

Evaluation of Fruit Peels for Some Selected Nutritional and Anti-Nutritional Factors

Archana Maniyan, Reshma John, Anu Mathew

Received: 9 June 2015, Accepted: 8 July 2015

Abstract

Fruit peels are an important source of bioactive compounds including anti-oxidants and proteins. The objective of the investigations performed was to evaluate the peels of selected fruits for some nutritional and anti-nutritional components including Carbohydrates, Protein, Antioxidants, Protease, Tannin and Phytic acid. Sundried and finely ground fruit peels are subjected to various reactions in order to estimate the quantities of each of the desired components. In the results accomplished, highest carbohydrate content was found in Guava (75 mg/ml) followed by Pomegranate (55.2 mg/ml), Apple (37.15) and Banana (32.64 mg/ml). Highest protein concentrations were observed in Musk melon (1.6 mg/ml) followed by Passion fruit (1.33 mg/ml), Sapota (1.06 mg/ml) and Mango (1.06 mg/ml). Highest antioxidant activity was noted in Pomegranate (0.57%) and Mango (0.57%) followed by Grapes (0.53%), Apple (0.5%) and Guava (0.47%). Phytic acid content was highest in peels of Mango (0.22 µg/ml) followed by Sapota (0.17 µg/ml). High Protease concentrations were noted in Pomegranate (1.06 mg/ml) followed by Mango (0.3 mg/ml). Highest Tannin content was observed in Apple and Pomegranate (42.46 µg/ml) followed by Grapes (35.72 µg/ml).

Society on the whole depends mainly on junk foods which ultimately lead to distressed lifestyle and poor health. So, many of these compounds under study are of special interest due to their ability to reduce the hazard caused by reactive oxygen and nitrogen species. There are several constituents in fruit peels that can be utilized in more efficient ways and hence suggested not to be discarded. These findings will pave way

for the readers of this journal to orient their food habits towards more healthy and nutritional foods as per their daily body requirements according to the profession they are engaged in.

Keywords antioxidants, carbohydrates, fruit peels, phytic acid, protease, tannin

Introduction

Although, human being has enormous strength to consume and adapt to a variety of eating stuff, there are certain things like fruits and vegetables that has become crucial for human diet. Fruits and their important components have a crucial role in supplying invaluable nutrients for maintaining human health. Interestingly, the seed and rind of some fruits have higher vitamins, fibers, minerals and other essential nutrients activity than the pulp fractions. It is therefore necessary to evaluate the nutritional and anti-nutrient contents of these fruits and their waste materials so that the knowledge derived can be used to encourage adequate consumption of fruits and re-utilization of the seeds and rind in possible value added applications in addition to medicinal significance.

Phytochemicals are diverse range of biologically active compounds found in plants, which provide color, flavor and natural protection against pests to the plants along with reduction of the risk of developing many forms of cancer (lung, prostate, pancreas, bladder and breast) and risk of cardiovascular diseases. The majority of these beneficial effects are at least in part due to the presence of phytochemicals in vegetables and fruits. Carbohydrates, proteins, antioxidants, proteases, tannin, phytic acid etc., are some of the important bioactive components present in fruit peels. Each of

them has their own significance and biological roles.

Free radicals are continuously produced in our body either naturally or on exposure to environmental stress as well as other factors and can be implicated in many diseases like cancer, atherosclerosis etc. Antioxidants are known for their capacity to avoid the injury caused by free radicals. Although, our body has a defense system to produce antioxidants, fruits and vegetables are rich source of them. Due to their nominal side effects, there are growing interests in using natural resources as antioxidants for preventive and therapeutic medicine (Blomhoff et al. 2006). It has been postulated that a network of antioxidants with different chemical properties may work in a synergistic way, protecting cells from damage. It has been proved that free radicals are damaging cell components causing several physiological and pathological defects like inflammation, cardiovascular diseases and ageing.

The antioxidant activity of different fruit peels and seeds were assayed on the basis of improved ABTS radical cation decolorization assay with some modifications incorporated (Duda-Chodak and Tarko 2007). Reducing power assay method was employed for potential antioxidant determination in different fruit peels (Saranya et al. 2013). The antioxidant activities of pulp peel and seed from 24 exotic fruits from Colombia were evaluated by ABTS (free radical-scavenging capacity) and FRAP (ferric reducing antioxidant power) methods (Contreras-Calderón et al. 2011).

