INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

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DETERMINATION OF THE TOTAL POLYPHENOLIC CONTENT AND TOTAL ANTIOXIDANT CAPACITY OF COMMONLY CONSUMED FOODS IN TAMIL NADU

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ABSTRACT
This study aimed to identify the total polyphenolic content and measure the antioxidant capacity present in selected foods *viz.*, *Oryza sativa* (rice), *Cajanus cajan* L. (red gram), *Solanum tuberosum* (potato), *Solanum melongena* (brinjal), *Raphanus sativus* (radish), *Daucus carota subsp. sativus* (carrot), *Solanum lycopersicum* (tomato), *Manilkhara achras* (sapota), *Psidium guajava* (guava), *Capsicum annuum* L. (Green chilli), *Coriandrum sativum* (coriander seeds) and *Cuminum cyminum* (cumin seeds). Results showed that, the acidified 80% methanol extract of the cumin seeds showed highest total polyphenolic content (195.24 mg GAE / 100 g FWB) next to coriander seeds (133 mg GAE / 100g FWB), whereas the lowest total polyphenolic content (2.98 mg GAE /100 g FWB) was seen in radish. Antioxidant capacity was determined by the free radical-scavenging (DPPH) and ferric reducing/antioxidant power (FRAP) assays. Among the selected foods, the effectiveness in the total antioxidant capacity was obtained in decreasing order by sapota<carrot<brinjal<tomato<radish<guava<potato<cumin seeds<red gram<coriander seeds<rice<green chilli which was correlated positively to the result of FRAP assay. The percentage inhibition (radical scavenging activity) was also found to be highest (85.76 %) in sapota and lowest in green chilli (63.45 %). Overall, the presence of highest total polyphenolic content did not have major impact on total antioxidant capacity of the selected foods which may be accompanied to the presence of other bio-active compounds like flavonoids, flavonols, tannins, vitamin C *etc.*,

KEYWORDS: Foods, DPPH, FRAP, Polyphenols.

INTRODUCTION

Antioxidants are substances that delay or inhibit oxidative damage to a target molecule by scavenging the free radicals or by promoting their decomposition (Jacob, 1995). Foods of plant origin are rich sources of nutrients especially vitamins, minerals, fibers, carbohydrates and bioactive compounds such as polyphenols, flavonoids, flavonols, carotenoids and tannin *etc.*, (Faller and Fialho., 2009). The major phytochemicals (flavonoids, coumarins, tannins and other phenolic compounds) found in plant sources are capable of terminating free radical reactions and prevent our body from oxidative damage (Casanova *et al.*, 2008; Lobo *et al.*, 2010). A number of epidemiogical studies have revealed that a high consumption of plant foods is strongly associated with lowering the incidence of degenerative diseases such as cáncer, cardiovascular diseases, premature aging, cataract and macular degeneration (Cheung and Ooi 2003; Zhang and Hamauzu, 2004). Many clinical studies have also shown that diet rich in plant foods may lower the risk of many chronic degenerative diseases especially degenerative ailments linked to ageing process. Surplus consumption of plant foods provide máximum micro-nutrients which is essential for maintaining normal function of the body physiology. It well documented that 44 per cent of disease, disability and death is attributed to the low intake of foods of plant origin (Bhupathiraju *et al.*, 2013). So, the increased consumption of foods from plant sources may confer protection against many chronic diseases. Therefore, the present study was aimed to investigate total polyphenolic content and total antioxidant capacity of the commonly consumed foods of Tamil Nadu.

MATERIALS AND METHODS

Plant material

A total of twelve commonly consumed foods in Tamil Nadu (*Oryza sativa* (rice), *Cajanus cajan* L. (red gram), *Solanum tuberosum* (potato), *Solanum melongena* (brinjal), *Raphanus sativus* (radish), *Daucus carota subsp. sativus* (carrot), *Solanum lycopersicum* (tomato), *Manilkhara achras* (sapota), *Psidium guajava* (guava), *Capsicum annuum* L. (green chilli), *Coriandrum sativum* (coriander seeds) and *Cuminum cyminum* (cumin seeds) were selected and used as research material.

Extraction of bioactive compounds

Antioxidant and polyphenols are present in plant foods both simple to highly polymerized chemcical substances. So there is no single satisfactory solvent extraction method suitable for the extraction of all clases of food antioxidants and phenolics. Several researchers have reported using acidified 80% methanol with 6N HCL, pH 2.00, for extraction to assess total antioxidant capacity and total polyphenolic content in plant foods and the reasons for it could be that methanol extraction gives high antioxidant activity as compared to that with other polar solvents. Hence in the present investigation acidified 80% methanol was used for extraction of total antioxidant capacity and total polyphenols (Rochford and Panozzo, 2007).

