Current Research on Agriculture and Life Science (2014) 32(2): 75–78
http://dx.doi.org/10.14518/crals.2014.32.2.014

Online ISSN 2288-0356
Print ISSN 2287-271x

Original Article

Physicochemical Characteristics of Different Parts of Burdock (*Arctium* sp.)

Seul Lee[1], Hye-Kyung Moon[2], Il-Doo Kim[3], and Dong-Hyun Shin[4]*

[1]*Department of Food and Food-Service Industry, Kyungpook National University, Sangju 742-711, Korea*
[2]*Center for Scientific Instrument, Kyungpook National University, Sangju 742-711, Korea*
[3]*International Institute of Agricultural Research and Development, Kyungpook National University, Daegu 702-701, Korea*
[4]*Division of Plant Biosciences, School of Plant Biosciences, Kyungpook National University, Daegu 702-701, Korea*

Received: June 2 2014 / Revised: June 27 2014 / Accepted: June 27 2014

Abstract Burdock (*Arctium* sp.) is known as a nutraceutical vegetable, especially in Japanese and Korean cuisine. While burdock plants are generally harvested for their tap roots, different parts of the plant are consumed as food or used as traditional medicines. This study investigated the physicochemical properties of the leaves, stems, roots, and peeled roots of the burdock plant based on their pH, soluble solid content, titratable acidity, color values, and mineral content. The pH differed significantly among the different plant parts, with the highest value in the leaves and the lowest in the stems. However, for the soluble solid content, the leaves had the lowest, while the peeled roots had the highest. The titratable acidity of the stems was significantly lower than that of the leaves, roots, and peeled roots. As regards the color values, the lightness value was highest for the stems, while the roots showed the highest redness value, followed by the peeled roots, and the leaves had the highest yellowness value. The leaves and stems contained almost three times more potassium than the roots and peeled roots. Thus, the higher content of different minerals in the leaves and stems of the burdock plant shows that these plant parts could be used as potential sources of dietary minerals.

Keywords: burdock *(Arctium*sp.*)*, leaf, physicochemical characteristics, root, stem

*Corresponding author: Dong-Hyun Shin
Tel: 82-53-950-5707; Fax: 82-53-958-6880
E-mail: dhshin@knu.ac.kr

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/3.0/) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.
© 2014 Institute of Agricultural Science and Technology, Kyungpook National University

Introduction

Burdock (*Arctium* sp.) is commonly known as a nutraceutical vegetable in Japanese and Korean cuisine (Duistermaat, 1996), and different parts of the plant, such as the leaves, roots, and seeds, are consumed as food or used as traditional medicine. Dried burdock fruit is also widely used to dispel pathogenic wind-heat, promote eruption, alleviate sore throat, eliminate toxic substances, and reduce swelling. Previous studies have already established that burdock has many bioactivities and pharmacological properties, including demutagenic (Shinohara et al., 1988), cytoxic (Moritani et al., 1996), anti-proliferative (Moritani et al., 1996), enhancement of immunological (Yan and Li, 1993), anti-inflammatory (Yan and Li, 1993), anti-carcinogenesis (Hirosea et al., 2000), platelet activating factor antagonist (Iwakami et al., 1992) and calcium antagonist (Ichikawa et al., 1986) activities.

Lappaol F, diarctignin, and arctigenin, found in the seeds or leaves of burdock can inhibit nitric oxide (NO) production, which in excessive amounts is involved in various inflammatory diseases, such as rheumatoid arthritis, autoimmune disease, chronic inflammation, and atherosclerosis. Therefore, the inhibition of NO production in macrophages is a potential treatment for certain inflammatory diseases (Wang et al., 2007). The extracts from different parts of burdock have long been considered to help enhance the body's immune system and improve metabolic functions (Lin et al., 2002). Natural products are also used in the treatment of various chronic human pathological conditions as they are rich in antioxidants (Guo et al., 2008).

The dried root of one-year-old burdock is the major part used for different therapeutic purposes, although burdock leaves and fruit/seeds are also sometimes used. Different parts of burdock have already been found to contain different compounds, such as arctigenin in the leaves, fruits, seeds, and roots (Awale et al., 2006;

Ishihara et al., 2006), arctigenin in the leaves and fruits (Hirose et al., 2000; Takasaki et al., 2000), diarctigenin in the fruits, roots, and seeds (Park et al., 2007), caffeic acid in the stems, leaves, and skin of the roots (Bhat et al., 2007; Pari and Prasath, 2008), chlorogenic acid in the leaves and skin of the roots (Chen et al., 2004; Bouayed et al., 2007; Li et al., 2008), and tannin in the roots (Miyamoto et al., 1993; Bralley et al., 2008). Thus, while previous studies have already investigated the neutraceutical, pharmacological, and pathological properties of burdock, the present study analyzed the physicochemical properties of different parts of the burdock plant.