The concentration of protein is one of the factors which determine the quality of fruit peels. Various studies have shown that as the quality of the protein increases nutritional quality also increases. Proteins are critical sources of nitrogen as well as sulfur and are essential dietary constituents. Hence estimation of protein is being undertaken. Fruit wastes rich in carbohydrate content and other basic nutrients could support microbial growth and hence can be utilized for the production of single cell protein (Adoki, 2008).

Phytic acid is considered as an anti nutritional factor as it can remarkably reduce Iron and Calcium absorption in our body. The complexing of phytic acid with nutritionally essential elements and the possibility of interference with proteolytic digestion have also been suggested

as responsible for anti nutritional activity, hence determination of phytic acid content is essential.

Protease enzymes help in protein breakdown, support digestion and metabolism process and are known to sustain immune system. These enzymes are artificially available in food supplements and additive products. However, as these enzymes are naturally available in some fruits, it will be beneficial to determine total protease activity in fruit peels.

Tannins which are present in most plant foods have traditionally been considered anti-nutritional but it is now known that they are beneficial and their anti-nutritional properties depend upon their chemical structure and dosage. It is therefore essential to know how much concentration is present in the sample of different fruit peels and one of the main focuses of this work is to estimate the quantity of tannin in each fruit peels selected.

Materials and methods

Collected fruits were washed, peeled and their peels were carefully separated removing any amount of edible portions. The peels were air dried for 1 week and then ground to fine powder. Powdered samples were kept in airtight bags under refrigeration during the study period. Standard procedures followed for estimation of various contents in the fruit peels are displayed in table 1.

Results and Discussion

When the fruit peels were analyzed for carbohydrate content, highest concentrations were found in Guava (75 mg/ml) followed by Pomegranate (55.2 mg/ml), Apple (37.15 mg/ml), Banana (32.64 mg/ml). Least concentration was found in Grapes (8.81 mg/ml). The result shows significant amount of carbohydrates in the fruit peels and hence they can be utilized as a source of carbohydrates. Carbohydrate concentration was also seen highest in Pomegranate peels in the studies of Rowayshed et al. (2013) which supports the present findings of the study but Guava is found to have even more amounts of carbohydrates than Pomegranate.

Banana and Orange peels also contain significant amounts of carbohydrates as estimated by

Table 1: Estimation of various components in fruit peels using standard procedures

