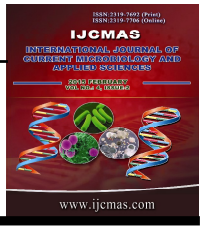
Int.J.Curr.Microbiol.App.Sci (2015) 4(2): 806-813

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 4 Number 2 (2015) pp. 806-813**
http://www.ijcmas.com



Original Research Article

Antioxidant and Nutritional Components of Egg plant (*Solanum melongena L*) Fruit Grown in Saurastra Region

Umesh K. Kandoliya*, Vijay K. Bajaniya, Nikunj K. Bhadja, Neha P. Bodar and Baljibhai A. Golakiya

Food Testing Laboratory, Department of Biotechnology, Junagadh Agricultural University, Junagadh (Gujarat) India
**Corresponding author*

Keywords

Brinjal, *Solanum melongena L.*, Polyphenol oxidase, Phenol, Chlorogenic acid, Antioxidant

A B S T R A C T

Eggplant or brinjal (*Solanum melongena* L.) fruit is known for vegetables of diet food because of high moisture content and low caloritic value. However, it is a good source of antioxidants as well as some phytonutrients. So the experiment was conducted to study the nutritional quality along with various parameters contributing antioxidant activity from brinjal fruits of local varieties. The findings revealed from all the variety studied, shows 25.17-40.35% radical scavenging activity (DPPH), comparable amount of flavanoids (7.42-13.25 $mg.100g^{-1}$) and anthocyanine content along with total phenol (32.89-39.12 $mg.100g^{-1}$), ascorbic acid (9.43-16.75 $mg.100g^{-1}$), protein (0.92-1.39 %) and titrable acidity (0.20-0.32 %) in a pulp of brinjal fruits. The activity value for polyphenol oxidase (PPO), the enzyme responsible for the browning reaction was ranges from 0.66 to 1.39 OD. min^{-1}. g^{-1} in a fresh pulp of brinjal. These results reveal that variety nutritionally found better due to its higher antioxidant property, proteins and sugar content.

Introduction

Eggplant or brinjal (*Solanum melongena* L., *Solanaceae*) originating from Asia is one of the most widespread vegetables in the world. The name eggplant derives from the shape of the fruit of some varieties, which are white and shaped very similarly to chicken eggs. The color, size, shape of the eggplant fruit vary significantly with the type of cultivar. Fruits and are ranked amongst the top ten vegetables in terms of antioxidant capacity due to the fruit phenols and flavonoic constituents (Timberlake, 1981;Singh *et al.,* 2009), which have been linked to various health benefits (Ames *et al.*, 1993; Hung *et al.,* 2004). Eggplant fruits have shown high hydrophilic oxygen radical absorbance capacity (Cao *et al.,* 1996), which has been correlated to phenols compounds presence, including delphinidin as a major component in peel (Wu *et al.*, 2006; Koponen *et al.,* 2007) and chlorogenic acid in flesh (Winter and Hermann, 1986; Whitaker and Stommel, 2003). Extracts

from eggplant are effective for curing a number of diseases, including cancer, high blood pressure, and hepatosis due to content of anthocyanins and strychnine (Magioli and Mansur, 2005; Silva *et. al.,* 1999). Thus the present experiment was planned to evaluate antioxidant activity of locally grown brinjal fruits along with its nutritional composition.

Material and Method

Source of Materials: Fruits of six varieties of brinjal viz., JBGR-1, GOB-1, GBL-1, GBL-2, GBL-3 and GBH-2 obtained from Vegetable research centre, Junagadh Agricultural University, Junagadh were divided in three replication and used for analysis of different parameters as under.

Nutritional componants: Moisture was determined by oven drying at 105°C for 8 hours AOAC (2005). The amount of total soluble sugar and true protein was estimated by Anthrone reagent (Hedge & Hofreiter, 1962) and Folin-Phenol reagent (Lowry *et al.,* 1951) respectively. Total acidity was determined by titration with a standard solution of NaOH as described by Rangana (1977). The glycoalkaloid was extracted from appropriate amount of fruit pulp in chloroform: acetic acid :methanol mixture(50:5:45), estimated as per Currier and Kuc(1975) and OD value obtained was directly used for comparison.

