# A Functional Food Additive: *Scolymus Hispanicus* L. Flour

Dilek Dulger Altiner
Department of Food Engineering, Faculty of Engineering, Istanbul Aydın University, Istanbul, Turkey
Email: dilek.dulgeraltiner@gmail.com

Yasemin Sahan
Department of Food Engineering, Faculty of Agriculture, Uludag University, Bursa, Turkey
Email: yaseminsahan@gmail.com

***Abstract*—In recent years, changing life conditions leading to increased industrial and agricultural activities has brought a negative influence on health conditions. Therefore, studies on new and functional, highly nutritious food production has become more important. Especially negative opinions about commonly used food additives in food industry lead to consumption of natural food additives. *Scolymus hispanicus* L. is a thistle-like plant in the family *Asteraceae*, native to the Southern Europe and Western Asia. This plant is a mild climate plant which grows in The Aegean, Mediterranean and The Marmara regions at altitudes 0-1580 meters high in Turkey. Although *Scolymus hispanicus* L. is generally consumed as a vegetable with young leaf and root, it is also used in alternative medicine. *Scolymus hispanicus* L. leaves, stems and flowers are traditionally used as a "bitter" tonic to stimulate appetite, enhance bile secretion, decrease flatulence, and aid digestion. It was also historically used as a diuretic, diaphoretic, and antipyretic. Although it grows almost everywhere in our country, use of this plant is limited and its economic value is considerably low. Therefore, *Scolymus hispanicus* L. was thought to have a potential as an alternative food additive and *Scolymus hispanicus* L. flour (SHF) was produced by washing its roots, peeling, removing the woody sections in the central part of the root, drying in hot air flow and grinding. SHF was rich in dietary fiber, total phenolic compounds, and also it had a high antioxidant capacity. Thus, a product was developed in food industry which could be used in bakery products(biscuits, crackers, cakes), dairy products (yoghurt, ice cream and dessert production), special diet products, energy-reduced products, chocolate and confectionary production. The purpose of this study is to put forward a disregarded product with low economic value and redound it to economy as a valuable substance. In addition, bringing in a new functional food additive to industry is likely to increase productivity and competition, variety in agriculture and exportation potential in industry.**

***Index Terms*—dietary fiber, *Scolymus hispanicus* L., food additive, antioxidant, total phenolic compounds**

## I. Introduction

Edible wild plants have been used since ancient times for their organoleptic characteristics or therapeutic and medicinal properties. Today the use of edible wild plants seems attractive because they are a source of healthy compounds. Various edible wild plants are the most abundant in the Mediterranean region and are available to purchase from the open markets or to pick from nature [1].

Turkey, which has the largest coastal area in the Mediterranean, possesses an extraordinarily rich flora and a great traditional knowledge. Due to its climate and geographical position, Turkey is one of the richest countries in Europe and the Middle East, in terms of flora [2]. A total of 1/3 of the plant taxa of Turkey is endemic [3]. This diversity of plants naturally affects the traditional use of plants and is reflected in the rich Turkish cuisine. This diet contains important dietary components that may contribute to a lower risk of cancer. Several micro-components with antioxidant potential are underlying factors that define the health benefits of this type of diet [4].

In terms of endemic plant species, the richest family of Turkey with 447 species is Asteraceae [5]. Asteraceae is known as the biggest family of flowering plants. *Scolymus hispanicus* L. is a thistle-like plant in the family Asteraceae, native to the Mediterranean region, from Portugal north to southern France and east to Iran [6]-[7]. *Scolymus hispanicus* L. has been found growing wild at the edge of fields and in gardens in the Marmara, Aegean and Mediterranean regions of Turkey [8]. Its leaves, stems and flowers are traditionally used as a "bitter" tonic to enhance appetite and digestion; it is also sometimes included in anti-cancer herbal remedies [9]-[10]-[3]. *Scolymus hispanicus* L. is called "Şevketi Bostan", an edible plant that cooked and consumed as a vegetable using the young leaf and root in Izmir, Turkey [9].

