Research Article

Potentialities of antioxidants in Tropical Fruit Crops

K. Thirumalaiselvi*, M. Elavarasan, and R. Prathana

ICAR Krishi Vigyan Kendra (RVS), Tirunelveli, Tamil Nadu, India

Abstract

The doctrine "Let food be thy medicine" espoused by Hippocrates nearly 2500 years ago is receiving interest by the researchers now a days. Recently, the focus has been shifted to the achievement of a balanced diet and maximization of both life expectancy and quality, by identifying food ingredients that improve the capacity to resist disease and enhance health. There has been a rapid increase in the oxidative stress and associated disorders such as prevalence of diabetes, cataract and cardiovascular diseases, due to the rapid changes in diet and lifestyle. The natural strategies such as increased intake of antioxidant rich food could be a valuable tool in coping up with the stress.

Fruits form an integral part of our daily balanced diet ensuring abundant supply of antioxidants which prevents the risk of many chronic diseases. Important antioxidants in fruits include polyphenols, ascorbic acid, β carotene and vitamin E.

Keywords: Potentialities, antioxidants and tropical fruit crops

***Correspondence**

Author: K. Thirumalaiselvi

Email: thiru.kanchi@mail.com

Introduction

"Antioxidants" are substances that prevent harmful molecules (free radicals) from damaging the body's DNA and act as protective agents for the more complex and functional parts of a nutritional complex. Antioxidants are the compound that are capable of quenching or stabilizing free radicals and plays an important role in the body defense system. It includes specific vitamins, minerals and enzymes that protect cells against damage from oxidation [1-4]. The four antioxidants, many experts consider to be the most important ones are vitamin A (beta-carotene), vitamin C (ascorbic acid), vitamin E (tocopherol) and the polyphenols. One of the best sources of antioxidant is different fruits. Some components of fruits are strong antioxidants and function to modify the metabolic activation and detoxification/disposition of carcinogens or even influence process that alters the course of the tumor cell [3].

Antioxidants defense and its importance in prevention of diseases

To encounter the harmful effect of ROS, antioxidant defense mechanism operates to detoxify or scavenge these ROS. A variety of antioxidant mechanism has been evolved to combat the potential threat of damage to vital biological structures from the aforementioned sources. An antioxidant can be considered as a molecule that, when present at low concentrations compared with those of an oxidizable substrate, significantly inhibits oxidation of that substrate. This antioxidant affect can be achieved in two different ways as;

Preventative antioxidants

Preventive antioxidant proteins exist to sequester free transitional metal ions such iron and copper include the iron-binding protein transferring and copper-binding proteins cerruloplasmin and albumin. These antioxidants preventing their interaction with H202 and 02, which would facilitate the production of the produce highly reactive hydroxyl radical (OH). Intracellular environment contains enzymes such as superoxide dismutase (SOD), catalase (CAT), glutathione reductase (GR), glutathione peroxidase (GPx), glutathione-S- transferase (GST) and low molecular weight antioxidant glutathione (GSH) that catalyze the breakdown of oxidants generated by cellular metabolism.

Sacrificial antioxidant (Chain breaking)

They are powerful electron donors and react preferentially with free radicals before more important target molecules are damaged. In doing so, the antioxidant is sacrificed (oxidized) and must be regenerated or replaced [5].

Methods to Assess Antioxidant Activity

DPPH free radical assay (1,1-Diphenyl-2-picrylhydrazyl)

The principle behind 1,1-Diphenyl-2- picrylhydrazyl (DPPH) free radical assay holds that the antioxidants react with the stable DPPH radical and convert it into 1,1-diphenyl-2-picryl hydrazine. Scavenging activity on DPPH was assessed according to the method reported by Blois (1958) with a slight modification. Briefly, 100 µl of extracts (0.1-0.5 mg/ml) were mixed with 1ml of solution of 0.1 mM DPPH. The mixture was shaken well and incubated at room temperature for 30 min and absorbance was measured at 517 nm in a spectrophotometer. Experiment was performed in triplicate and the average was taken. This experiment often express its unit as IC 50 value, which is the concentration of sample, which is required to scavenge 50% of DPPH free radicals.it is also expressed as percentage of radical scavenging activity. Percent inhibition was calculated from control using the following equation:

Scavenging activity (%) = (1-Absorbancesample/ Absorbance control) x 100

Ferric Reducing Antioxidant Power (FRAP)

The assay was based upon the methodology of Benzie and Strain [6]. The FRAP reagent consisted of 10 mM TPTZ in 40 mM HCl, 20 mM FeCl3 and 250 mM sodium acetate buffer (pH 3.6). FRAP reagent was freshly prepared by mixing 2,4,6-tripyridyl-s-triazine (TPTZ) solution, FeCl3 solution and acetate buffer in a ratio 1:1:10. A 100 Il of extract solution containing 0.1 mg extracts was mixed with 900 µl of FRAP reagent. After the mixture stood at 37 oC for 4 min, the absorbance at 593 nm was determined against blank. Trolox was used as calibration standard in concentration range (0.002-0.01 mg/ml) FRAP values were calculated as µmol /g wet weight of fruit.

In **Table 1** briefed about the list of tropical fruits with their scientific and botanical family name.

Table 1 Tropical fruit crops

Mango	*Mangifera indica*	Anacardiaceae
Banana	*Musa spp.*	Musaceae
Papaya	*Carica papaya*	Caricaceae
Guava	*Psidium guajava*	Myrtaceae
Pineapple	*Ananas comosus*	Bromeliaceae

Mango

Mango (Mangifera indica L.) is one of the most important commercial crops worldwide in terms of production, marketing and consumption [7]. Mango is one of the most important tropical fruits worldwide in terms of production and consumer acceptance [3]. **Table 2**, briefed about the Antioxidants and health benefits of Mango [8].

Table 2 Antioxidants and health benefits of Mango

Antioxidants	**Health benefits**
Ascorbic acid	Anticarcinogenic
Carotenoids	Antiatherogenic
Phenolic compounds	Antitumor
1. Flavonol	Antiviral
2. Xanthone	Anti-inflammatory
3. Gallotannins	
4. Benzophenone derivatives	
Mangiferin	

Four mango cultivars grown in Brazil were used in this study: Haden, Tommy Atkins, Palmer and Uba. Total phenolic contents in the extracts were estimated using the Folin-Ciocalteu reagent, according to Singleton [9]. Absorbance (λ_{max} = 765 nm) was measured using a UV spectrophotometer. Gallic acid was used as a spectrophotometer standard and total phenolic content was determined on the basis of calibration equations with values expressed as Gallic Acid Equivalents (GAE) in milligrams per 100 grams of pulp.

Total phenolic content was different among the four varieties, being higher in Uba mango pulp **Figure 1** [10]. The Palmer cultivar showed an intermediary value and Haden and Tommy Atkins presented lower values. The analyzed mango cultivars contain expressive total phenolic concentrations that may contribute to increase antioxidant

intake in human diet, since the intake of polyphenolic compounds in the diet was estimated to range between 0.15 and 1.0 g/day.

Varieties Tommy Atkins, Palmer and Haden showed no difference in β-carotene contents, but were significantly lower than varieties Uba. The latter showed the highest content of β-carotene, which was the prevailing type of carotene in the pulp **Figure 2** [10].

The total ascorbic acid content obtained for Haden, Tommy Atkins and Palmer mangoes was lower than those described for the variety Uba **Figure 3** [10].