Known quantity of weighed fresh plant foods was, ground manually using pestle and mortor by adding 15 ml acidified 80% methanol. The ground aliquot was transfered in 100 ml conical flask and kept in rotary shaker for 30 minutes at room temperature. After 30 minutes the supernatant was decantad and the residue was reextracted for complete reomoval of polyphenolic and antioxidant compounds. The supernatant was centrifuged at 6000 rpm for 15 minutes and filtered through Whatman No.1 filter paper into 50 ml volumetric flask and the volume was made up to 50 ml with the solvent. Then the filtered extracts were transfered into 50 ml propylene bottles and stored at -20^{o}C and used for estimation of both total polyphenolic content and total antioxidant capacity.

Estimation of total polyphenolic content

Total polyphenolic content of the extracts was determined with Folin-Ciocalteu colorimetric method (Singleton *et al.,* 1999). Briefly 0.2 ml extract was taken in 15 ml test tube and volume was made up to 1.5 ml with distilled wáter. To 0.5 ml Folin-Ciocalteu reagent, 10 ml of 7.5 % sodium carbonate was added and the mixture was mixed well and incubated for 60 minutes at 37°C. The reading was taken at 750 nm against blank and Gallic acid was used as a standard for the calibration curve. The total polyphenolic content was expressed as milligrams of gallic acid equivalents (GAE) per 100 g sample in fresh weight basis.

Determination of radical scavenging activity

The radical scavenging activity of the extracts was determined using the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) methods reported by Brand – Williams *et al.* (1995). Trolox was used as the reference compound. In this method, 0.2 ml extract was taken in 10 ml test tube and volume was made up to 1 ml with methanol. To this 3 ml of DPPH solution was added and the content was mixed properly and incubated for 20 minutes at 37°C and reading of resulting oxidized solution was taken at 517 nm against methanol as blank. The percentage of radical scavenging activity (%RSA) or percentage inhibition of DPPH of the extracts of the samples were calculated by the following formula:

$$\% \text{ inhibition} = \frac{(Ac - Ae)}{Ac} X\ 100$$

(Where, Ac is absorbance of control and Ae is absorbance of simple extract)

Determination of total antioxidant capacity by Ferric Reducing Antioxidant Power (FRAP) assay

In this method, 0.2 ml extract was taken in 15 ml test tube and volume was made up to 0.3 ml with distilled wáter. To this, 1.8 ml of FRAP working reagent was added, mixed properly and incubate at 37°C for 10 minutes. After 10 minutes, the reading was taken at 593 nm against blank. Trolox was used as a standard for the calibration curve. The total antioxidant capacity was expressed as milligrams of trolox equivalents (TE) per 100 g sample in fresh weight basis.

Statistical analysis

Results of total polyphenolic compound and total antioxidant capacity were expressed as Mean ± Standard Error. Significant difference among means were determined using analysis of variance (ANOVA). All analyses were performed using Microsoft Excel 2016.

RESULTS AND DISCUSSION

Total antioxidant capacity

The total antioxidant capacity of the selected foods is presented in Table 1. In the present investigation, the effectiveness in the antioxidant capacity of the selected foods were obtained in decreasing order by the *Manilkhara achras* (sapota), *Daucus carota subsp. sativus* (carrot), *Solanum melongena* (brinjal), *Solanum lycopersicum* (tomato), *Raphanus sativus* (radish), *Psidium guajava* (guava), *Solanum tuberosum* (potato), *Cuminum cyminum* (cumin seeds), *Cajanus cajan* L. (red gram), *Coriandrum sativum* (coriander seeds), *Oryza sativa* (rice) and *Capsicum annuum* L. (green chilli) which was correlated positively to the results of FRAP assay. Among the selected foods, the highest total antioxidant capacity (222.68±0.69 mg and 78.46 ±0.32 mg in DPPH and FRAP assays) was found in acidified methanolic extracts of sapota and lowest in green chilli (164.75 ±0.37 mg and 43.31 ±0.12 mg in DPPH and FRAP assays). It was an agreement with study by Sreeramulu *et al*. (2013) and Sidharth Suman and Geetha (2016).

TABLE 1. Total antioxidant capacity of the commonly consumed foods in Tamil Nadu.