***Polyphenol oxidase* (*PPO*, EC 1.14.18.1)**

Appropriate amount of fruit pulp tissue were ground in 5 ml of 100mM sodium phosphate buffer, pH 6.5 The homogenate was centrifuged at 10,000 rpm for 15 min at 4°C and the supernatant was used for enzyme assay. The reaction mixture contained 2.9 ml of catechol (10mM catechol in 10 mM phosphate buffer pH 6.5) and reaction was initiated by the addition of 100 µl of enzyme extract. The changes in the colour due to the oxidized catechol were read at 490 nm for one minute at an interval of 15 second. Blank was carried out without substrate. The enzyme activity was expressed as change in OD.min.$^{-1}$g.$^{-1}$ Fr.Wt. tissues (Malik and Singh, 1980).

Determination of Antioxidant related components: The phenol content in was determined by method of Malik and Singh (1980) using methanolic extract. The chlorogenic acid and cinnamic acid were estimated by HPLC as per (Kandoliya and Vakhariya, 2013).Total Ascorbic acid was quantified according to the colorimetric method described by Omaye *et al.,* (1979). Total flavonoid was estimated as described by the Chanda and Dave (2009). Quercetin was used as a standard and the results were expressed as mg of quercetin equivalents per gm of fresh weight sample. Total anthocyanins were analyzed by differential pH method (Cheng and Breen, 1991) and expressed as OD per g fresh weight.

Determination of Antioxidant Activity by DPPH: Methanolic extract (100 µL) of sample was mixed with 900 µL of Tris HCl buffer (50 mM, pH 7.4) and 2 ml of DPPH (0.1 mM in methanol). The solution was incubated at room temperature for 30 minutes and the absorbance was read at 517 nm. The percentage of DPPH scavenging activity was determined as follows,

DPPH Radical Scavenging Activity (%) = [(A0−A1)/A0]

where A0 is the absorbance of control and A1 is the absorbance of sample (Gyamfi *et al.,* 1999).

Statistical analysis of results: For interpretation, data was statistically analyzed as per CRD design as out lined by Snedecor and Cochran, (1967).

Result and Discussion

The results of various nutritional components as well as antioxidant contributing factors like total phenol, flavonoids, total anthocyanins, ascorbic acid content and radical scavenging assays in fruits of brinjal varieties are given in Table.1 and Fig.1 to 6**.** The results were reported as mean values from three replication on fresh weight basis only.

Brinjal is known for vegetables of diet food because of high moisture per cent and low caloritic value. In a present study, the moisture content in fruits of brinjal variety varied from 91.1 to 93.0 %. There were no statistical significant differences found among the varieties. Total soluble sugar content varied significantly in the brinjal varieties were ranged between 3.02 to 3.64 $mg.g^{-1}$ on fresh weight basis (Table.1). The highest amount was noted in case of JBL-1 compared to other varieties. Ghadsingh and his coworker, (2012) also reported the value of soluble sugar ranged from 2.7 to 5.0g.$100g^{-1}$. Basalah *et al.,* (1984) estimated soluble sugar level 0.154 to 2.40 $\mu g.mg^{-1}$ dry weights. Our result is also in agreement with them. These high amounts of sugar components in varieties investigated confer on them, significant roles to human health. This is because, apart from the supply of energy, they are also needed in numerous biochemical reactions not directly concerned with energy metabolism. In addition, these carbohydrates may serve as substrates for the production of aromatic amino acids and phenolic compounds through the Shikimic acid pathway and this may confer high phenolic and antioxidant potentials for the same variety. Protein present in the brinjal fruit is responsible for its nutritional value. It varied from 0.66 % to 1.28%. The highest protein was recorded in GOB-1 (1.39%) followed by JBL-1 (1.28%) in brinjal fruits. Shahnaz and coworkers, (2003), also estimated protein in brinjal row material; which was 1.18g. $100g^{1.}$. The higher protein indicates that its intake can contribute to the formation of hormones which controls a variety of body functions such as growth, repair and maintenance (replacement of wear and tear of tissues) of body. The titrable acidity ranges from 0.23-0.32%. It found low in GJB-3 and high in JBL-1.

