Nutritional importance of some dry fruits based on their phenolic acids

P Tiwari, A Singh, U Singh, S Maurya, M Singh

Citation

P Tiwari, A Singh, U Singh, S Maurya, M Singh. *Nutritional importance of some dry fruits based on their phenolic acids.* The Internet Journal of Nutrition and Wellness. 2008 Volume 8 Number 1.

Abstract

Dry fruits are an important group of agricultural and confectionary commodities being used since human civilizations all over the world because flavor, taste and nutritional requirements. Healing of various physical, emotional and psychological problems by dry fruits has been reported in ancient traditional medical system (Ayurvda). High performance liquid chromatographic analysis was performed to estimate phenolic acids in eleven dry fruits viz., Date palm (Phoenix reclinata) Cardamom (Ellettaria cardamomum), Almond (Terminalia catappa), Coconut (Cocas micifera), Groundnut (Arachis hypogea), Kishmish (Vitis venifera), Cashewnut (Anacardium occidentale), Pista (Pistachia vera), Makhana (Euryale ferox), Chiraungi (Beuchanania latifoli) and resins of higher plants commonly used in India. Among several peaks of phenolic acids, only eight could be identified viz., tannic, gallic, caffeic, vanillic, O-coumaric, ferulic, cinnamic and salicylic acids on the basis of their retention time with standard compounds and co-chromatography. Some phenolic acids were present in rich amount in some of the dry fruits. Tannic, ferulic and salicylic acids were found in high amount in Pista. Gallic and vanillic acids were maximum in chiraungi, while caffeic and O-coumaric acids were righ in resin and almond, respectively. Cinnamic acid was maximum in groundnut. The role of these phenolic acids has been discussed in the light of their several nutritional related to human health.

INTRODUCTION

The dry fruits are a rich pool of biochemical ingredients that add flavour, taste and nutritients to food. The curative power of plant-based natural medicines has been relied by nearly two-third of the world population for the reason of their knowledge, economics, affordability, availability or their belief in safe traditional system of medicines (Indian medicine-Ayurveda). Dry fruits, condiments and spices have been used by many civilizations as traditional methods to boost energy, improve the nervous system, aid digestion, relieve headache due to stress or cold and against many other diseases (Table 1) [123] .

With the development of modern isolation, purification and identification techniques, many bioactive natural products have been isolated from a number of dry fruits [45] . These include alpha-pinene, sabinene, limonene, cineole, para-cymene linalyl acetate, alpha-terpineole acetate and nerol. Besides these, dry-fruits contain enzymes that detoxify carcinogens, inhibit cholesterol synthesis, block estrogen, lower blood pressure and prevent blood clotting [67] . Keeping this in view a detailed analysis of phenolic acids in some dry fruits { Date palm (Phoenix reclinata) Cardamom (Ellettaria cardamomum), Almond (Terminalia catappa), Coconut (Cocas micifera), Groundnut (Arachis hypogea), Kishmish (Vitis venifera), Cashewnut (Anacardium occidentale), Pista (Pistachia vera), Makhana (Euryale ferox), Chiraungi (Beuchanania latifoli) and resin of higher plants} has been conducted by High Performance Liquid Chromatography (HPLC) and the results are presented here.

MATERIALS AND METHODS

EXTRACTION OF PHENOLIC ACIDS

Eleven dry-fruits (Chhuara, Cardamum, Chiraunji, Pista, Cashewnut, Kishmish, Almond, Resin, Groundnut, Coconut and Makhana) were purchased from authentic dry-fruit shops. One gram of each dry-fruit was weighed and powdered in a pestle-mortar followed by suspending fine crushed samples in 5 ml ethanol-water (80:20, v/v) in glass tubes. The suspension was subjected to ultra-sonication by Branson sonifiers 450 (Branson Ultrasonic Corps, Danury CT, USA) for 15 min at 4 ° C followed by centrifugation at 10,000 rpm for 15 min at room temperature. The supernatant of each sample was collected and the residue was re-extracted twice. Supernatant from each extraction was pooled together and added with charcoal to remove pigments prior to solvent evaporation under vacuum (Buchi type Rotavapor). Dried samples were resuspended in 1.0 ml

HPLC grade methanol by vortexing and stored at 4 ° C for further analysis by HPLC. The amount of phenolic acids is expressed in terms of (g/g) dry weight of the dry-fruits.

