soybean oil retained per g sample.

RESULTS AND DISCUSSION

The proximate composition of root and leaf of fresh Godulbaegi was compared in Table 1. There was a high content of crude protein contents in leaf samples than compared with roots. Those results were similar to those reported by Shin (12). Ripe Godulba-

Table 1. Proximate composition of fresh Godulbaegi*(Korean lettuce, *Ixeris sonchifolia* H.) (%)

Composition	Leaf	Root
Moisture	84.00	78.01
Crude protein	2.99	2.34
Crude lipid	1.44	1.01
Crude ash	1.55	1.03

*Godulbaegi samples were harvested in November

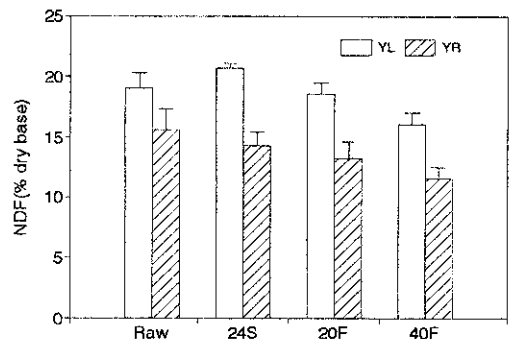


Fig. 1. Changes in neutral detergent fiber (NDF) contents during processing of Godulbaegi (Korean lettuce) kimchi prepared with young plants.

YL : Young Korean lettuce leaves (harvested in September)

YR : Young Korean lettuce roots

24S : Soaked in 5% NaCl solution for 24 hrs

20F : Fermented at 4°C for 20 days

40F : Fermented at 4°C for 40 days

egi samples showed a lower content in crude protein than that in the other Korean wild plants (13).

The contents of NDF in raw and processed Godulbaegi are presented in Fig. 1 and 2. A higher content of NDF was observed in young samples (16~19% for leaves, 11~15% for roots) than ripe ones (10~15% for leaves, 9~11% for roots) and all of roots showed a lower NDF than that of leaves. Soaking of Godulbaegi in brine altered NDF content of all samples except

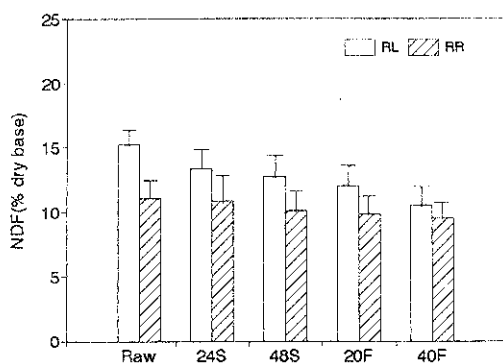


Fig. 2. Changes in neutral detergent fiber (NDF) contents during processing of Godulbaegi (Korean lettuce) kimchi prepared with ripe plants.

RL : Ripe Korean lettuce leaves (harvested in November)

RR : Ripe Korean lettuce roots

24S : Soaked in 5% NaCl solution for 24 hrs

20F : Fermented at 4° C for 20 days

40F : Fermented at 4° C for 40 days

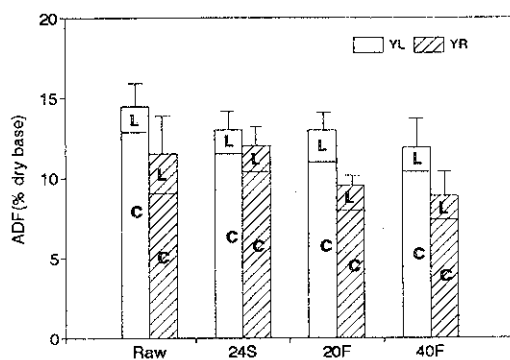


Fig. 3. Changes in acid detergent fiber (ADF) contents during processing of Godulbaegi (Korean lettuce) kimchi prepared with young plants.