*Scolymus hispanicus* L. plants and flour shown in Fig. 1.

Plants and their constituents have a key position in the progression of modern studies and knowledge on biological activity or active substances. The emergency of dietary compounds with health benefits offers an excellent opportunity to improve public health [11]. Nowadays, consumers prefer and choose foods that not only provide them with essential nutrients but also contain substances which may have positive long-term

Manuscript received February 19, 2016; revised August 11, 2016.


doi: 10.18178/ijfe.2.2.124-127

effects [12]. Therefore, studies on new and functional, highly nutritious food production has become more important. Especially negative opinions about commonly used food additives in food industry lead to consumption of natural food additives. For this reason, *Scolymus hispanicus* L. roots were dried and obtained its flour (SHF). This flour may be used as a functional ingredient in the production of bakery products, yoghurt, ice cream, infant food, chocolate, confectionery.

Recently, many investigations have been concerned with antioxidant properties of different alternative wild plants. However, very few studies are available on health promoting total phenolics, bioaccessible phenolics and antioxidant capacity of *Scolymus hispanicus* L. Therefore, the aim of this study was to determine the chemical properties, antioxidant activities, total polyphenolic content and their bioaccessibility of *S. hispanicus* L. samples and their flours.

Figure 1. *Scolymus hispanicus* L. roots and flour

## II. Materials and Methods

### A. Materials

Plant samples were collected from Manisa-Akhisar, Turkey. Root of the *Scolymus hispanicus* L. were used the obtaining SHF. The harvested plants put in polyethylene bags and brought to the laboratory in cold chain.

### B. Preparation of Scolymus Hispanicus Flour

The plant preparation method was performed as follows; harvesting of *S. hispanicus* L. plant, separated of leaves, washed, peeling, peeled and removed the woody part located in the middle section of the plant and sliced into small pieces. Afterwards, plant samples were dried at 50 ℃ for 20 hours in a hot air oven dryer for 24 hours [13] until the moisture reduces to 12%. The dried slices were ground in a blender (Braun MX2050 Black Multiquick Glass Blender) and sieved through 60 mm sieve to obtain *S. hispanicus* L. flour. The flours were placed in glass jars and kept in a refrigerator prior to analyses.

### C. Chemicals

All reagent used were analytical grade purity. High quality water, obtained using a Milli-Q system (Millipore, Bedford, MA, USA), was used exclusively.

### D. Chemical Analysis

*S. hispanicus* L. fresh samples and SHF were analyzed for moisture (Method No:925.40), ash (Method No:950.49), Dietary Fiber (DF) (Method No:985.29) [14]. Protein contents of samples were determined by the Kjeldahl method according to AACC Metod No:46-10.01 [15]. Crude fat was carried out according to the AOAC methods [16].

### E. Determination of Antioxidant Capacity and Total Phenolic Contents

Sample preparation: Extraction of phenolic compounds in food is influenced by their chemical nature, extraction method applied, sample particle size, storage time and conditions and presence of interfering substances [17]. Therefore, there is no uniform procedure that is suitable for extraction of all phenolics in different food matrixes. Therefore, the antioxidant capacity of extractable and hydrolysable phenolics of *Scolymus hispanicus* L. was determined using radical cation decolorization assay (ABTS) [18], cupric ion reducing antioxidant capacity assay (CUPRAC) [19], free radical scavenging assay (DPPH) assay ([20]. The total phenolic contents of these plants were measured by the Folin–Ciocalteu method [17]. Phenolic contents were expressed as gallic acid equivalents (mg of GAE $100g^{-1}$dw).

*Extractiton Method:* 2 g samples were taken for each samples and these samples were extracted in 20ml of HCl (conc)/methanol/water (1:80:10, v/v) mixture at room temperature on orbital shaker (at 250 rpm) for two hour.

The obtained extracts were centrifuged (Sigma 3K 30) at 3500 rpm for 10 min. The same procedure was repeated 2 times with same solvent on the remaining part of the plants. All extracts were combined, and used for determination total phenolics and antioxidant capacity for extractable phenolic compounds [21]-[18].