Browning reaction is important for fruit quality of brinjal is concerned. Polyphenol oxidase (PPO) is the enzyme responsible for the same. The enzyme catalyses the *o*-hydroxylation of monophenols (phenol molecules in which the benzene ring contains a single hydroxyl substituent) to *o*-diphenols (phenol molecules containing two hydroxyl substituents). They can also further catalyzed the oxidation of *o*-diphenols to produce *o*-quinines. It is the rapid polymerization of *o*-quinones to produce black, brown or red pigments (polyphenols) that is the cause of fruit browning. The PPO activity for brinjal fruit of different variety studied in present investigation varied from 0.66 to 1.39 OD. min^{-1}. g^{-1}. The highest value was recorded for GOB-1 where as lowest value was observed for GJB-3.

A high anthocyanin content and a low glycoalkaloid content are considered essential, regardless of how the fruit is to be used. Bitterness in eggplant is due to the presence of glycoalkaloids which are of wide occurrence in plants of Solanaceae family. The glycoalkaloid contents in the Indian commercial cultivars vary from 0.37 mg to 4.83 $mg.100g^{-1}$ fresh weight (Bajaj *et al.,* 1981). Generally, the high content of glycoalkaloids produce a bitter taste and off flavor. The Ascorbic acid content, the major antioxidant and neutraceutically important compound, was analyzed from different varieties of eggplant showed significant variation.

Table.1 Nutritional composition of studied Brinjal varieties**

Variety	Moisture %	Acidity %	Protein %	Total Soluble Sugar %	PPO (OD. min^{-1}. g^{-1})	Glycoalkaloid ($OD.g^{-1}$)	Ascorcrbic acid ($mg.100g^{-1}$)
JBGR-1	91.1	0.30	1.22	3.23	1.22	0.41	15.23
GOB-1	92.5	0.26	1.39	3.22	1.39	0.33	12.35
GBL-1	92.1	0.32	1.28	3.64	1.28	0.41	16.75
GJB-2	92.4	0.20	1.26	3.11	1.26	0.37	14.68
GJB-3	93.0	0.23	0.66	3.03	0.66	0.37	11.57
GBH-2	92.1	0.29	0.92	3.22	0.92	0.46	9.43
S.Em±	0.6	0.01	0.05	0.09	0.03	0.01	0.347
C.D at 5%	NS	0.02	0.16	0.30	0.09	0.04	1.081
C.V.%	1.14	7.04	8.18	5.18	3.64	5.61	4.506

** Data are mean of three replication, on the fresh weight basis.

S.Em± :0.74 C.D. at 5%: 2.29

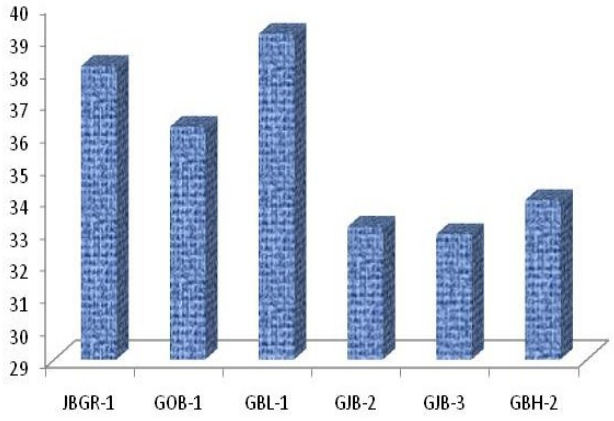


Fig.1 Phenol content $mg.100g^{-1}$ in fruit pulp of different brinjal varieties

S.Em± : 0.049 C.D. at 5%: 0.152

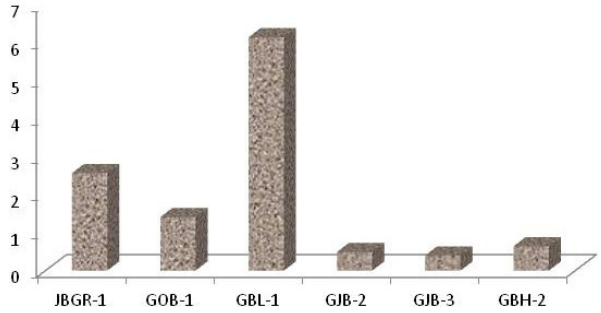


Fig.2 Cinnamic acid content $\mu g.g^{-1}$ in fruit pulp of different brinjal varieties