HPLC ANALYSIS

High performance liquid chromatography (HPLC) of the sample was performed [8]. The HPLC system (Shimadzu Corporation, Kyoto, Japan) was equipped with two Shimadzu LC-10 ATVP reciprocating pumps, a variable Shimadzu SPD-10 AVP UV-VIS detector and Rheodyne model 7725 in factor with a loop size of 20 l. Reverse phase chromatographic analysis was carried out using a C-18 reverse phase coloum (250 x 4.6 mm inner diameter, particle size 5 m, Luna 5 C-18 (2), Phenomenex, Torrance, USA) at 25 ° C under isocratic condition included an injection volume of 5 micro liters, mobile-phase methanol: 0.4 % acetic acid (80:20 v/v), flow rate 1 ml / min, and detection at 290 nm. Samples were filtered through membrane filter (pore size 0.45 micron meter, E-Merck, Germany) prior to injection in sample loop. Tannic, gallic, salicylic, ferulic, cinnamic, vanillic, O-coumaric and caffeic acids were used as internal and external standards. Phenolic compound in the samples of dry-fruits were identified by comparing the retention time (Rt) of individual standard. Concentrations were calculated by comparing peak areas of reference compounds with those in sample run under the same elution conditions.

QUANTITATIVE ESTIMATION: PREPARATION OF STANDARD CURVES

Phenolic acid standards were accurately weighted (1 mg/ml) and dissolved in HPLC grade methanol. A range of concentrations form 1 g/ml to 10 g/ml was prepared by serial dilution. Quantitative HPLC was conducted using reversed phase C-18 column under similar running conditions as has been described for the analysis of samples. The analysis was carried out in triplicate and the detection was monitored at 290 nm. Calibration curves were plotted showing a linear correlation between concentration and peak areas for phenolic acids separately.

RESULTS

HPLC analysis of phenolic of dry-fruits showed presence of several phenolic acids (Table 2). Maximum amount of tannic acid (43.51 g/g) was present in pista followed by chhuhara (41.13), almond (7.19), cashew nut (4.36) and resin (4.31) while in the remaining dry fruits the amount of phenolic acids was under detectable level. Gallic acid was maximum in chiranuji (16.03) followed by kishmish (14.97), groundnut (14.05), coconut (11.64), cashew nut (8.62), cardamom (6.41) and makhana (3.92) while in other preparations it was under detectable level. Similarly, caffeic acid was maximum in resin of higher plants (28.81) followed by cashew nut (12.04 g), kishmish (9.88) and coconut (3.96) while in chiraunji it was found in traces. Vanillic acid was maximum in cardamom (3.12) followed by chiraunji (1.83), chhuhara (1.16) while in almond (0.52) it was present in traces. O-coumaric acid was maximum in almond (8.54) followed by cashew nut (1.42), while in other dry fruits such as chhuhara (0.76), cardamom (0.63), unroasted cashewnut (0.11), makhana (0.14), chiraunji (0.28), resin (0.03) and ash of date (0.01) it was present in traces. Ferulic acid was maximum in pista (11.10) followed by ground nut (1.34) while in other dry fruits such as almond (0.77), cardamom (0.65) makhana (0.41), resin (0.24) and ash of date (0.01) it was found in traces. Cinnamic acid was maximum in ground nut (5.24) followed by almond (1.65) while in cashew nut (0.34), cardamom (0.12), makhana (0.05) and resins of higher plants (0.03) was in traces. Salicylic acid was maximum in pista (284.02) followed by cashew nut (14.36) while in others [almond (0.78), makhana (0.60), chiraunji (0.52), cashew nut (0.47), kishmish (0.30), cardamom (0.27) and cashew nut (0.19 g/g) was in traces.