For hydrolysable phenolics, after extractable phenolic extraction, the residue was combined with 20mL of methanol/$H_2SO_4$conc (10:1) and placed in a water bath at 85 ℃ for 20h before being cooled to room temperature. The mixtures were centrifuged at 3500 rpm for 10 min at 4 ℃ in a centrifuge (Sigma 3K 30, Germany). The supernatants were collected. All supernatants were stored at -20 ℃ until used.

### F. Determination of Bioaccessibility

For the determination of bioaccessible phenolics, investigated samples were processed by an in vitro digestive enzymatic extraction that mimics the conditions in the gastrointestinal tract according to the procedure of [21].

### G. Statistical Analysis

JMP IN 7.0.0 (SAS, 2007) software was used to perform the statistical analyses. When significant differences were observed ($p \leq 0.05$), the least significant difference (LSD) test was used to determine the differences among means. Data are presented as mean values +/- standard error of 3 replicates.

## III. Results and Discussion

### A. Chemical Compositions

Chemical compositions of *Scolymus hispanicus* L. and SHFs are presented in Table I. *Scolymus hispanicus* L. were showed high total dietary fiber, similar the protein values whereas low fat content compared to cultivated plants.

Total Dietary Fiber (TDF) levels of the samples varied from 15.11 to 15.14 %. These results were higher than lentil (14.11%), pea (9.74%), chickpea (16.1%) flour samples found by Özmen [22] were similar value with carrot powder (18.5%) [23]. This property may provide priority to SHF to be used in food formulations instead of wheat flour in terms of dietary fiber enrichment.

TABLE I. Chemical Compositions of SH and Shf *

| | Moisture % | Protein % | Ash % | Fat % | TDF % |
|---|---|---|---|---|---|
| **SH** | 70.00±5.2 | 2.35±0.2 | 8.03±0.8 | 0.18±0.1 | 15.14±0.2 |
| **SHF** | 8.53±0.8 | 11.07±0.2 | 4.74±0.0 | 0.46±0.1 | 15.11±0.2 |

* Data are expressed as means ± standard deviations.

### B. Total Phenolics Content, Antioxidant Capacity and Bioaccessibility

Antioxidant activities of S. hispanicus L. are presented in Table II. The total phenolic contents of S. hispanicus L. samples analyzed in this study were ranged from 135.28-156.18mg/100g GAE fw (extractable) and 1630.85-1706.42mg/100g GAE fw (hydrolysable).

Antioxidant capacity and phenolic contents of SH was determined as the above average compaire to other vegetables. Average total antioxidant capacity of samples were methods of CUPRAC (121.22 μmol Trolox/g fw), DPPH (47.82μmol Trolox/g fw) and ABTS (101.88 μmol Trolox/g fw), average total phenolic content were 1797.39mg of GAE 100 $g^{-1}$ dw.

According to all assay (CUPRAC, ABTS, and DPPH), hydrolysable phenolic extracts of S. hispanicus L. had the highest antioxidant capacity (115.38, 87.01, and 34.29 μmol trolox/g fw, respectively) and extractable phenolic extract had the lowest (5.84, 14.87 and 13.53 μmol trolox/g fw, respectively). The results of the present study showed that the CUPRAC assay of S. hispanicus L. samples exhibited higher antioxidant capacity values than ABTS and DPPH assays.

Bioaccessibility has been defined as the fraction of a compound that is released from the food on the gastrointestinal tract and so becomes available to the intestinal absorption. Both chemical and biochemical factors that affect the absorption and metabolism of phenolics. The bioaccessibility of S. hispanicus L. shown in Table III. The average bioaccessibility of phenolics content were determined 356.55mg of GAE 100$g^{-1}$ fw in the samples. The bioavailability of phenolics is affected by numerous factors that include the physicochemical properties (chemical speciation, crystalline vs. liquid state, trans vs. cis isomers, and. protein bound complexes), food sources and matrix (localization, particle size, supplements), processing (raw, processed food), and interaction with other dietary compounds such as lipids, fiber, phytosterols and other phenolics during digestion and absorption [24].