Food Items	Total antioxidant capacity (mg TE / 100 g FWB)	
	DPPH Assay	FRAP assay
Rice (*Oryza sativa*)	178.72±0.41	51.59±0.14
Red gram (*Cajanus cajan* L.)	190.22±0.53	60.51±0.21
Brinjal (*Solanum melongena*)	215.28±0.66	66.03±0.23
Radish (*Raphanus sativus*)	206.66±0.58	63.96±0.18
Tomato (*Solanum lycopersicum*)	212.39±0.62	65.18±0.27
Sapota (*Manilkhara achras*)	222.68±0.69	78.46±0.32
Guava (*Psidium guajava*)	201.28±0.46	62.42±0.20
Potato (*Solanum tuberosum)*	199.67±0.51	61.14±0.26
Carrot (*Daucus carota subsp. sativus*)	218.16±0.64	69.29±0.75
Green chilli. (*Capsicum annuum* L)	164.75±0.37	43.31±0.12
Coriander seeds (*Coriandrum sativum*)	189.39±0.42	53.94±0.16
Cumin seeds (*Cuminum cyminum*)	195.96±0.47	61.83±0.24

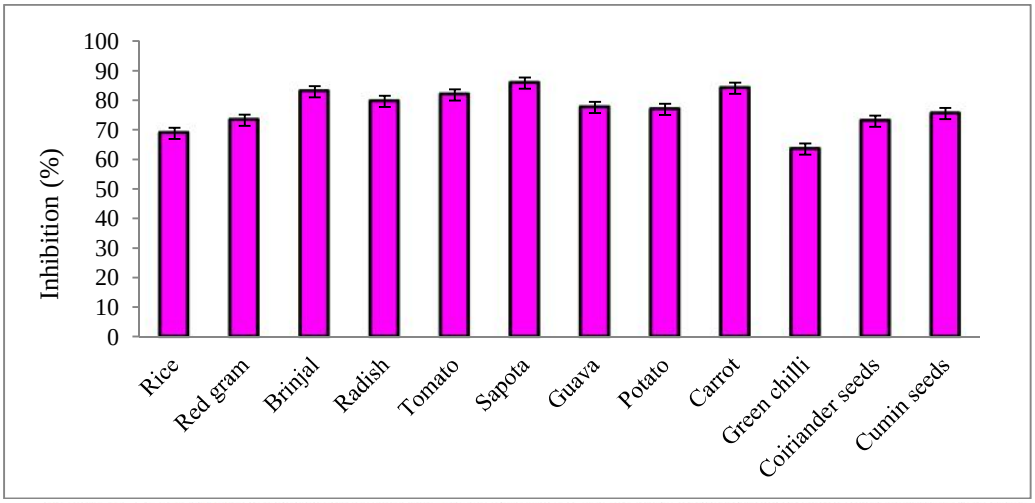

FIGURE 1. Radical scavenging activity (% inhibition) of the commonly consumed foods in Tamil Nadu

Radical scavenging activity in percentage (% RSA)

The results of percentage inhibition of the selected foods are illustrated in Figure 1. The highest efficiency in terms of free radical scavenging activity was found in the acidified methanolic extract of sapota (85.76%), carrot (84.02%), brinjal (82.91%) and tomato (81.80%) while the green chilli (63.45%) and rice (68.83%) showed inhibition percentage lower than 70% which indicates a weak capacity of scavenging DPPH radical. Other foods like radish, guava, potato, cumin seeds, red gram and coriander seeds showed moderate action (70 – 79%). The results of the present study is in confirmation with the findings of Melo *et al.* (2006) who reported that the methanolic extracts of tomato showed high inhibition percentage.

Total polyphenolic content

Polyphenolic compounds are one of the important groups of compounds acting as antioxidants or free radical terminators in plant spices, which are produced by plants as secondary metabolites. The amount of total polyphenolic content (GAE) was found to highest in cumin seeds (195.24 ±1.62 mg GAE / 100g FWB) and coriander seeds (133±1.86 mg GAE / 100g FWB) while all other food samples contained a significant amount of total polyphenolic contents in the range of 2.98 ±0.05 - 52.98 ±0.41 mg / 100 g FWB (Table 2). The present study revealed that the highest total antioxidant capacity of the food samples was not independent of the presence of total polyphenolic content which may be acquired to the presence of other bioactive compounds like flavonoids, flavonols, tannins, vitamin C *etc.*, Ferreira *et al.* (2015) found significant amount of total phenolic content in fresh carrot (12.4 mg GAE / 100 g FWB). In a study carried out by Gacche *et al.* (2010) coriander has exhibited to 220 mg total phenols in rutin hydrate equivalent per hundred gram sample in fresh weight basis.