Components analyzed	Method	Procedure	Estimation
Carbohydrates	Anthrone method (Roe J.H, 1955)	1g each of 10 powdered peel samples were weighed and filtered, then centrifuged at 10,000 rpm for 10 minutes. Supernatant was made up to a volume of 30 mL. Then 4 mL of Anthrone reagent was added and kept in a boiling water bath for 10 minutes.	Supernatant was rapidly cooled and provided the dark green color at 620 nm using a spectrophotometer. Total carbohydrate content was then calculated using the obtained absorbance values of samples and standard
Protein	Folin-Lowry's method (Lowry et al., 1951)	Samples were mixed thoroughly with 7 ml phosphate buffer and filtered out using cheese cloth. Filtrate was centrifuged at 5000 rpm for 10 minutes. Supernatant was made up to 10 ml using buffer. 1 ml of 10% TCA was added to one mL of the solution and shaken thoroughly. It was then kept in freezer for 15 minutes. Centrifuged at 10,000 rpm for 10 minutes and upper layer was decanted. Pellet is taken and dissolved in 0.1N NaOH. 0.1 ml aliquot was taken and made up to 1 ml using 0.1N NaOH. 5 ml alkaline copper reagent was added and kept for 10 minutes. Then 0.5 ml of reagent D (1ml Folin's reagent + 1 ml 0.1 N NaOH) was added and the solution was kept for 30 minutes.	Resultant blue color was read at 670 nm using a spectrophotometer. Bovine Serum Albumin (BSA) solution (20-100 Mg/ml) was used as standard. Protein concentration was calculated by applying test and standard values in the corresponding equation.
Phytic acid	Wheeler E.L and Ferrel, R E, 1971	30 mg of powdered samples was extracted in 50 ml 3% TCA. Shaken thoroughly for 45 minutes and centrifuged at 5000 rpm for 10 minutes, to 10 ml of supernatant 4 ml FeCl ₃ was added, Again, centrifuged, pellet washed twice by 25 ml of 3% TCA. Supernatant was discarded. Once again centrifuged pellet was taken and precipitated in 2 ml of distilled water. 3 ml 1.5 N NaOH was added, Heated in boiling water bath for 30 minutes filtered hot through Whatman No.2 filter paper. Precipitate dissolved with 30 ml hot 3.2 N HNO ₃ . Cooled, 5 ml aliquot is taken, Added 20 ml 1.5 M potassium thiocyanate solution and diluted to 70 ml. Added 20 ml 1.5 M potassium thiocyanate solution and the red color is developed.	Red color developed was read immediately within 1 minute at 480 nm using a spectrophotometer. Using standard curve, Iron was present in the test and phytate was calculated as per the equation.
Antioxidant	Reducing power assay method (Yen GC and Duh PD; 1994)	1 g each of powdered samples was extracted using 10 ml distilled water, then 2.5mL phosphate buffer (0.2M, pH 6.6) and 2.5mL potassium ferricyanide was added. To this 2.5mL of trichloroacetic acid (100g/L) was added, and centrifuged at 3000rpm for 10 minutes, then the mixture was incubated at 50°C for 20 minutes. Finally, 2.5mL of the supernatant was mixed with 2.5mL of distilled water and 0.5mL FeCl ₃ (1g/L).	The absorbance was measured at 700nm in UV- Visible Spectrophotometer. Ascorbic acid was used as standard and phosphate buffer as blank solution.
Tannin	Vanillin Hydrochloride method (Robert, E B; 1971)	1g each of ground sample was extracted with 50 ml methanol. After 24 hours Centrifuged, and to 1 ml of supernatant 5 ml of vanillin hydrochloride reagent was added	Read in a spectrophotometer at 500 nm after 20 minutes. Blank was set with vanillin hydrochloride reagent alone. A standard graph with 20-100 µg catechin was prepared using the diluted stock solution (1 mg catechin/ml).
Protease	Anson, M.L., 1938	1 g each of samples was extracted in 10 ml distilled water, centrifuged at 5000 rpm for 10 minutes. 0.5 ml of the aliquot again incubated for 30 minutes with 1 ml 2% casein in 0.1M Tris-HCl buffer at 37°C for 10 minutes. Reaction was stopped by adding 5 ml 5% TCA and incubated for 30 minutes. To the filtrate 4 ml 0.1N NaOH and 0.5 ml Folin-Ciocalteu reagent was added.	Amount of tyrosine released was measured at 670 nm using a spectrophotometer

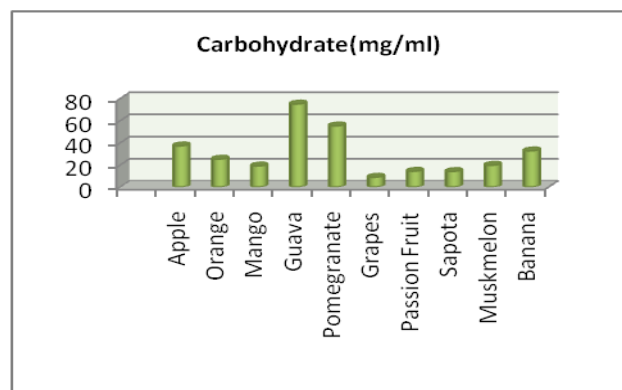


Figure 1: Graph of showing concentration of carbohydrate in different fruit peels

Anhwange et al. (2009) and Osarumwense et al. (2013), respectively (Figure 1). When the fruit peels were analyzed for carbohydrate content, highest concentrations were found in Guava (75 mg/ml) followed by Pomegranate (55.2 mg/ml), Apple (37.15 mg/ml), Banana (32.64 mg/ml). Least concentration was found in Grapes (8.81 mg/ml). The result shows significant amount of carbohydrates in the fruit peels and hence they can be utilized as a source of carbohydrates. Carbohydrate concentration was also seen highest in Pomegranate peels in the studies of Rowayshed et al. (2013) which supports the present findings of the study but Guava is found to have even more amounts of carbohydrates than Pomegranate. Banana and Orange peels also contain significant amounts of carbohydrates as estimated by Anhwange et al. (2009) and Osarumwense et al. (2013) respectively.