TABLE II. The Antioxidant Capacity and Phenolic Content of *S. hispanicus* L

| Sample | Extractable | Hydrolyzable |
|---|---|---|
| **Total Phenolic content** (mg of GAE 100 $g^{-1}$ fw) | 135.28±2.09 b | 1662.11±31.85 a |
| **ABTS** (μmol trolox $g^{-1}$ fw) | 14.87±0.56 b | 87.01±7.44 a |
| **CUPRAC** (μmol trolox $g^{-1}$ fw) | 5.84±0.26 b | 115.38±15.83 a |
| **DPPH** (μmol trolox $g^{-1}$ fw) | 13.53±0.67 b | 34.29±2.16 a |

* Mean values represented by the same letters within the same column are not significantly different at p≤0.05.

TABLE III. The Bioaccessibility of *S. hispanicus* L

| Methods | Bioaccessibility |
|---|---|
| **DPPH** (μmol trolox $g^{-1}$ fw) | 58.14 ±0.62 |
| **ABTS** (μmol trolox $g^{-1}$ fw) | 4.22 ±1.02 |
| **CUPRAC** (μmol trolox $g^{-1}$ fw) | 2.93 ±0.26 |
| **Total Phenolic Contens** (mg of GAE 100 $g^{-1}$ dw) | 356.55 ±18.82 |

*Data are expressed as means ± standard deviations.

## IV. Conclusion

Although *Scolymus hispanicus* L. grows almost everywhere in Turkey, use of this plant is limited and its economic value is considerably low. Our study indicated that *Scolymus hispanicus* L. has the potential to be a source of dietary fiber and can be included in the daily diet as an alternative vegetable. It may be used as functional foods because of their naturally antioxidant potential.

*Scolymus hispanicus* L. flour was rich in dietary fiber, total phenolic compounds, and also it had a high antioxidant capacity. Thus, a product was developed in food industry which could be used in bakery products (biscuits, crackers, cakes), dairy products (yoghurt, ice cream and dessert production), special diet products, energy-reduced products, chocolate and confectionary production. Moreover, the SHF could also be used in the preparation of low-fat, high-fiber dietetic products due to its high dietary fiber content. It has been thought that SHF used as a new food additive substance having functional properties in food industry with improving the nutritional and functional properties of the product.

The purpose of this study is to put forward a disregarded product with low economic value and redound it to economy as a valuable substance. In addition, bringing in a new functional food additive to industry is likely to increase productivity and competition, variety in agriculture and exportation potential in industry.

## ACKNOWLEDGMENT

This study is a part of PhD thesis of the first author. The authors would like to thank the Uludag University Scientific Research Committee for financially support this research project (Project No: UAP (Z) 2011/26). Patent number is TR 2013 01091 B [25].

## REFERENCES

[1] D. D. Altıner and Y. Sahan, "Chemical composition of blessed thistle consumed as a alternative vegetable in aegean region," presented at ISNFF 2014, İstanbul, Turkey, October 14-17, 2014.

[2] Y. Dogan, A. M. Nedelcheva, D. Obratov-Petkovic, and I. M. Padure, "Plants used in traditional handicrafts in several Balkan countries," *Indian J. Tradit Know*., vol. 7, pp. 157–161, 2008.

[3] E. Ugurlu and O. Secmen, "Medicinal plants popularly used in the villages of Yunt Mountain (Manisa-Turkey)," *Fitoterapia*, vol. 79, pp. 126-131, 2008.

[4] F. R. Pérez-López, P. Chedraui, J. Haya, and J. L Cuadros, "Effects of the Mediterranean diet on longevity and age-related morbid conditions," *Maturitas*, vol. 64, no. 2, pp. 67–79, 2009.