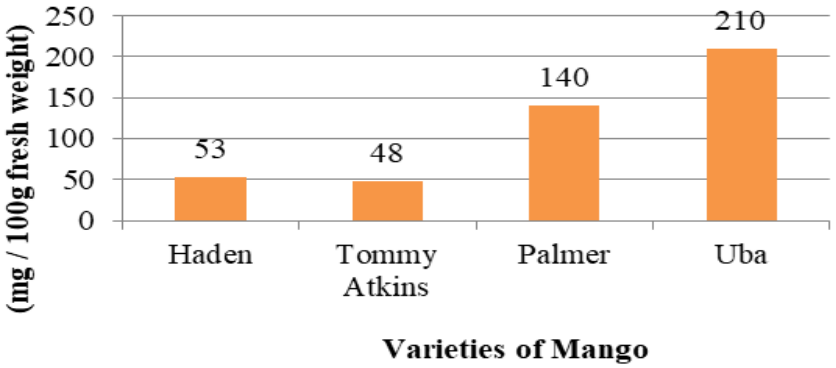

Figure 1 Comparison of total phenolic content in mango varieties

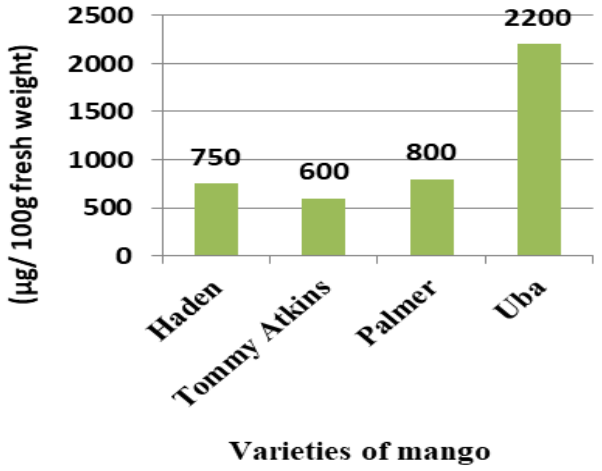

Figure 2 Beta carotene in mango varieties

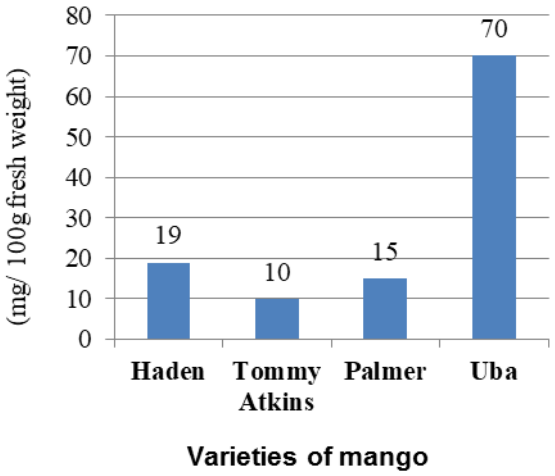

Figure 3 Ascorbic acid in mango varieties

The pulp extracts from the four mango varieties showed significantly different values of DPPH radical - scavenging activities, ranging from 39.6% to 94.2% (**Figure 4)** [10]. Variety Uba scavenged more than 94% of the DPPH radical, showing RSAs 1.8, 2.1 and 2.4 times greater than the extracts from Tommy Atkins, Haden and Palmer varieties, respectively.

In summary, the investigation of four mango varieties has demonstrated that the secondary metabolites content varies with the variety. Although the Uba variety has a commercial value limited to Brazil, it proved to be particularly promising as a source of bioactive antioxidants.

Seven varieties of mango fruits (Alphonso, Banginapalli, Raspuri, Neelam, Imampasand, Rumani, Totapuri and Sindhura) were obtained from the local mango fruit market of Tirupati (India) and were evaluated for the antioxidant activity by FRAP assay [6]. The Banganapalli mango exhibited the highest antioxidant potential among the different mango varieties based on the FRAP assay.

The reducing power obtained was in the range of 0.6 – 3 mM ascorbic acid equivalents in all the varieties. Alphonso and Rumani mangoes also exhibited the highest antioxidant potential followed by Neelam, Sindura, Imampasand, and Totapuri (**Figure 5**) [8].