Materials and Methods

Plant materials and chemicals

The burdock plants, harvested at the commercial maturity stage, were obtained from the local market at Gumi, Gyeongsangbuk-do, Korea and transported to the laboratory at Sangju Campus, Kyungpook National University for analysis. All the chemicals used in this study were of analytical grade.

Preparation of burdock samples

The burdock plants were separated into different parts: leaves, stems, roots, and peeled roots. Each sample was freeze-dried (SFDTS-10K, Samwon Engineering, Korea) and then homogenized using a homogenizer (HR-2860/55, Philips Electronics Ltd, Korea) for 5 min.

Physicochemical parameters

The pH of the burdock powders was measured using a pH meter (Beckman 250, Beckman Coulter, Inc., USA). The titratable acidity (equivalent to lactic acid in grams per liter) was analyzed by adding 5 g of the burdock powder samples to 125 mL of deionized water, titrating with 0.1 N sodium hydroxide to an endpoint pH of 8.2, and measuring using a refractometer (N-1E, Atago, Tokyo, Japan). All the chemical measurements were replicated three times and the average values are reported.

Color measurement

The L* (lightness), a* (redness, +or greenness, –), and b* (yellowness, +or blueness, –) values of the burdock powders were measured using a Chroma Meter (CR-300, Minolta Corp., Japan). A Minolta calibration plate (YCIE=94.5, XCIE= 0.3160, YCIE= 0.330) and Hunter Lab standard plate (L*=97.51, a*=–0.18, b*= +1.67) were used to standardize the instrument with a D65 illuminant. The color was measured directly on three spots of the powdered samples and the average calculated.

Determination of mineral content

The mineral (K, Mg, Ca, Na, Fe, Zn, Mn, Co, Cu, and Mo) contents were determined using the method of Bond et al., (2005) with a slight modification. Two replicate aliquots of approximately 0.1 g of each sample were digested using 20 mL of concentrated nitric acid and 1 mL of concentrated perchloric acid. The samples were set on a hot-plate at 120°C for 1 h and then at 150°C to reflux overnight. Thereafter, the samples were treated with 2.5 mL of nitric-perchloric acid (4:1, v/v) and a minimal amount of deionized water. After cooling, the solutions were diluted with deionized water to a final volume of 50 mL. The samples were then analyzed by ICP-AES (Spectro Analytical Instruments, USA) for the trace metal content. The instrument was calibrated using known standards for each mineral. The average value of the 2 replicate samples is reported.

Statistical analysis

The data were subjected to a one-way or two-way analysis of variance (ANOVA) when required. The statistical version 4.0 package (Analytical Software, AZ, USA) was used for the data analysis. The differences between the means at $p<0.05$ were identified using Tukey's means test.

Results and Discussion

Soluble solids, pH and titratable acidity

The pH values for the different plant parts were significantly different. Among the different parts analyzed, the pH value for the burdock leaves was the highest (6.17), while that for the stems was the lowest (5.5) (Table 1). However, the soluble solid content

Table 1. Chemical characteristics of different parts of burdock plant

Sample	pH	Soluble solid (°Brix)	Titratable acidity (%)
Burdock leaf	6.17±0.02[a1)]	2.47±0.15[b]	1.03±0.08[a]
Burdock stem	5.50±0.02[d]	2.63±0.06[b]	0.67±0.01[b]
Burdock root (unpeeled)	5.86±0.05[b]	3.53±0.25[a]	0.98±0.15[a]
Burdock root (peeled)	5.74±0.05[c]	3.80±0.20[a]	0.94±0.13[a]

[1)]Quoted values are the mean±standard deviation of triplicate experiments.
The values followed by different superscripts (a-d) in the same column are significantly different ($p<0.05$).

Table 2. Hunter's color values in different parts of burdock plant

Color value[1)]	Sample			
	Burdock leaf	Burdock stem	Burdock root (unpeeled)	Burdock root (peeled)
L (Lightness)	56.46±0.64^{c}[2)]	67.91±0.08^{b}	66.75±1.66^{b}	84.06±0.28^{a}
a (Redness)	−4.39±0.21^{d}	−1.90±0.09^{c}	2.27±0.15^{a}	0.62±0.09^{b}
b (Yellowness)	14.76±0.42^{a}	13.55±0.09^{b}	11.16±0.10^{c}	11.40±0.12^{c}

[1)]L: lightness (100, white; 0, black), a: redness (−, green; +, red), b: yellowness (−, blue; +, yellow).
[2)]Quoted values are mean±standard deviation of triplicate experiments.
The values followed by different superscripts (a-d) in the same row are significantly different (p<0.05).