S.Em± : 0.505 C.D. at 5%:1.572

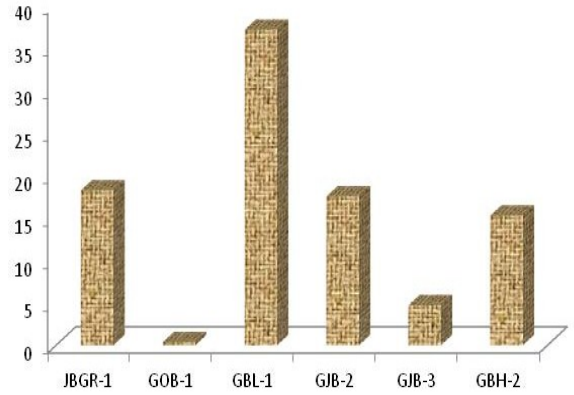


Fig.3 Chlorogenic acid content µg.g^{-1} in fruit pulp of different brinjal varieties

S.Em± : 0.523 C.D. at 5%:1.639

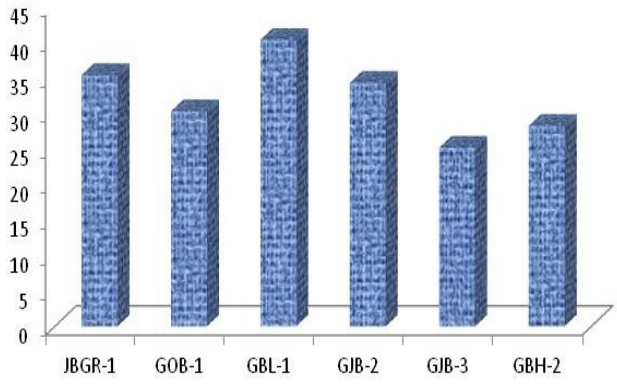


Fig.4 Per cent radical scavenging activity (DPPH) value in fruit pulp of different brinjal varieties

S.Em± : 0.013 C.D. at 5%:0.042

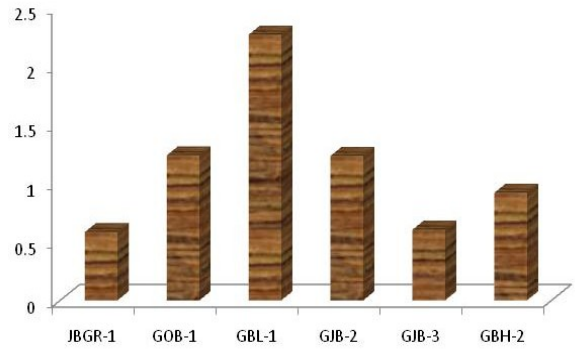


Fig.5 : Anthocyanin content OD.g^{-1} in fruit pulp of different brinjal varieties

S.Em± : 0.119 C.D. at 5%:0.369

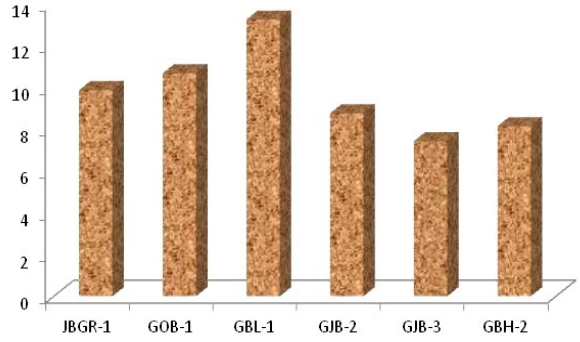


Fig.6 : Flavanoid content mg.100g^{-1} in fruit pulp of different brinjal varieties

The higher value for ascorbic acid was obtained from fruits of variety GBL-1 (16.75 mg.100g^{-1}) followed by variety JBGR-1 (15.23 mg.100g^{-1}). The lowest value was recorded from the fruits of brinjal variety GBH-2 (9.43 mg.100g^{-1}). Ghadsingh *et al.*,(2012) also reported the content was 8.9 mg.100g^{-1} to 13 mg.100g^{-1} in a fruit of brinjal. Jaime *et al.* (2007), taken 69 different varieties of brinjal of Spanish, African, Caribbean, European, and Asian types & estimated the ascorbic acid content which was varied species to species from 21.7 mg.kg^{-1} to 11.4 mg.kg^{-1}. These result

showed wide variability of ascorbic acid content in brinjal fruits.