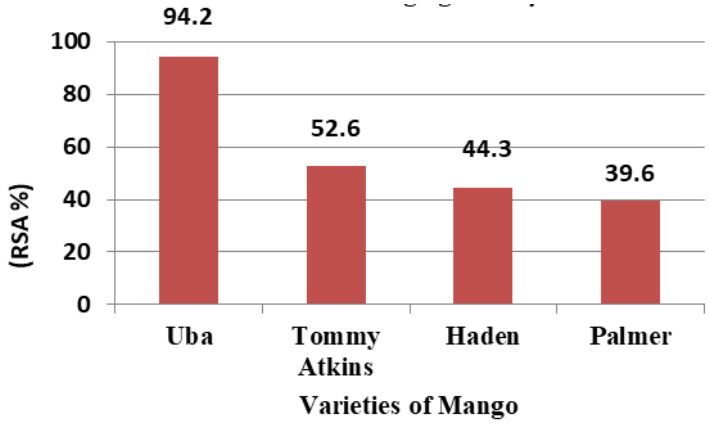

Figure 4 DPPH radical-scavenging activity in mango varities

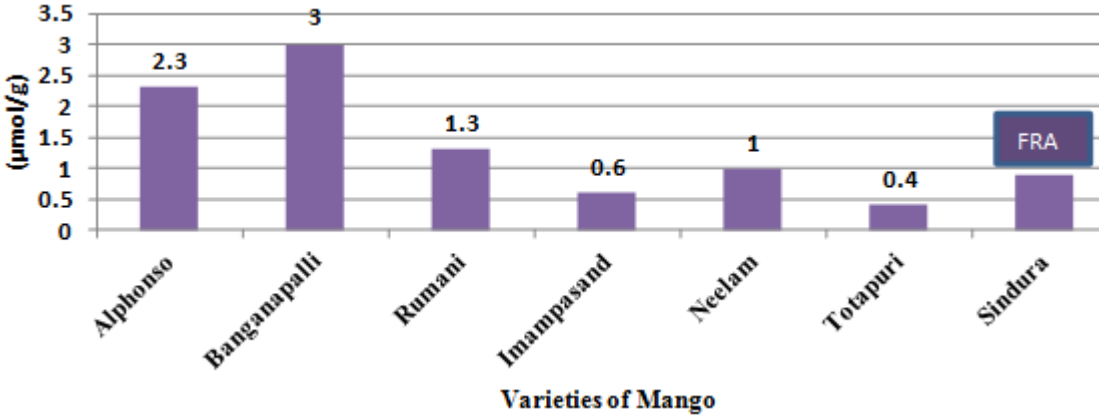

Figure 5 Antioxidant activity in Indian mango varieties

Banana

Musa spp., comprising banana and plantain are among the world's leading fruit crops and in terms of economic value, it is the number five agricultural crop in world trade. **Table 3** briefed about the Antioxidants and health benefits of Banana [11].

The banana varieties Monthan, Karpooravalli, Nendran, Kadali, Poovan Rasthali, Robusta and Red banana were collected locally from different farms in the same locality in Coimbatore (Tamil Nadu, India) and were evaluated for the antioxidant activity. From the (**Figure 6)** [12], it is inferred that Rasthali extract showed higher phenol content compared to other varieties, which could be related to its antioxidant potential.

Many flavonoids are found to be strong antioxidants capable of effectively scavenging the reactive oxygen species because of their phenolic hydroxyl groups. In this study, from the (**Figure 7)** [12], Poovan extract exhibited higher flavonoid content which might be correlated with its anti-lipid peroxidation activity.