Figure 1

Table 1. Dry-fruits used in culinary art and their pharmacological properties

Sample No.	Phenolic Acid (µg/g dry wt)							
	Tannic Acid	Gallic acid	Caffeic acid	Vanillic Acid	O-Coumaric acid	Ferulic Acid	Cinnamic acid	Salicylic acid
1	41.13	UDL	UDL	1.16	0.76	UDL	UDL	14.36
2	UDL	6.41	UDL	3.11	0.63	0.65	0.12	0.27
3	UDL	16.03	0.06	1.83	0.27	UDL	UDL	0.52
4	43.51	UDL	UDL	UDL	UDL	11.10	UDL	284.02
5	4.36	UDL	12.04	UDL	1.42	UDL	0.34	0.19
6	UDL	14.97	9.88	UDL	UDL	UDL	UDL	0.30
7	7.19	UDL	UDL	0.52	8.54	0.77	1.65	0.78
8	4.31	UDL	28.81	UDL	0.03	0.24	0.03	UDL
9	UDL	8.62	UDL	UDL	0.11	UDL	0.01	0.47
10	UDL	14.05	UDL	UDL	UDL	1.34	5.24	UDL
11	UDL	11.64	3.962	UDL	UDL	UDL	UDL	UDL
12	UDL	3.92	UDL	UDL	0.14	0.41	0.05	0.60

UDL = Under Detectable Level

Figure 2

Table 2. Phenolic acids in different of dry fruits (g/g dry wt)

General Name	Botanical name	Part (s) used	Bioactive ingredients	Household use	Medicinal use
Cashewnut	*Anacardium occidentale*	Fruit, pulp, seed, kernal, resin, roiot, bark tincture	Anacardic acid with 15 carbon unsaturated side chain, arginine, gumarabic-gum, uyellow-oleaginous liquid cardole	Edible, oil in soap industries	Supresses cancer, tumors, purgative, high protein value, emollient, antidiarrhoel, reduces blood pressure
Groundnut	*Arachis hypogea*	Seed, husks, nuts	Protein, phytosterol, reveratrol, beta-sitosterol	Edible, fodder, oil, fertilizer, lubricants, illumimants	48% protein rich, 600 caloric value latagogue, emollient
Chiraungi	*Beuchanania latifoli*	Kernal, seed, leaves, wood, bark, gum	Tannin	Edible, fodder, oil, domestic articles	Antidiarrhoeal, Tannin, muscle strengthing (oil)
Coconut	*Cocas micifera*	Fruit, kernels	Calcium, coconin, medium chain fatty acids (MAFA), try-ptophan, leutin, arthocyanidine, catechine, epicatechin, quercetin, proanthocyandin e,tyrosi-n, isoleucine, leucine	Edible, hair oil, message, fodder, ropes, sweet meat	Aphrodisiac, diuretic, tonic restroretive, resistant to cold, anticolitic, stomachic, reduces heart bum, laxative
Cardamom	*Ellettaria cardamomum*	Seed, fruits	α-pinene, sabinene, limonene, cineole, para cymene, β-terpineole, nerole, nerolidol, α-terpeneole, lynalyl acetate	Edible, oil, flavouring dishes	Aromatic, stimulant, carminative, diuretic
Pista	*Pistachia vera*	Seed, kernal, wood	Folate, linplenic and linolic acids, omega-3-fattyacids, Zn, K, Mg, Fe, Se	Edible, fodder, falvour sweets, message oil, varnish, dyeing, fuel, fine articles	Cell formation, preventing birth defects, reduces heart diseases, digestive, sedative, nutritive, high calorific value, applied on swellings
Almond	*Terminalia catappa*	Fruit, seed, bark, leaves, tree gum	Vitamin E	Edible, cosmetics, dyeing cotton silk to grey, silk worm feed on tree gum, culinary use	Sudorific, applied in rheumatic pains, ointment for ulcer, mild cardico tonic, diuretic, antidysentery, adhesive
Chhuhara	*Phoenix reclinata*	Fruit		Edible	
Makhana	*Euryale ferox*	Seed	Starch, Protein	Edible, fodder, domestic articles	