In general, the higher phenol content was associated with higher antioxidant capacity (Santas *et al.,* 2008). Several studies have also reported a good correlation between the total phenol content of plant extracts and antioxidant activity (Bahorun *et al.,* 2004). However in present study, the variety GBL-1 having highest phenol content (39.12 $mg.100g^{-1}$) including higher fraction of chlorogenic as well as cinnamic acid, has comparatively higher antioxidant activity (Fig.1 to 4).

So far as antioxidant activity is concerned, the DPPH method is frequently used to determine the antioxidant activity. The brinjal fruit extracts showed good antioxidant activity varying from 25.17 to 40.35% (Fig.4). The results showed that the antioxidant activity remarkably decreased in variety having less phenol, flavonoid contents as well as ascorbic acid content in present study.

The anthocyanin content was varied between 0.583 to 2.269 $OD.g^{-1}$. The highest vale was recorded for the variety JBL-1 (2.269 $OD.g^{-1}$) (Fig.5). The flavanoid content also follows the same trend, ranges from 7.42 to 13.25 $mg.100g^{-1}$. The highest value was also observed in same variety JBL-1(Fig.6).

The findings revealed from all the variety studied, shows 25.17-40.35% radical scavenging activity (DPPH), comparable amount of flavanoids (7.42-13.25 $mg.100g^{-1}$) and anthocyanine content along with total phenol (32.89-39.12 $mg.100g^{-1}$), ascorbic acid (9.43-16.75 $mg.100g^{-1}$) , protein (0.92-1.39 %) and titrable acidity (0.20-0.32 %) in a pulp of brinjal fruits. The activity value for polyphenol oxidase (PPO) is the enzyme responsible for the browning reaction ranges from 0.66 to 1.39 OD. min^{-1}. g^{-1} in a fresh pulp of brinjal. These results reveal that variety nutritionally found better due to its higher antioxidant property, proteins and sugar content.

Acknowledgement

We wish to gratefully acknowledge Research scientist (Onion and Garlic), Vegetable Research station, Junagadh Agricultural University, Junagadh, for providing fruits of brinjal for the investigation.

References

Ames, B.N., Shigenaga, M.K. and Hagen, T.M., (1993). Oxidants, antioxidants, and the degenerative diseases of aging. Proc. Natl. Acad. Sci. U.S.A. 90, 7915–7922.

Association of Official Analytical Chemists (AOAC) (2005). Official Methods of Analysis of AOAC International. 18th Edition. Maryland, USA: AOAC International.

Bahorun, T., Luximon, R. A., Crozier, A., and Aruoma, O. I., (2004). Total phenol, flavonoid, proanthocyanidin and vitamin C levels and antioxidant activities of Mauritian vegetables. *J. of the Sci. Food and Agri.,* 84: 1553–1561.

Bajaj, K. L., Kaur G, and Chadha M. L, (1979). Glycoalkaloid content and other chemical constituents of the fruits of some egg plant (*Solanum melongena L.*) varieties. *J. of Pl. Foods,* 3(3): 163-168.

Basalah, M.O., AliWhaibi, M.H. and Sher, M. (1985). Comparative study of some metabolities of Citrullus colocynthis Schrad and Cucumis prophetarum L. *J. Biol. Sci. Res.,* 16(1): 105-123.

Cao, G., Sofic, E. and Prior, R.L. (1996). Antioxidant capacity of tea and common vegetables. *J. Agr. Food Chem.,* 44(11):3426-3431.

Chanda, S., and Dave. R. (2009).In vitro models for antioxidant activity evaluation and some medicinal plants possessing antioxidant properties: An overview. *Afr. J. Microbiol. Res.*, 3:981-996

Cheng, G. W. and Breen, P. J., (1991). Activity of phenylalaline ammonia lyase (PAL) and concentrations of anthocyanins and phenolics in developing strawberry fruit. *J. of the Ame. Soc. for Horti*.,116 (5):865-869

Currier, W,W and J.Kuc (1975). Effect of temperature on rishitin and steroid glycoalkaloid accumulation in potato tube. *Phytopatho*.,65: 1195-97

Ghadsingh, P.G. and Mandge, S.V. (2012). Nutritional spoilage of tomato and brinjal fruits due to postharvest fungi. *Curr Bot*, 3 (4):10-12.