Table 3 Antioxidants and health benefits of Banana

Antioxidants	Health benefits
Vitamin C	Anti-inflammatory
Vitamin E	Reduces
β Carotene	Hypolipidemia
Polyphenols	Hypoglycemia
1. Flavonoids	Heart diseases
2. Gallocatechin	Ageing
3. Dopamine	

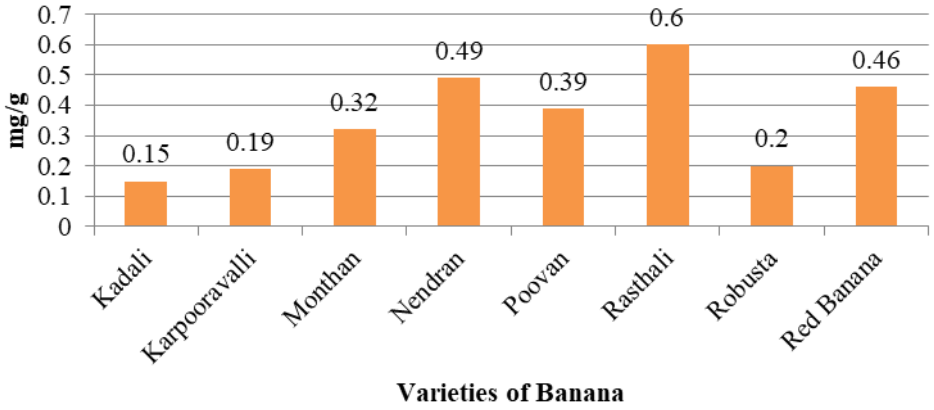

Figure 6 Total phenols in Banana varieties

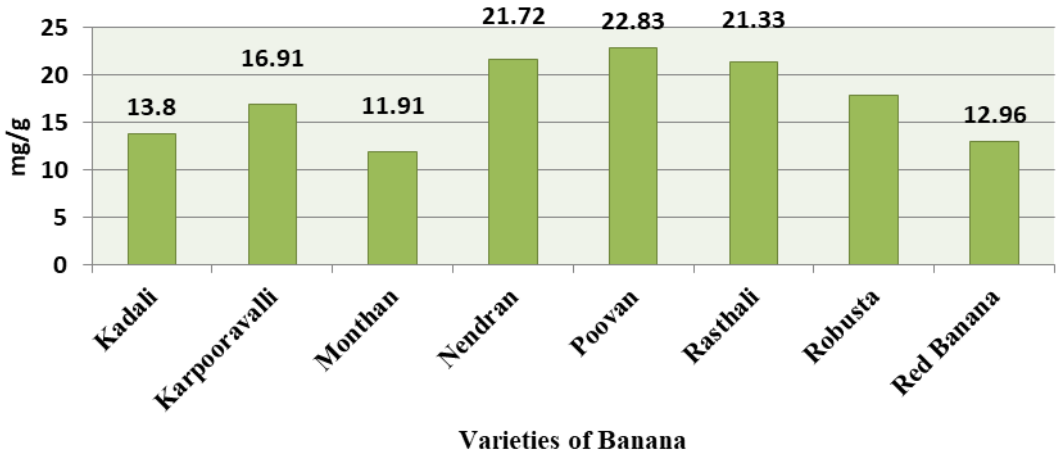

Figure 7 Flavonoids in Banana varieties

The total antioxidant activities of various banana peel extracts are depicted in Fig No.8. The values represent the total antioxidant capacity of banana extracts expressed in terms of equivalents of ascorbic acid. According to (**Figure 8)** [12], the extract of Kadali showed higher activity in the range of 4.89 mM/g in comparison to other varieties of banana, whereas the extract of Nendran showed least activity.

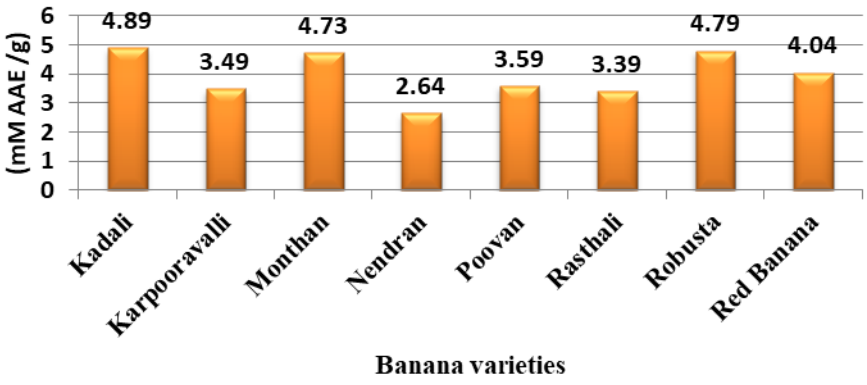

Figure 8 Total antioxidant activity of Banana varieties (DPPH)

Papaya

The Papaya (Carica papaya) is a tropical fruit having commercial importance because of its high nutritive and medicinal value. **Table 4** Explains about the Antioxidants and health benefits of Papaya [13 & 14].

