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Full Length Article

Proximate composition, available carbohydrates, dietary fibre and anti-nutritional factors of Broccoli (*Brassica oleracea* L. Var. *Italica* Plenck) leaf and floret powder

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ABSTRACT

The objective of research was to study the nutritional composition two different powders prepared from broccoli crop. Florets, and leaves of broccoli, they were dried at 60°C, and the powder obtained were analysed for proximate composition, available carbohydrates, dietary fibers constituents, minerals and anti-nutritional factors. The florets powder showed the highest protein content (24.5±0.57/100 g dry weight); crude fiber was higher in leaves flour (12.6 g/100 g dry weight), and the lipid content was similar in the powder of leaves and stalks. Broccoli (*brassica oleracea* l var *italica plenca*) floret and leaf powder had 1.75±0.05 and 4.26±0.04 g of total sugars, 2.43±0.04 and 2.75±0.15g of reducing sugars, 1.3±0.05and 1.4±0.05 g of non-reducing sugars and 3.37±1.94 and 3.76±0.08 g of starch. The concentrations of zinc in Broccoli (*brassica oleracea L.* var *italica plenck*) floret and leaf powder was 4.6±0.56 and 4.0±0.56 mg, chromium 0.44±0.00 and 0.56±0.01 mg and iron 6.5±0.56 and 7.8±0.56 mg, potassium was 2.5±0.01and 2.8±0.00 g . The dietary fiber constituent in broccoli (*brassica oleracea* l var *italica plenca*) floret and leaf powder had. 4.5±0.57 and 5.6±0.04g of neutral detergent fiber, 11.65±0.31 and 12.80±0.44g of acid detergent fiber, 7.15±0.28 and 7.2±0.14 g of hemicellulose, 2.2±0.28 and 2.0±0.23 g of cellulose, 2.3±0.44 and 3.6±0.44 g of lignin and 0.62±0.02 and 0.77±0.01 g of pectin. Antinutritional factors in broccoli (*Brassica oleracea* L. var *italica plenca*) floret and leaf powder had 2.9±0.00 and 2.4±0.00 mg of tannin, 0.12±0.88 and 0.31±0.50 mg of phytates and 9.66±0.02 and 11.1±0.20 g of oxalates.

Keywords: Broccoli powder, available carbohydrates, dietary fibers constituents and antinutritional factors.

INTRODUCTION

The commercial success of functional foods has led to intense interest in the discovery and the characterization of plant based bioactive compounds. In the post-genomic era, it remains true that the goal of the pharmaceutical industry is not simply to find novel drug targets, but to find small molecule compounds that modulate their biological activity. Plants have always been an exemplary source of drugs and many of the currently available drugs have been derived directly or indirectly from them. The ethnobotanical information reports about 800 plants that may possess anti-diabetic potential (Grover *et al.,* 2002).

The broccoli is a vegetable that belongs to family Cruciferae and genus Brassica; this genus also includes commercially important crops such as cauliflower and cabbage. The main edible parts of broccoli are edible sprouts and florets named the inflorescence (Olga *et al.,* 2009). Broccoli is known as the "Crown Jewel of Nutrition" since it posses all the nutrients namely vitamins, minerals, secondary metabolites and fiber proclaiming its exceptional

health benefits. The breakdown products of the sulfur containing glucosinolates, isothiocyanates are the active principles in exhibiting the anticancer property at every stage (Vasanthi *et al.,* 2009). The edible portion of broccoli has a high water content (89.30%), and is low in fat (0.37%). Other constituents are proteins (2.82%), total dietary fibre (2.60%) and carbohydrates (6.64%). It is a rich source of minerals such as potassium, phosphorus, calcium and sodium. Additionally, broccoli provides vitamins, especially vitamin C, vitamin A and folic acid (US Department of Agriculture 2008). There are many varieties of green leafy vegetables which are rich in micronutrients, but are usually discarded or not used for human consumption. Broccoli leaves are one of them, which are available at no cost and are rich in all the macronutrient. It is an exceptionally nutritious vegetable with a variety of potential uses. According to FAO, India produces approx 5,014,500 tonnes of broccoli annually, out of which leaves contribute 50 percent of the total production. In the field, up to 70% of the total weight of the broccoli plant is discarded, generating high quantities of florets, leaves and stalks as crop remains. These materials are often regarded as crop remains and a small percentage is used without treatment in animal feed. Recently, recovery and bioconversion of vegetables residues to high-value compounds has been receiving great attention (Mahro and Timm, 2007). USDA (2011) reported the nutritional value of broccoli leaves as calories 28 kcal, protein 3 g, calcium 48g, iron 0.88mg, vitamin A 16000IU, vitamin C 93.2 mg.They also reported that this food is low in saturated fat, and very low in cholesterol. It is also a good source of protein, thiamin, niacin, pantothenic acid, calcium, iron, and selenium and a very good source of vitamin A, Vitamin C, riboflavin, vitamin B6, folate, magnesium, phosphorus, potassium and magnese.