Table 3. Mineral content in different parts of burdock plant (mg/100 g)

Mineral	Sample			
	Burdock leaf	Burdock stem	Burdock root (unpeeled)	Burdock root (peeled)
Ca	81.436±1.877^{a}[1)]	81.111±1.974^{a}	49.789±1.931^{b}	45.679±3.007^{b}
Co	0.016±0.001^{a}	0.006±0.001^{b}	0.005±0.001^{b}	ND[2)]
Cu	0.483±0.003^{a}	0.178±0.004^{d}	0.299±0.004^{b}	0.252±0.022^{c}
Fe	11.897±0.203^{a}	3.124±0.079^{b}	1.744±0.087^{c}	1.096±0.056^{d}
K	1491.722±5.665^{a}	1422.322±3.710^{b}	597.100±1.790^{c}	404.233±24.377^{d}
Mg	93.791±1.757^{b}	101.398±1.142^{a}	74.308±1.869^{c}	66.362±2.688^{d}
Mn	2.569±0.079^{a}	0.463±0.029^{b}	0.010±0.001^{c}	ND
Mo	0.310±0.021^{a}	0.157±0.006^{b}	0.095±0.002^{c}	0.072±0.001^{d}
Na	15.206±0.185^{b}	11.646±0.069^{c}	18.030±0.200^{a}	18.089±1.406^{a}
Zn	1.673±0.019^{a}	0.596±0.005^{c}	1.544±0.022^{b}	1.664±0.134^{a}
Total	1699.092	1621.002	742.924	537.139

[1)]Quoted values are means of duplicate experiments.
[2)]ND: Not detected.
The values followed by different superscripts (a-d) in the same row are significantly different (p<0.05).

of the leaves was the lowest (2.47°Brix), while that of the peeled roots was the highest (3.8°Brix). The soluble solid contents of the leaves and stems were not significantly different, along with those of the roots and peeled roots. Yet, the titratable acidity of the stems was significantly lower when compared to that of the leaves, roots, and peeled roots.

Acidity contributes to both taste and food safety, as it hinders the spoilage of food by microorganisms. Thus, different parts of the burdock plant could be used to enhance the taste of foods.

Color value

The lightness values for the stems (67.91) and roots (66.75) were not significantly different, yet higher than that for the leaves (56.46) and lower than that for the peeled roots (84.06). The burdock roots showed the highest redness value (2.27), followed by the peeled roots (0.62), whereas the leaves and stems revealed a greenness value of 4.39 and 1.9, respectively. The yellowness value for the leaves was significantly higher (14.76) than those for the other parts (Table 2).

Thus, since the different parts of the burdock plant have different color values and also possess nutritional and medicinal properties, they could be used as a nutraceutical coloring agent in foods. However, their impact on the taste of the food should also be considered.

Mineral content

Potassium was the major nutrient found in the different parts of the burdock plant. The leaves and stems contained almost 3 times more K than the roots and peeled roots. Meanwhile, Co and Mn showed the lowest content, and were not even detected in the peeled roots. All the nutrients, except for Na, showed a higher concentration in the leaves than in the roots and peeled roots.

Therefore, the results showed that burdock leaves and stems could be a good source of minerals, along with the roots (Table 3).

In conclusion, the higher content of different minerals in the leaves and stems of the burdock plant shows that they could be used as a potential source of dietary minerals. Plus, the aerial parts of the burdock plant are richer in mineral nutrients than the underground parts.

References

Awale S, Lu J, Kalauni SK, Kurashima Y, Tezuka Y, Kadota S, Esumi H (2006) Identification of arctigenin as an antitumor agent having the ability to eliminate the tolerance of cancer cells to nutrient starvation. Cancer Res 66: 1751-1757.

Bhat SH, Azmi AS, Hadi SM (2007) Prooxidant DNA breakage induced by caffeic acid in human peripheral lymphocytes: Involvement of endogenous copper and a putative mechanism for anticancer properties. Toxicol Appl Pharm 218: 249-255.

Fernandez DR, Vanderjagt DJ, Williams M, Huang YS, Chuang LT, Millson M, Andrews R, Pastuszyn A, Glew RH (2005) Fatty acid, amino acid and trace mineral analysis of three complementary foods from Jos, Nigeria. J Food Compos Anal 18: 675-690.

Bouayed J, Rammal H, Dicko A, Younos C, Soulimani R (2007) Chlorogenic acid, a polyphenol from *Prunus domestica* (Mirabelle), with coupled anxiolytic and antioxidant effects. J Neurol Sci 262: 77-84.