Sunrise Solo had higher Total phenolic content than Red Lady which accounted for its antioxidant property (**Figure 9**) [15].

The free radical scavenging potential of different concentrations was tested by the DPPH method [16]. All cultivars had scavenging effects against DPPH radicals, ranging from 52.1-63.4 mL /g DPPH. The hierarchy for free radical scavenging activity with respect to IC_{50} values was Sunrise Solo > Red Lady (**Figure 10**) [15]. Sunrise Solo had an IC_{50} value of 52.1 mL of juice, while Red Lady had IC_{50} values of 63.4mL of juice. The lower IC_{50} values are associated with higher free radical scavenging activity.

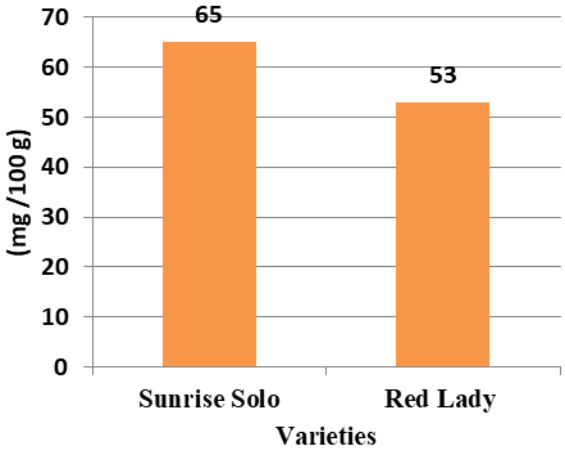

Figure 9 Total phenolic content in Sunrise solo & Red Lady Mango varieties

Table 4 Antioxidants and health benefits of Papaya

Antioxidants	Health benefits
Carotenoids	Atherosclerosis
Vitamin C	Reduce constipation Immune booster
Flavanoids	Anti-inflammatory Papain – dyspepsia Bacteriostatic properties

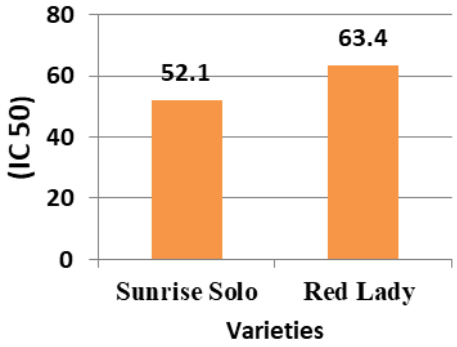

Figure 10 Antioxidant activity in Sunrise solo & Red Lady Mango varieties

Guava

Guava (Psidium guajava L.) is one of the most important fruit crop of India. It was originated in tropical America. It covers around 3.3% of the total area under fruit crops and contributes 3.3 % of the total fruit production in India. In **Table 5**, the antioxidants properties and health benefits were shown [17].

The total phenolic content, ascorbic acid content, and antioxidant activity of seeded and seedless guava are compared. Both varieties of guava fruit contain relatively high quantity of antioxidants. Whereas antioxidant activity is found higher in seedless guava compared to seeded guava (**Figure 11**) [17].