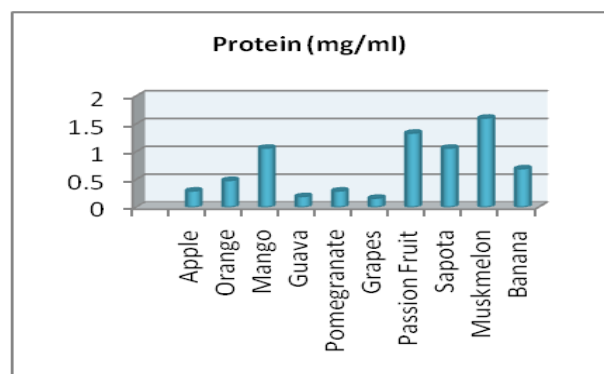


Figure 2: Graph showing concentration of Protein in various fruit peels

On estimation, highest protein concentration was found in Musk melon (1.6 mg/ml) followed by Passion fruit (1.33 mg/ml), Sapota (1.06 mg/ml) and Mango (1.06 mg/ml). So, findings of this study suggest that Musk melon can be highly recommended for daily consumption or usage in the diet owing to its high protein content. Least amounts were found in Grapes (0.16 mg/ml) and Guava (0.19 mg/ml). The result agrees with Saranya et al. (2013) about high concentrations of protein in Musk melon, Sapota and Mango and low amounts in Guava (Figure 2). The results show that significant amounts of protein are present in various fruit peels and their proper and economical recycling can lead to many economical protein containing products.

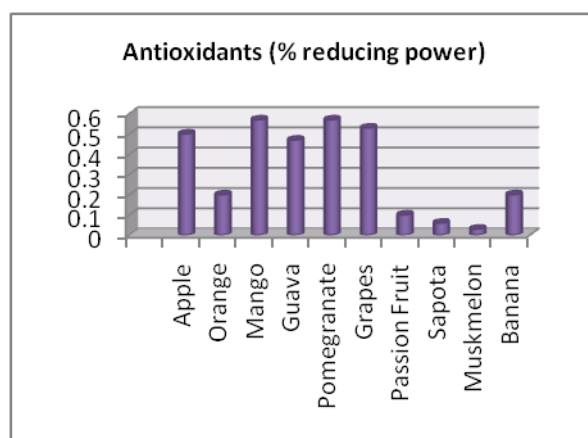


Figure 3: Graph showing percentage concentration of antioxidants in different fruit peels

Antioxidant activity of different fruit peels were analyzed by estimating their reducing power percentage in this study. Pomegranate and Mango showed the maximum level (0.57 %) of antioxidants followed by Grapes (0.53 %), Apple (0.5 %) and Guava (0.47 %). Least amounts were found in Musk melon (0.03 %) (Figure 3). As earlier studies show that food with high anti-oxidant properties will have great potential to fight or curb many degenerative diseases, in this context it can be recommended that both pomegranate and mango are vital sources of antioxidant components and thereby should be included in our daily consumption. The result of this study is in accordance with Saranya et al. (2013) which also revealed high antioxidant concentration and activity

in Pomegranate, Guava and mango. In a study conducted by Kim (2013) fruits were ranked according to their antioxidant capacity as pineapple>pear>apple>grapes>banana>watermelon. The ranking of the fruits based on their antioxidant activity in the present investigation is similar with their observation. The differences in the antioxidant activities among the fruits could be attributed to their differences in phenolic contents and compositions and to other non-phenolic antioxidants present in the samples (Wolfe et al. 2003). The probable reason for low antioxidant capacity observed in the present investigation compared to available values in the literature may be (i) low quality of the grape fruits available in the local market, (ii) long period of transportation from the place of production to the market (iii) geographical differences and (iv) difference in variety of the fruits.

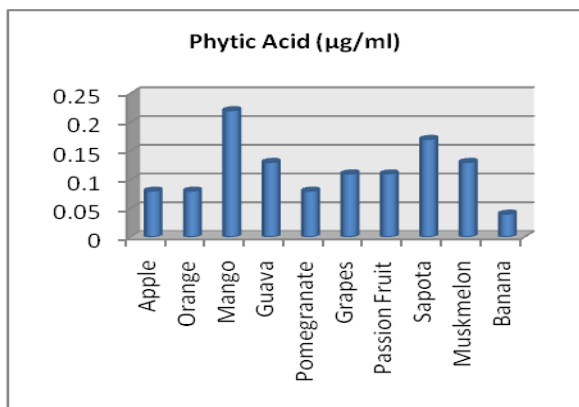


Figure 4: Graph showing concentration of Phytic acid in various fruit peels

Phytic acid is considered an anti nutrient, as it interferes with the daily activities of human body like digestion and protein breakdown (Schjønning et al. 2004). It captures essential nutrients like iron, zinc, calcium etc. diminishing their accessibility in human system (FAO 1990). In this study concentration of phytic acid was found to be highest in peels of Mango (0.22 µg/ml) followed by Sapota (0.17 µg/ml) and the least amount of Phytic acid was found in peels of Banana (0.04 µg/ml) which is lower when compared to the value reported by Anhwange et al. (2009) (Figure 4). It is essential to know the phytate level in foods due to their damaging effect on digestive system. Hurrell (2004) reported that phytic acid intake of 4-9