Gyamfi, M.A., Yonamine, M., Aniya, Y. (1999). Free radical scavenging activity of medicinal herb of Ghana: Thonningia sanguinea on experimentally induced liver injuries. *Gen. Pharmacol.,* 32(6): 661-667

Hedge, J.E. and Hofreiter, B.T. (1962). In: Methods in Carbohydrate Chemistry. Vol.17, (Eds.,) Whistler, R.L. and BeMiller, J.N., Academic Press, New York, p. 420.

Hung, H.C., Joshipura, K.J., Jiang, R., Hu, F.B., Hunter, D. and Smith-Warner, S.A. (2004). Fruit and vegetable intake and risk of major chronic disease. *J. Nat. Cancer Inst.*, 96, 1577–1584.

Jaime P., Adrián R.B.,María D. R. and Fernando N. (2007) Total Phenolic Concentration and Browning Susceptibility in a Collection of Different Varietal Types and Hybrids of Eggplant: Implications for Breeding for Higher Nutritional Quality and Reduced Browning. *J. of the Ame. Soc. for Horti.*, 132 (5): 638-646

Kandoliya, U.K. and Vakharia, D. N. (2013)., Induced resistance and phenolic acid accumulation in biological control of chickpea wilt by *Pseudomonas fluorescens*. *Asian J. Bio. Sci.*, 8(2):184-188

Koponen JM, Happonen AM, Mattila PH, Torronen R (2007). Contents of anthocyanins and ellagitannins in selected foods consumed in Finland. *J. Agr. Food Chem.,* 55(4):1612-1619.

Lowry, O.H., Rosenbrough, N.J., Farr, A.L. and Randall, R.J. (1951). Protein measurement with folin- phenol reagent. *J. Biol. Chem.*, 193, 265-275.

Magioli C, and Mansur E. (2005). Eggplant (*Solanum melongena* L.): Tissue culture, genetic transformation and use as an alternative model plant. *Acta Botanica Brasilica* , 19 (1): 139-148.

Malik, C. P. and Singh, M. B. (1980). In : Plant Enzymology and Histo-Enzymology. Kalyani Publications, New Delhi.

Omaye, S.T., Turnbull, J.D., and Saubelich, H.E., (1979) Selected Methods for the determination of Ascorbic Acid in Animal Cells, Tissues and Fluids," Methods in Enzymology. 62 (1): 3-10.

Rangana, S., 1977. Manual for analysis of fruit and vegetable products.Tata McGraw Hill Co. Pvt.Ltd.,New Delhi,pp.5

Santas. J., Carbó, R., Gordon, M.H. and Almajano M.P. (2008). Comparison of the antioxidant activity of two Spanish onion varieties. *Food Chem.*, 107: 1210–1216.

Shahnaz, A., Khan, K. M. and Munir A. (2003). Effect of peeling & cooking on nutrients in vegetables. *Pak. J. of Nutri*., 2(3):189-191.

Silva, M.E., Santos, R.C., O'Leary, M.C.and Santos, R.S. (1999). Effect of aubergine (*Solanum melongena*) on serum and hepatic cholesterol and triglycerides in rats. *Braz. Arch. Biol. Technol.,* 42: 339-342.

Singh, A.P., Luthria, D., Wilson, T., Vorsa, N., Singh, V., Banuelos, G.S., Pasakdee, S., (2009). Polyphenols content and antioxidant capacity of eggplant pulp. *Food Chem.,* 114: 955–961.

Snedecor, G. W. and Cochran, W. G. (1967). Statistical methods. 6th Ed. Oxford and IBH Publishing Co.; Culcatta.

Timberlake, C.F.(1981). Anthocyanins in Fruit and Vegetables. In: Recent Advances in the Biochemistry of Fruit and Vegetables. J and M.J.C. Rhodes Eds. Academic Press, New York; 1981 Friend USA. p. 221- 47.

Whitaker, B.D. and Stommel, J.R. (2003). Distribution of hydroxycinnamic acid conjugates in fruit of eggplant (*Solanum melongena* L.) cultivars. *J. Agr. Food Chem.,* 51(11):3448-3454.

Winter, M. and Herrmann, K. (1986). Esters and glucosides of hydroxycinnamic acids in vegetables. *J. Agr. Food Chem.,* 34(4):616-620.

Wu, X., Beecher, G.B., Holden, J.M., Haytowitz, D.B., Gebhardt, S.E. and Prior, R.L. (2006). Concentrations of anthocyanins in common foods in the United States and estimation of normal consumption. *J. Agr. Food Chem.,* 54(11):4069-4075.