YL : Young Korean lettuce leaves (harvested in September)

YR : Young Korean lettuce roots

24S : Soaked in 5% NaCl solution for 24 hrs

20F : Fermented at 4° C for 20 days

40F : Fermented at 4° C for 40 days

L : Lignin, C : Cellulose

ripe roots. The apparent loss of NDF in Godulbaegi samples appeared related to the fermentation. In the case of ripe leaves, Fermentation (4° C, 40 days) lowered NDF content by 5% on moisture free basis. The exception to this was the case of ripe root samples. This decrease in NDF could indicate that for certain samples, ripe roots had a compact tissue and that led to a slight decrease in NDF during soaking and fermentation. On the contrary water soluble fibers could be solubilized in other Godulbaegi samples (young roots and both leaves) as a result of soaking and fermentation and that resulted in apparent decrease of NDF easily. Result obtained for NDF by soaking were in agreement with previous observations with vegetables (14-17). In addition to changes of NDF by fermentation, further studies are required to definitively determine the composition changes occurring in soluble NDF fraction. Although the ADF content in ripe roots was unaffected by fermentation, a similar changes of ADF content were observed in the other samples likewise NDF (Fig. 3 and 4). Those figures also exhibited that ADF in Godulbaegi comprised of cellulose and lignin as the ratio of 9 : 1 (w/w). The results imply fermentation might be involved in decrease of ADF enzymatically. The content of ADF was decreas-

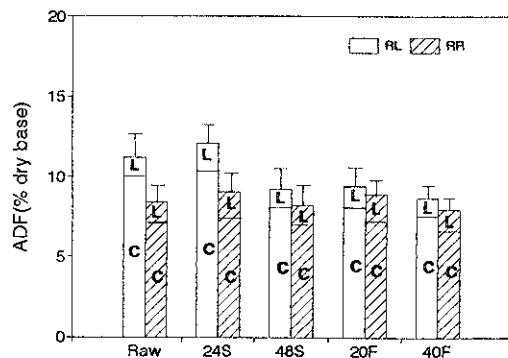


Fig. 4. Changes in acid detergent fiber (ADF) contents during processing of Godulbaegi (Korean lettuce) kimchi prepared with ripe plants.

RL : Ripe Korean lettuce leaves (harvested in November)

RR : Ripe Korean lettuce roots

24S : Soaked in 5% NaCl solution for 24 hrs

48S : Soaked in 5% NaCl solution for 48hrs

20F : Fermented at 4° C for 20 days

40F : Fermented at 4° C for 40 days

L : Lignin, C : Cellulose

ed from 14% to 11% for leaves and from 11% to 8% for roots during fermentation (4°C, 40 days). Soaking in 5% brine solution caused a slight increase in ADF content. This increase in ADF after soaking could be explained by losses in other components of dietary fiber (18). An exception of soaking was showed in fresh samples where ADF decreased. Aside from soaking in brine, fermentation of Godulbaegi brought about a decrease in 3~5% of NDF and 2~3% of ADF.

Table 2 shows the water holding capacity (WHC) of two kinds of Godulbaegi (young and ripe) at various

Table 2. Water holding capacity (WHC) of Godulbaegi (Korean lettuce) kimchi products

Processing	WHC (ml/g)	
	Young ^a	Ripe ^b
Leaves		
Fresh	6.32±0.03	6.26±0.04
Soaked (24 hours) ^c	7.02±0.02	5.84±0.02
Fermented (20 days) ^d	5.56±0.05	4.20±0.28
Fermented (40 days) ^e	4.88±0.17	3.24±0.01
Roots		
Fresh	5.78±0.08	3.68±0.03
Soaked (24 hours)	5.82±0.05	3.50±0.06
Fermented (20 days)	4.64±0.06	3.31±0.14
Fermented (40 days)	2.76±0.03	2.90±0.08