Table 5 Antioxidants and Health benefits of Guava

Antioxidants	Health Benefits
Ascorbic acid β carotene Vitamin B Thiamine (B1) Riboflavin (B2) Niacin Pantothenic acid	Reduces risk of Hypertensive Hypercholesterolemia Arthritis Arteriosclerosis Cancer Heart disease Inflammation

Carotenoids 1. Lutein 2. Zeaxanthine 3. Lycopene	Brain dysfunction

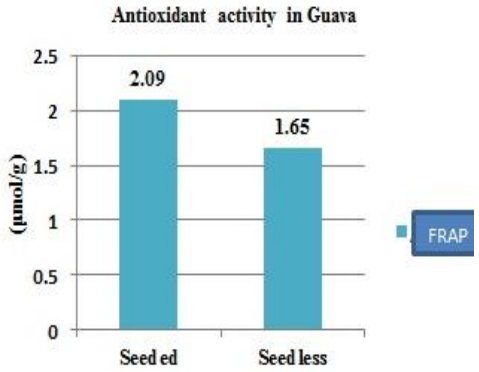

Figure 11 Antioxidant activity in Guava

Pineapple

It is the only common food plant in the Bromeliaceae. It is cultivated commercially in the tropics and parts of the subtropics of the world, with Hawaii producing one-third of the world's crop. In **Table 6** depicted about the antioxidants and health benefits of Pineapple [18].

Antioxidant capacities and total phenolic contents of 62 fruits were evaluated. Of these while comparing the antioxidant capacity of tropical fruit crops guava is said to have highest antioxidant activity followed by pineapple. Whereas banana, papaya and mango is said to have similar antioxidant capacities (**Figure 12**) [17].

Table 6 Antioxidants and health benefits of Pineapple

Antioxidants	Health benefits
Vitamin C - 18.88 (mg/100 g)	Anti-inflammatory
β-carotene - 3.35 (µg/100 g)	Lowers risk of
Total phenolics - 26.2 (mg /100g)	Cardiovascular disease
FRAP - 118.18 (µmol/100g FW)	Cancer

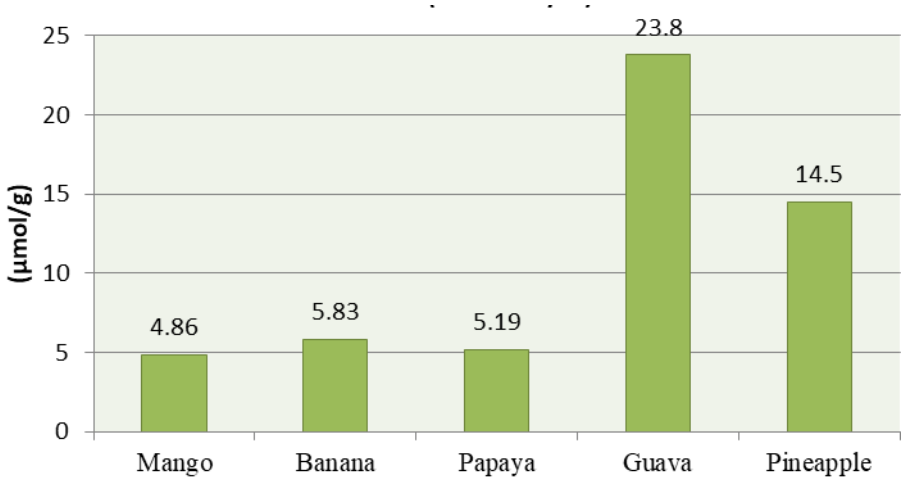

Figure 12 Antioxidant activity of Tropical fruits (FRAP Analysis)

Conclusion

Fruits form an integral part of our daily balanced diet ensuring abundant supply of antioxidants which prevents the risk of many chronic diseases. Important antioxidants in fruits include polyphenols, ascorbic acid, β carotene and vitamin E. Therefore Fruits are considered to be one of the best sources of nutritional values and health benefits. The rich natural source of essential vitamins, amino acids, minerals and dietary fibre and its established nutritional values

and health benefits, reinforces the recommendation to increase the intake of fruits rather than any specific supplement. Nutrition and medical science continues to identify and study new phytochemicals in fruits for their benefits in human health protection. Tropical fruits contain a broad range of phytochemicals, which are reported to protect against several chronic diseases viz., cardiovascular diseases and cancer.