Bralley E, Greenspan P, Hargrove JL, Hartle DK (2008) Inhibition of hyaluronidase activity by select sorghum brans. J Med Food 11: 307-312.

Chan E, Wong CY, Wan CW, Kwok CY, Wu JH, Ng KM, So CH, Au AL, Poon CC, Seto SW, Kwan YW, Yu PH, Chan SW (2010) Evaluation of anti-oxidant capacity of root of *Scutellaria baicalensis* Georgi, in comparison with roots of *Polygonum multiflorum* Thunb and *Panax ginseng* CA Meyer. Am J Chin Med 38: 815-827.

Chen FA, Wu AB, Chen CY (2004) The influence of different treatments on the free radical scavenging activity of burdock and variations of its active components. Food Chem 86: 479-484.

Duistermaat H (1996) Monograph of Arctium L. (Asteraceae): Generic delimitation (including Cousinia Cass. p.p.), revision of the species, pollen morphology, and hybrids. Rijksherbarium/Hortus Botanicus, Leiden University, The Netherlands.

Guo JF, Zhou JM, Zhang Y, Deng R, Liu JN, Feng GK, Liu ZC, Xiao DJ, Deng SZ, Zuh XF (2008) Rhabdastrellic acid-A inhibited PI3K/Akt pathway and induced apoptosis in human leukemia HL-60 cells. Cell Biol Int 32: 48-54.

Hirosea M, Yamaguchib T, Linb C, Kimotob N, Futakuchib M, Konoc T, Nishibe S, Shirai T (2000) Effects of arctiin on PhIP-induced mammary, colon and pancreatic carcinogenesis in female Sprague-Dawley rats and MeIQx-induced hepatocarcinogenesis in male F344 rats. Cancer Lett 155: 79-88.

Ichikawa K, Kinoshita T, Nishibe S, Sankawa U (1986) The calcium antagonist activity of lignans. Chem Pharm Bull 34: 1514-1517.

Ishihara K, Yamagishi N, Saito Y, Takasaki M, Konoshima T, Hatayama T (2006) Arctigenin from *Fructus Arctii* is a novel suppressor of heat shock response in mammalian cells. Cell Stress Chaperon 11: 154-161.

Iwakami S, Wu JB, Ebizuka Y, Sankawa U (1992) Platelet activating factor (PAF) antagonists contained in medicinal plants: lignans and sesquiterpenes. Chem Pharm Bull 40: 1196-1198.

Li Y, Shi W, Li Y, Zhou Y, Hu X, Song C, Ma H, Wang C, Li Y (2008) Neuroprotective effects of chlorogenic acid against apoptosis of PC12 cells induced by methylmercury. Environ Toxicol Pharmacol 26: 13-21.

Lin SC, Lin CH, Lin CC, Lin YH, Chen CF, Chen IC, Wang LY (2002) Hepatoprotective effects of *Arctium lappa* L. on liver injuries induced by chronic ethanol consumption and potentiated by carbon tetrachloride. J Biomed Sci 9: 401-409.

Miyamoto K, Nomura M, Sasakura M, Matsui E, Koshiura R, Murayama T, Furukawa T, Hatano T, Yoshida T, Okuda T (1993) Antitumor-activity of Oenothein-B, a unique macrocyclic ellagitannin. Jpn J Cancer Res 84: 99-103.

Moritani S, Nomura M, Takeda Y, Kada T (1996) Cytotoxic components of *Bardanae fructus* (Goboshi). Biol Pharm Bull 19: 1515-1517.

Pari L, Prasath A (2008) Efficacy of caffeic acid in preventing nickel induced oxidative damage in liver of rats. Chem Biol Interact 173: 77-83.

Park SY, Hong SS, Han XH, Hwang JS, Lee D, Ro JS, Hwang BY (2007) Lignans from *Arctium lappa* and their inhibition of LPS-induced nitric oxide production. Chem Pharm Bull 55: 150-152.

Shinohara K, Kuroki S, Miwa M, Kong LZ, Hosoda H (1988) Antimutagenicity of dialysates of vegetables and fruits. Agric Biol Chem 52: 1369-1375.

Takasaki M, Konoshima T, Komatsu K, Tokuda H, Nishino H (2000) Anti-tumor-promoting activity of lignans from the aerial part of *Saussurea medusa*. Cancer Lett 158: 53-59.

Wang BS, Yen GC, Chang LW, Yen WJ, Duh PD (2007) Protective effects of burdock (*Arctium lappa* L.) on oxidation of low-density lipoprotein and oxidative stress in RAW 264.7 macrophages. Food Chem 101: 729-738.

Yan LX, Li YM (1993) Effects of extract from *Arctium lappa* on the immunology and blood glucose in rats. J NW Pharma 8: 79.