^a Young Korean lettuce samples were harvested in September

^b Ripe Korean lettuce samples were harvested in November

^c Soaked in 5% NaCl soln for 24 hours

^d Fermented at 4°C for 20 days

^e Fermented for 4°C for 40 days

Table 3. Oil adsorption capacity (OAC) of Godulbaegi (Korean lettuce) kimchi products

Processing	OAC (ml/g)	
	Young ^a	Ripe ^b
Leaves		
Fresh	3.74±0.01	3.14±0.02
Soaked (24 hours) ^c	3.90±0.08	3.02±0.05
Fermented (20 days) ^d	2.32±0.03	2.16±0.03
Fermented (40 days) ^e	1.88±0.07	1.57±0.05
Roots		
Fresh	3.06±0.04	2.32±0.04
Soaked (24 hours)	2.54±0.18	2.05±0.04
Fermented (20 days)	2.02±0.04	1.99±0.09
Fermented (40 days)	1.34±0.08	1.13±0.01

^a Young Korean lettuce samples were harvested in September

^b Ripe Korean lettuce samples were harvested in November

^c Soaked in 5% NaCl soln for 24 hours

^d Fermented at 4°C for 20 days

^e Fermented at 4°C for 40 days

stages of kimchi processing. WHC of all fresh samples ranged from 5.8 (ml/g) to 6.3 (ml/g) but ripe roots showed 40% lower (3.7ml/g) WHC beyond that range. A higher WHC noted in leaf samples than roots samples. The large discrepancy was found between ripe leaves and roots samples. Similar to trends for NDF or ADF, all of young samples also had a greater WHC than that of corresponding ripe samples. Fermentation of young Godulbaegi decreased their WHC clearly, while soaking could give somewhat greater WHC than fresh samples. But in case of ripe samples, soaking and prolonged fermentation lowered WHC. Our result indicated that some of the easily fermented types of fiber (2,19) and cellulose, which had a great role in WHC (20), leached into kimchi aliquots during fermentation process, thus lowering the WHC of Godulbaegi. Differences in WHC of preparations were dependent on whether the NDF or ADF content were changed during fermentation, as shown in Fig. 1, 2, and Table 2 for ripe Godulbaegi samples. The WHC reported in previous study for fresh young Godulbaegi were about 30% less than the corresponding values of our results (5). WHC in our study was determined on the freeze-dried powder, while in the other study it was determined using the hot-air blast (50°C) dried products. The difference in samples preparation as grinding and drying condition caused a great discrepancy in WHC (21). A similar pattern was obtained when water was substituted with soybean oil (Table 3). However, retention capacities for oil expressed as oil adsorption capacity (OAC) were generally lower than those for WHC. The data also demonstrated that content of a porous fiber like cellulose and if this fiber matrix is altered, its OAC would be affected.

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고들빼기김치 식이섬유질의 식품학적인 특성

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요 약

고들빼기 김치의 식품학적 특성을 알아보기 위하여 김치 제조과정 중의 식이섬유질 함량과 구성 변화를 실험하였으며, 진공동결건조 김치분말에 대한 보수력과 오일 흡착력을 측정하였다. 어린 고들빼기일수록 중성 세제 섬유질(NDF) 및 산성세제 섬유질(ADF)의 함량이 많았으며 뿌리부분에는 잎부분에 비하여 적은량의 식이섬유질(ADF 및 NDF)이 함유되어 있었다. 성숙한 뿌리를 제외하고는 일반적으로 5% 식염수에 침지할 경우에는 식이섬유질 함량은 높아지나 발효가 진행됨에 따라 이들 섬유질의 함량은 서서히 줄어들고 있었다. 셀룰로오스가 산성세제 섬유질의 90%를 차지하는 것으로 보아 김치제조과정 중의 식이섬유질 함량 변화는 일부 가용성 식이섬유질의 유출 및 셀룰로오스의 구조변화에 영향을 받은 것으로 생각되었다. 보수력과 오일 흡착력은 식이섬유질 함량변화와 비슷한 결과를 보였으며 오일 흡착력은 보수력의 40% 정도였다.