References

[1] V. Agte and K. Tarwadi, 2012. Fruits and Vegetables Micronutrient and Antioxidant Quality, Studium Press, Delhi, 225p.
[2] FAO [Food and Agriculture Organisation]. 2004. Fruit and Vegetable for Health. Report of a joint FAO / WHO workshop, 1-3 September 2004, Kobe, Japan, 46p.
[3] S. K. Mitra, H. L. Devi and S. Debnath, 2014. Tropical and subtropical fruits and human health. Acta Hortic.1024:39-47.
[4] V. Ribeiro, L.C.A. Barbosa, J.H. Queiroz, M. Knodler and A. Schieberd, 2008. Phenolic compounds and antioxidant capacity of Brazilian mango (Mangifera indica L.,) varieties Food Chem.,110: 620–626.
[5] A.P. Kaur and K. Singh, 2011. Free radicals, antioxidant activities in fruit crops and their importance as phytomedicines. J. Asian Hortic., 6 (2):496-509.
[6] I. F. F. Benzie and J. J. Strain, 1999. The ferric reducing ability of plasma (FRAP) as a measure of "antioxidant power": the FRAP assay. Anal. Biochem., 239: 70-76.
[7] Y. S. Kumar, S. Varakumar and O. V. S. Reddy, 2012. Evaluation of antioxidant and sensory properties of mango (Mangifera indica L.) wine. J. Food. 10:12–20.
[8] Y.S. Kumar, S. Varakumar and O.V.S. Reddy, 2012. Agric., Ind., Special Issue. S44-S50. Evaluation of antioxidant and sensory properties of mango (Mangifera indica L.,), wine. J. Food. 10:12–20.
[9] V. L Singleton, R. Orthofer and R. Lamuela, 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. Methods Enzy., Mol. 299: 152–177.
[10] S. M. R. Ribeiro, J. H. Queiroz, M. E. Lopes, R. Queiroz, F. M. Campos and H. M. P. Santana, 2007. Antioxidant in Mango (Mangifera indica L.,) Pulp. Plant Foods Human Nutri., 62:13–17.
[11] S. Vijayakumar, G. Presannakumar and N. R. Vijayalakshmi, 2008. Antioxidant activity of banana flavonoids. Fitoterapia 79:279–282.
[12] R. Baskar, S. Shrisakthi, B. Sathyapriya, R. Shyampriya, R. Nithya and P. Poongodi, 2011. Antioxidant Potential of Peel Extracts of Banana Varieties (Musa sapientum), Food Nutrition Sci., 2: 1128-1133.
[13] C. Kaur and H. C. Kapoor, 2005. Antioxidant activity of some fruits in Indian diet. Acta Hortic. 696:563-565.
[14] E. S. Khor and N. K. Wong, 2014. Potential antioxidant and cytotoxic properties of secondary metabolite extracts from carica papaya fruits and seeds. Int. J. Pharmacy Pharma. Sci., 6 (7): 220-224.
[15] A. Ozkan, H. Gubbuk, E. Gunes and A. Erdogan, 2011. Antioxidant capacity of juice from different papaya (Carica papaya L.,) cultivars grown under greenhouse conditions in Turkey. Turkey J. Biol., 35: 619-625.
[16] M. S. Blois, 1958. Antioxidant determination by the use of a stable free radical. Nature,18:1199-1200.
[17] L. Y. Yan, L. T. Teng and T. J. Jhi, 2006. Antioxidant properties of guava fruit: comparison with some local fruits. Sunway Academic J., 3: 9–20.
[18] A. Kongsuwan, P. Suthiluk, T. Theppakorn, V. Srilaong and S. Setha, 2009. Bioactive compounds and antioxidant capacities of phulae and nanglae pineapple. Asian. J. Food. Ag-Ind. S44-S50.

Publication History
Received 12.11.2019
Revised 26.11.2019
Accepted 27.11.2019
Online 30.11.2019