[5] B. Akyıldırım. Türkiye'nin floristik (bitkisel) zenginliği. [Online]. Available: http://www.wildlifevet.org/index.php/turkiyenin-bitki-çeşitliliği

[6] S. Polo, J. Tardío, A. Vélez-del-Burgo, M. Molina, and M. Pardo-de-Santayana, "Knowledge, use and ecology of golden thistle (*Scolymus hispanicus* L.) in Central Spain," *Journal of Ethnobiology and Ethnomedicine*, vol. 5, no. 22, 2009.

[7] F. Ertug, "Wild edible plants of the Bodrum Area (Mugla, Turkey)," *Turkish Journal of Botany*, vol. 28, pp. 161-174, 2004.

[8] P. H. Davis, *Flora of Turkey and the East Aegean Islands*, Edinburgh: Edinburgh University Press, 1965, vol. 1-9.

[9] K. J. Kemper. (1999). Blessed Thistle (*Cnicus Benedictus*). [Online]. Available: http://www.longwoodherbal.org/blessed thistle/blessed thistle.pdf

[10] M. Tamayo, M. A. Richardson, S. Diamond, and I. Skoda, "The chemistry and biologic activity of herbs used in Flor-Essence herbal tonic and Essiac," *Phytotherapy Research*, vol. 14, pp. 1-14. 2000.

[11] B. V. D. Silva, J. C. M. Barreira, and M. B. P. P. Oliveira, "Natural phytochemicals and probiotics as bioactive ingredients for functional foods: Extraction, biochemistry and protected-delivery technologies," *Trends in Food Science & Technology*, vol. 50, pp. 144-158, 2016.

[12] C. Ozuna, I. Paniagua-Martínez, E. Castaño-Tostado, L. Ozimek, and S. L. Amaya-Llano, "Innovative applications of high-intensity ultrasound in the development of functional food ingredients: Production of protein hydrolysates and bioactive peptides," *Food Research International*, vol. 77, pp. 685-696, 2015.

[13] N. A. A. Aziah and C. A. Komathi, "Physicochemical and functional properties of peeled and unpeeled pumpkin flour," *Journal of Food Science*, vol. 74, no. 7, pp. 328-333. 2009.

[14] AOAC. Official Methods of Analysis of Association of Official Analytical Chemists, Washington DC, USA, 1990.

[15] AACC. Official Methods of American Association of Cereal Chemists, MN, USA, 2000.

[16] AOAC. *Official Methods of Analysis of AOAC*, 15th ed., Method 920.85, Association of Official Analytical Chemists, Arlington, VA, USA, 1990.

[17] M. Naczk and F. Shahidi, "Extraction and analysis of phenolics in food," *Journal of Chromatography A*, vol. 1054, pp. 95–111, 2004.

[18] R. Apak, K. Guclu, M. Ozyurek, and S. E. Celik, "Mechanism of antioxidant capacity assays and the CUPRAC (cupric ion reducing antioxidant capacity) assay," *Microchimica Acta*, vol. 16, pp. 413–419, 2008.

[19] R. Apak, K. Guclu, M. Ozyurek, and S. E. Karademir, "Novel total antioxidant capacity index for dietary polyphenols and vitamins C and E, using their cupric ion reducing capability in the presence of neocuproine: CUPRAC method," *Journal of Agricultural and Food Chemistry*, vol. 52, pp. 7970-8798, 2004.

[20] W. Brand-Williams, M. E. Cuvelier, and C. Berset, "Use of a free radical method to evaluate antioxidant activity," *LWT-Food Science and Technology*, vol. 28, pp. 25-30, 1995.

[21] D. Vitali, I. V. Dragojevic, and B. Šebecic, "Effects of incorporation of integral raw materials and dietary fibre on the selected nutritional and functional properties of biscuits," *Food Chemistry*, vol. 114, pp. 1462–1469, 2009.

[22] F. H. Özmen, "Çölyak hastaları için baklagil unları ile zenginleştirilmiş pirinç tarhanası," M.S thesis, Hacettepe Üniversitesi Fen Bilimleri Enstitüsü, Ankara, 2011.