mg/100g decreases iron absorption by 4-5 folds. The study shows generally low values of phytates compared to the aforementioned value. This means that if the peels are properly processed could be good source of livestock feed. Pomegranate (1.06 mg/ml) was found to have highest protease concentration followed by Mango (0.3 mg/ml). Least amounts were found in Banana (0.11 mg/ml), Sapota (0.1 mg/ml) and Apple (0.1 mg/ml) (Figure 5).

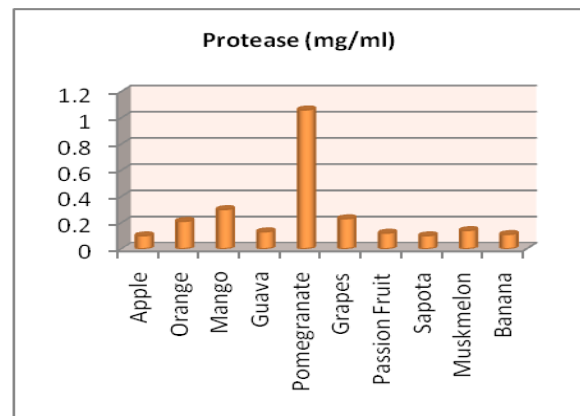


Figure 5: Graph showing concentration of Protease in different fruit peels

The result obtained does not comply with results of Saranya et al. (2013). As here Pomegranate is found to have highest amount of protease activity rather than Sapota in the aforementioned report and mango is found to have more protease concentration than estimated.

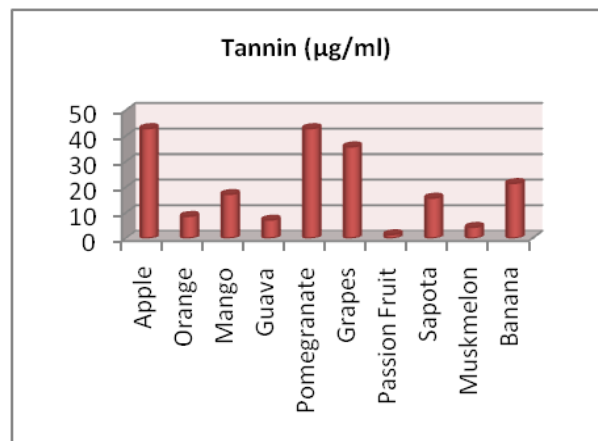


Figure 6: Graph showing concentration of Tannin in various fruit peels

Highest concentration of Tannin was found in Apple and Pomegranate (42.46 µg/ml) followed by Grapes (35.72 µg/ml). Least amount was found in Passion fruit (1.43 µg/ml) (Figure 6). The result complies with that of Duda-Chodak *et al*; 2007 about high concentrations of tannins in Grapes and apple and low quantities in Orange. Pomegranate peels have been attested as an important source of Tannins by Saad et al. (2012). Tannins constitute an essential fraction in the peels of fruits. In many cases, the fruit peels are the waste products of technological processes. These results showed that extracted tannic acid from peel sources can be used as preservation material in food processing and component of cosmetic materials and pharmacological drugs and as an antioxidant source. This could bring measurable economical profits.

Conclusion

Peels are the major by-products obtained during the processing of various fruits. Present study shows that these are good sources of many bioactive components which possess various beneficial effects on human health. But there are anti-nutritional factors also which can have adverse effects and reduce the nutritional quality but they are less in amount compared to the nutritional factors.

The study on fruit peels can be helpful in understanding the nature of various components and their levels in different fruit peels provide insights on better usage of fruit wastes. Thus, we may conclude that peels and seeds of several fruits are effective resource of antioxidants which can be effectively utilized in food, pharmaceutical and agricultural industries. Further studies on the identification, isolation, characterization and elucidation of structure of the bioactive compounds can help in utilizing the valuable nutrients in fruit peels instead of wasting them. Moreover, analyzing the anti-nutritional factors and their levels in peels can help in developing various processing methods that can lower their negative effects and also their correlation with other components in the peels. If done, it will be very useful from dietary point of view as well because then peels can be used in livestock feed as well as human diet without concern.