The prevalence of diabetes has dramatically increased in the latter half of the the 20th century, largely due to ready availability of large quantities of calorie rich foods and the technology driven reduction in routine daily exercise (Birnbaum 2005). Obesity and physical inactivity independently contribute to the development of type-2 diabetes. However, magnitude of risk contributed by obesity is much greater than that imparted by lack of physical activity (Rana *et al.,* 2007).

Broccoli has been reported as the one of main sources of natural antioxidants i.e., phenolic compounds and vitamins and chemopreventive compounds i.e., glucosinolates and their degradation products, isothiocyanates (Olga *et al.,* 2009). The organosulfur chemicals namely glucosinolates and the S-methyl cysteine sulphoxide found in broccoli in concert with other constituents such as vitamins E, C, K and the minerals such as iron, zinc, selenium and the polyphenols namely kaempferol, quercetin glucosides and isorhamnetin are presumably responsible for various health benefits of broccoli (Vasanthi *et al.,* 2009). Keeping in mind the present study planned the nutritional composition of broccoli floret and leaf powder.

MATERIALS & METHODS

Procurement and Processing of the Material: The raw material broccoli floret and leaves were procured from the vegetable farm of PAU, Ludhiana. Fresh leaves & floret were thoroughly washed to remove unwanted material and dirt, cut in small sizes, blanched in boiling water for 10-15 sec and dried at room temperature for 1-2 h by spreading on filter paper followed by drying in hot air oven at 40±5˚C for 4-6 hours. Dried leaves and floret were powdered.

Chemical composition

The moisture content was determined by drying to constant weight at 105°C for 8 hours. The nitrogen content was determined and protein content was calculated by multiplying % N –by the factor 6.25.To evaluate the lipid content moisture free samples in thimbles place in soxhlet assembley and put petroleum ether in the flask and run for 2 hours until fat extracted.The ash content was determined by placing samples in preweighed crucible and place in muffle furnace at 550°C for 4 hrs (AOAC 1990). Per cent carbohydrates were determined by calculation. (100 - per cent estimated proximate components represented the per cent carbohydrate in the sample).

Minerals: Mineral analysis Zinc, Iron, chromium and potassium was done by using Atomic Absorption Spectroscopy method by AOAC (2000).

Available Carbohydrates*:* Extraction of water soluble sugar other than starch was carried out by the method of Corning and Guilhot (1973). Total

soluble sugar in the above solution was estimated by method of Yemen and Willis(1987). Reducing sugars were estimated by the method of Somogyi **(1945)**. The content of nonreducing sugar was calculated from the difference between soluble sugar and reducing sugar. Starch was estimated by the method of Clegg (1956).

Dietary Fibre Constituents: Neutral detergent fibre, Acid detergent fibre, Hemicellulose, Cellulose, Lignin were determined by method described by Van Soest and Wine (1967). Total pectin was determined by the method Ranganna (1977).

Anti-nutritional Factors: Phytic acid contents was determined by the method Sadasivan and Manickam (1992)**.**The amount of tannic Acid by Singh and Jambunathan (1981). The oxalate was analyzed by the method by Abaza *et al* (1968).

Statistical analysis*:* The data on proximate composition, available carbohydrates, mineral content, dietary fiber and anti-nutritional factors were analyzed statistically. The average and mean standard error was ascertained using a computer programme package Cheema and Singh (1990).

RESULTS AND DISCUSSION

Broccoli (*Brassica oleracea L.* var. *italica* plenck) floret and leaf powder were analyzed chemically for proximate composition, available carbohydrates, mineral content, dietary fiber and anti-nutritional factors by using standard methods. The values have been calculated for 100 g of broccoli (*brassica oleracea* l var *italica plenca* floret and leaf powder.

Proximate composition

Broccoli (*Brassica oleracea L.* var. *italica* plenck) floret and leaf powder had 2.4±0.12 and 13±0.18of moisture respectively, 24.5±0.57and 1.9±0.14 g of crude protein respectively, 5.8±0.05and 6.3±0.17g of crude fat, 11.0±0.31 and 12.6 ±0.22g of crude fiber, 2.68±005and 2.1±0.13of ash, 53.62 and 64.8 g of carbohydrate and provided 364.68 and 367.9 Kcal of energy respectively. (Table 1) Sigmond *et al*, (2010) also reported the nutrient composition of dried broccoli leaf powder to be 2.84% moisture 22.43% Crude protein, and 12.6 g of dietary Fiber. Olga *et al.,* 2009 has been revealed the chemical composition of broccoli floret and leaf flours i.e.,22.41 g and 12.31 g protein, 7.87 g and 14.67 g ash, 4.59 and 6.72g fat, 11,65 and 12.83 g crude fiber and 65.13 g and 66.48 g of carbohydrates which is almost equal to present study.