[23] S. Y. Baljeet, B. Y. Ritika, and K. Reena, "Effect of incorporation of carrot pomace powder and germinated chickpea flour on the quality characteristics of biscuits," *International Food Research Journal*, vol. 21, no. 1, pp. 217-222, 2014.

[24] M. L. Failla, T. Huo, and S. K. Thakkar, "In vitro screening of relative bioaccessibility of carotenoids from foods," *Asia Pac. J. Clin. Nutr.*, vol. 17, pp. 200-203, 2008.

[25] Y. Sahan and D. D. Altıner, "Şevketi bostan bitki kökünden elde edilen un ve bahsedilen unun üretim metodu," TSE Patent, TR 2013 01091 A1, 09/21/2015.

**Dilek Dülger Altiner** was born in İstanbul, Turkey in 1987. She received her Bachelor degree in 2010, MS in 2012, PhD degree in Food Engineering from Uludag University, Turkey in 2015. Now Assist. Prof. Dr. Dulger Altiner is a lecturer in Istanbul Aydın University, Faculty of Engineering, Department of Food Engineering. Her research area is Food Chemistry. She is author and coauthor of 6 scientific papers published on international and national journal. She has got more than 50 presentation in international and national congresses. She has 3 patents in the field of food. Some of her publications are:

Y. Sahan, D. Gocmen, A. Cansev, G. Çelik, E. Aydın, N. A. Dündar, D. Dulger, H. B. Kaplan, A. Kılcı, and S. Gucer, "Chemical and techno-functional properties of flours from peeled and unpeeled oleaster (*Elaeagnus angustifolia* L.)," *Journal of Applied Botany and Food Quality*, vol. 88, pp. 34–41, 2015.

D. D. Altiner, E. Aydin, A. I. Dundar, G. Celik, B. Kaplan, A. Cansev, Y. Sahan, and D. Gocmen, "Innovative food additives: Oleaster flour," *Academic Platform Journal of Engineering and Science*, pp. 1052-1061, 2015.

Y. Sahan, A. N. Dundar, E. Aydin, A. Kilci, D. Dulger, F. B. Kaplan, D. Gocmen, and G. Celik, "Characteristics of cookies supplemented with oleaster (Elaeagnus angustifolia L.) flour. I physicochemical, sensorial and textural properties," *Journal of Agricultural Science*, vol. 5, no. 2, pp. 160-168, 2013.

**Yasemin Şahan** was born in Bursa, Turkey in 1976. She received her Bachelor degree in 1996, MS in 2000, PhD degree in Food Engineering from Uludag University, Turkey in 2004. Now Assoc. Prof. Dr. SAHAN is a lecturer in Uludag University, Faculty of Agriculture, Department of Food Engineering. Her research area is Food Chemistry. She is author and coauthor of 45 scientific papers published on international and national journal. She has got more than 70 presentation in international and national congresses. She has 4 patents in the field of food. Some of her publications are:

Y. Sahan, D. Gocmen, A. Cansev, G. Celik, E. Aydin, A. N. Dundar, D. Dulger, H. B. Kaplan, A. Kilci, and S. Gucer, "Chemical and techno-functional properties of flours from peeled and unpeeled oleaster (*Elaeagnus angustifolia* L.)," *Journal of Applied Botany and Food Quality*, vol. 88, pp. 34–41, 2015.

Y. Sahan, A. Cansev, and H. Gülen, "Effect of processing techniques on antioxidative enzyme activities, antioxidant capacity, phenolic compounds, and fatty acids of table olives," *Food Science and Biotechnology*, vol. 22, no. 3, pp. 613-620, 2013.

Y. Şahan, F. Başoğlu, and Ş. Gücer, "ICP-MS analysis of a Series of metals (Namely: Mg, Cr, Co, Ni, Fe, Cu, Zn, Sn, Cd, and Pb) in black and green olive samples from bursa, Turkey," *Food Chemistry*, vol. 105, pp. 395-399, 2007.