Acknowledgements

The authors are extremely thankful for the financial support in addition to the laboratory facilities provided by the PG Department of Environmental Sciences, All Saints' College, University of Kerala for carrying out this study successfully.

References

- A. Adoki (2008). Factors affecting yeast growth and protein yield production from orange, plantain and banana wastes processing residues using *Candida* Spp. *African J. Biotech.*, **7**: 290-295.
- B.A. Anhwange, T.J. Ugye, T.D. Nyiaatagher, (2009). Chemical composition of *Musa sapientum* (banana) peels. *Electron. J. Environ. Agric. Food Chem*, **8**: 437-442.
- C. Jose, Lilia Calderón-Jaimes, Eduardo Guerra-Hernández, Belén García-Villanov (2011). Antioxidant capacity, phenolic content and vitamin C in pulp, peel and seed from 24 exotic fruits from Colombia. *Food Res. Int.*, **44**: 2047-2053.
- D.H. Lowry, N.J. Rosebrough, A.L. Tarr, R.J. Randall (1951). Protein measurement with the folin-Phenol reagent. *J. Biol. Chem.*, **193**: 265-276.
- D. Aleksandra and T. Tarko (2007). Antioxidant properties of different fruit seeds and peels. *Acta Sci. Pol., Technol. Aliment*, **6**: 29-36.
- E. L. Wheeler and R. E. Ferrel (1971). A Method for Phytic Acid Determination in Wheat and Wheat Fractions. *Cereal Chem* **48**: 312-320.
- E.B. Robert (1971). Method for estimation of tannin in grain sorghum. *Agro. J.*, **63**: 511-512.
- FAO (1990). "Roots, Tubers, Plantains, and Bananas in Human Nutrition". FAO Corporate Document Repository: Rome, Italy.
- G. C. Yen and P. D. Duh (1994). Scavenging effect of methanolic extracts of peanut hulls on free-radical and active-oxygen species. *J. Agric. Food Chem.*, **42**: 629-632.
- G. Rowayshed, A. Salama, M. Abul-Fadl, S. Akila-Hamza, A.M. Emad (2013). Nutritional and Chemical Evaluation for Pomegranate (*Punica granatum* L.) Fruit Peel and Seeds Powders by Products. *Middle East J. Appl. Sci.*, **3**:169-179.

- J.H. Roe (1955). The determination of sugarin blood and in spinal fluid with anthrone reagent. *J. Biol. Chem.*, **212**: 335- 343.
- J.S. Kim (2013). Preliminary Evaluation for Comparative Antioxidant Activity in the Water and Ethanol Extracts of Dried Citrus Fruit (Citrus unshiu) Peel Using Chemical and Biochemical in Vitro Assays, *Food Nutri. Sci.*, **4**: 177-188.
- M.L. Anson (1938). The estimation of pepsin, trypsin, papain, and cathepsin with hemoglobin. *J. Gen. Physiol.* **22**: 79-89.
- N. Saad, C. Delattre, M. Urdaci, J.M. Schmitter, P. Bressollier (2012). An overview of the last advances in probiotic and prebiotic field. *Food Sci. Technol.*, **50**: 1-16.
- P.O. Osarumwense, L.O. Okunrobo, E.G. Uwumarongie-ilori (2013). Phytochemical screening, proximate and elemental analysis of Citrus sinensis peels (L.) Osbeck, *J. Appl. Sci. Environ. Manage.*, **17**: 47-50.
- P. Schjonning, B.T. Christensen, S. Elmholt (2004). *Managing Soil Quality — Challenges in Modern Agriculture*, CAB International, Wallingford, UK pp. 69–84
- R. Blomhoff, M.H. Carlsen, L.F. Andersen, D.R. Jacobs (2006). Health benefit of nuts: Potential role of antioxidants. *Br. J. Nutr.*, **96**: 52-60.
- R.F. Hurrell (2004). Phytic acid degradation as a means of improving iron absorption. *Int. J. Vitam. Nutr. Res.*, **74**: 445-52.
- S. Chitturi, V. Gopichand, Talatam, S. Vuppu (2013). Studies on protein content, protease activity, antioxidants potential, melanin composition, glucosinolate and pectin constitution with brief statistical analysis in some medicinally significant fruit peels. *Der. Pharmacia Lettre.*, **5**: 13-23.
- K. Wolfe, X. Wu, R.H. Liu (2003). Antioxidant Activity of Apple Peels. *J. Agri. Food Chem.*, **51**: 609-614.