TABLE 2. Total polyphenolic content of the selected foods

Food Items	Total polyphenolic compound (mg GAE / 100 g FWB)
Rice (*Oryza sativa*)	51.79±0.36
Red gram (*Cajanus cajan* L.)	23.21±0.47
Brinjal (*Solanum melongena*)	02.98±0.05
Radish (*Raphanus sativus*)	10.71±0.11
Tomato (*Solanum lycopersicum*)	16.07±0.14
Sapota (*Manilkhara achras*)	35.72±0.26
Guava (*Psidium guajava*)	12.51±0.12
Potato (*Solanum tuberosum)*	14.88±0.18
Carrot (*Daucus carota subsp. sativus*)	08.93±0.14
Green chilli. (*Capsicum annuum* L)	133.00±1.86
Coriander seeds (*Coriandrum sativum*)	195.24±1.62
Cumin seeds (*Cuminum cyminum*)	

CONCLUSION

The dietary intake of plant foods can be useful in the management of oxidative stress and age related human aliments. Among the selected commonly consumed plant foods, sapota, carrot, brinjal and tomato had the highest amount of total antioxidant capacity and percentage inhibition of radical scavenging activity (% RSA). Whereas the presence of total polyphenolic content was highest in cumin seeds. The study revealed that the commonly consumed plant foods of Tamil Nadu contained significant amount of total polyphenols and total antioxidant capacity which may lower the risk of many degenerative diseases among the people who consumed higher. It was also noted that the total antioxidant capacity of the selected plant foods did not depend on the presence of total polyphenolic content which may be acquired the presence of other bioactive compounds. However further *in vivo* studies are required to investigate the antioxidant potential of individual components and to quantify the same in plant foods.

ACKNOWLEDGEMENTS

The authors are grateful to All India Coordinated Research Project on Home Science (AICRP on Home Science) for financial assistance.

REFERENCES

Bhupathiraju, S. Pan, A. Manson, J.E. Rexrode, K.M. Willett, W. C. and Rimm, E.B. (2013) Quantity and variety in fruit and vegetable intake and risk of coronary heart disease. American Journal of Clinical Nutrition. 98 (6): 1514 – 1523.

Brand – Williams, W. Cuvelier, M.E. and Berset, C.L.W.T. (1995). Use of a free radical method to evaluate antioxidant activity. LWT – Food Science and Technology. 28 (91): 25 – 30.

Casanova, E. Garcia-Mina, J.M and Calvo, M.I. (2008). Antioxidant and antifungal activity of *Verbena officinalis* L. leaves. Plant Foods Human Nutrition. 63: 93 – 97.

Cheung, L.M. Cheung, P.C.K. and Ooi, V.E.C. (2003). Antioxidant activity and total phenolics of edible mushroom extracts. Food Chemistry. 81: 249 – 255.

Faller, A.L.K. and Fialho, E. (2009) The antioxidant capacity and polyphenol content of organic and conventional retail vegetables after domestic cooking. Food Research International. 42: 210 – 215.

Ferreira, V.B. Silva, T.T.C. Couto, S.R.M. and Sabaa srur, A.U. O. (2015) Total phenolic compounds and antioxidant activity of organic vegetables consumed in brazil. Food and Nutrition Sciences. 6: 798 – 804.

Gacche, R.N. Kabaliye, V.K. Dhole, N.A. and Jadhav, A.D. (2010) Antioxidant potential of selected vegetables commonly used in diet in Asian subcontinent. Indian Journal of Natural Products and Resources. 1 (3): 306 – 313.

Jacob, R.A. (1995) The integrated antioxidant system. Nutrition Research. 15: 755-766.

Lobo, V. Patil, A. Phatak, A. and Chandra, N. (2010) Free radicals, antioxidants and functional foods: Impact on human health. Pharmacognosy Reviews. 4 (8): 118 – 126.

Melo, E.A. Maciel, M.I.S. Lima, V.L.A.G. Leal, F.L.L. Caetano, A.C.S. and Nascimento, R.J. (2006) Capacidade antioxidante de horralicas usualmente consumidas. Ciencia Technologia de Alimentos. 26: 639- 644.

Rochfort, S. and Panozzo, J. (2007) Phytochemicals for health, the role of pulses. Journal of Agricultural and Food Chemistry. 55 (20): 7981 – 7994.

Sidharth Suman and Geetha, K. (2016) Effect of household processing on total antioxidant capacity and total phenolic content in selected green leafy vegetables. Ph.D Thesis, Department of Food Science and Nutrition, College of Agricultural, UAS, GKVK, Banglore.

Singleton, V.L. Orthofer, R. and Lamuela – Raventos, R.M. (1999) Analysis of total phenols and other oxidation substrates and antioxidant by means of Folin – Ciocalteu reagent. Methods of Enzymology. 299: 152 – 158.

Sreeramulu, D. Reddy, C.V.K. Chauhan, A. Balakrishna, N. and Raghunath, M. (2013) Natural antioxidant activity of commonly consumed plant foods in India: Effect of domestic processing. Oxidative Medicine and Cellular Longevity. Article ID 369479, 12 Pages.

Zhang, D. and Hamauzu, Y. (2004) Phenolics, ascorbic acid, carotenoids and antioxidant activity of broccoli and their changes during conventional and microwave cooking. Food Chemistry. 88: 503 – 509.