Available carbohydrates

Broccoli (*Brassica oleracea L.* var. *italica* plenck) floret and leaf powder had 1.75±0.05 and 4.26±0.04 g of total sugars, 2.43±0.04 and 2.75±0.15g of reducing sugars, 1.3±0.05and 1.4±0.05 g of non-reducing sugars and 3.37±1.94 and 3.76±0.08 g of starch respectively . (Table 2)

Mineral content

The concentrations of zinc in Broccoli (*Brassica oleracea L.* var. *italica* plenck) floret and leaf powder was 4.6±0.56 and 4.0±0.56 mg ; chromium 0.44±0.00 and 0.56±0.01 mg and iron 6.5±0.56 and 7.8±0.56 mg, potassium was 2.56±0.01and 2.89±0.00 g respectively. (Table 3).USDA, 2008 reported the iron content of fresh broccoli floret and leaf i.e., 0.73mg and 0.88mg, Zinc is 0.41 mg and 0.40mg, Potassium is 316 and 325 mg.

Dietary fiber

Broccoli (*Brassica oleracea L.* var. *italica* plenck) floret and leaf powder had. 4.5±0.57 and 5.6±0.04g of neutral detergent fiber, 11.65±0.31 and 12.80±0.44g of acid detergent fiber, 7.15±0.28 and 7.2±0.14 g of hemicellulose, 2.2±0.28 and 2.0±0.23 g of cellulose, 2.3±0.44 and 3.6±0.44 g of lignin and 0.62±0.02 and 0.77±0.01 g of pectin respectively. (Table 4).

Table 1: Proximate composition of broccoli (*Brassica oleracea L. var. italica plenck*) leaf and floret powder

	Broccoli floret(g/100g)	Broccoli leaf(g/100g)
Moisture(g/100g)	2.4±0.12	1.2±0.19
Crude protein(g/100g)	24.5±0.57	13±0.18
Crude fat(g/100g)	5.8±0.05	6.3±0.17
Crude fiber(g/100g)	11.0±0.31	12.6 ±0.22
Ash(g/100g)	2.68±005	2.1±0.13
Carbohydrates(g/100g)	53.62	64.8
Energy(Kcal)	364.68	367.9

Anti-nutritional factors

Broccoli (*Brassica oleracea L.* var. *italica* plenck) floret and leaf powder had 2.9±0.00 and 2.4±0.00 mg of tannin, 0.12±0.88 and 0.31±0.50 mg of phytates and 9.66±0.02 and 11.1±0.20 g of oxalates respectively (Table 5).

Conclusion

Drying is a viable alternative to utilize broccoli crop. The broccoli powder obtained have good amount of nutritional composition. In addition fewer amounts of total sugars specially in floret and good amount of dietary fibers as well as antinutritional factors was less. Broccoli is considered a low-glycemic food which helps to normalize blood sugar. One of the keys to weight loss in controlling the body's response to insulin. It also gives a boost to enzymes which helps to detoxify the body. Detoxification leads to weight loss and helps prevent certain diseases Thus, these broccoli floret and leaf powder have the potential to be used as food natural supplements as well as raw material for the extraction of chemopreventive compounds.

Table 2: Available carbohydrates of broccoli (*Brassica oleracea L. var. italica plenck*) leaf and floret powder

	Broccoli floret(g/100g)	**Broccoli leaf(g/100g)**
Total sugars	1.75±0.05	4.26±0.04
Reducing sugars	2.43±0.04	2.75±0.15
Non reducing sugars	1.3±0.05	1.4±0.05
Starch	3.37±1.94	3.76±0.08

Table 3: Mineral content of broccoli (*Brassica oleracea L. var. italica plenck*) leaf and floret powder

	Broccoli floret	**Broccoli leaf**
Zinc (mg/100g)	4.6±0.56	4.0±0.56
Chromium(mg/100g)	0.44±0.00	0.56±0.01
Potassium(g/100g)	2.56±0.01	2.89±0.00
Iron(mg/100g)	6.5±0.56	7.8±0.56

Table 4: Dietary fiber constituents of broccoli (*Brassica oleracea L. var. italica plenck*) leaf and floret powder

	Broccoli floret(g/100g)	**Broccoli leaf(g/100g)**
ADF	4.5±0.57	5.6±0.04
NDF	11.65±0.31	12.80±0.44
Hemicellulose	7.15±0.28	7.2±0.14
Cellulose	2.2±0.28	2.0±0.23
Pectin	0.62±0.02	0.77±0.01
Lignin	2.3±0.44	3.6±0.44

Table 5: Anti-nutritional factors of broccoli (*Brassica oleracea L. var. italica plenck*) leaf and floret powder

	Broccoli floret	**Broccoli leaf**
Tannins (mg/100ml)	2.9±0.00	2.4±0.00
Phytates(mg /100g)	0.12±0.88	0.13±0.50
Oxalates(g/100g)	9.66±0.02	11.1±0.20

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