Figure 3

Table 3

Sample No.	Details
1	Chhuhara (date palm)
2	Cardamom
3	Chiraunji
4	Pista
5	Cashewnut (Roasted)
6	Kishmish
7	Almond
8	Resins of higher plants
9	Cashewnut
10	Groundnut
11	Coconut
12	Makhana

DISCUSSION

Besides adding nutrients and taste to the food, dry-fruits also possess valuable medicinal properties. Most of the dry-fruits under investigations are traditionally known to have pronounced effect on human health. Phenolics constitute an important group of natural products, contributing significantly to the medicinal value of a number of plants including dry-fruits [9].

Gallic acid and its ethyle ester are the most potent scavengers of super oxide radical [10]. Ellagic acid, a dimmer of gallic acid, is a potent antioxidant (molar antioxidant activity in terms of Trolox Equivalent Antioxidant Capacity: TEAR = 3.0), the antioxidant activity of which is three times that of vitamin C or vitamin E [11]. Derivatives of gallic acid with a number of free hydroxyl groups having free radical scavenging property are also powerful antioxidants and possess antibacterial activity against gram-negative and gram positive bacteria [12]. Gallic acid has anti-inflammatory and cyotoxic property against all cancer cell lines studied in vitro [13]. It also possesses hepatoprotective effects at fairly high concentrations corresponding to its level in plasma that might only be achieved by dietary means [14].

Caffeic acid is the most prominent cinnamate that provides protection against genotoxic agents. It has been demonstrated to possess anti-carcinogenic properties in experimental animals [15]. It has also been reported that caffeic acid in the form of an extract of the artichoke (rich in chlorogenic and caffeic acids) can be used to lower serum cholesterol level in human beings [1617]. Cinnamic and hydroxycinnamic acids are rather more abundant and diverse groups of phenolics with higher dietary intake [18]. In terms of

dietary load, total cinnamic acid intake in different populations ranges up to 1000 mg/day. Cinnamic acid and analogs provide natural protection against infections caused by pathogenic microorganisms. 4- propoxycinnamic acid residue shows antimalarial activity [19] . Ferulic acid is present as natural dietary supplements with pronounced anti-inflammatory and antioxidant activity and is a pharmacological agent used as photoprotectants in skin lotions [20] . Similarly, ferulic aicd is known to possess antifungal and antimicrobial properties [21] .

Very little work has been done on the phenolic acid contents of dry fruits as only anacardic acid, cardanols and cardols have been reported in A. occidentale [2223] . The root mucilage of Arachis hypogea contains 4 methoxycinnamic acid [[[24.]]] The total phenolic acids has been estimated in Pistachia vera [25] . The solvent and aqueous extract of Terminalia catappa leaves shown strong antioxidant activity due to presence of several phenolic acids [26] . Therefore the information regarding the presence of several phenolic acids in some dry fruits under study forms the basis of the nutritional value being thought since time immemorial by human beings. This is completely new information to science

References

1. Aydin, S and Ozean, M. 2002. Some phsio mechanic properties of terebinth (Pistacia terbinthus L.) fruits. J. Food Eng. 53:97-101.
2. Perricone, N.V. 2006. Fruit and nut for the brain. http://starlight2 wordpress.com. Fruit-nut-for-the-brain. 11:3
3. Cannella, C. and Dernini, S. Walnut: Insight and nutritional value. V International walnut symposium www.actahort.org/members/showpdf? Booknrarnr. ISHS. Acta Horticulture 705: pp.80.
4. The Wealth of India. Raw materials. 1962. Council of Scientific and Industrial Research, CSIR India.
5. Chadha, K. L. 2001. Handbook of Horticulture. Published by Directorate of Information and Publication of Agriculture. ICAR, Krishi Anusandhan Bhavan (PUSA), New Delhi. pp. 688-726.
6. Chrungoo N., Koul, K. K. and Farooq, S. 1986. Phenolic compounds in corms of saffron (Crocus sativus L.) during bud development. Pl. Phys. Biochem. 3 : 78-81.
7. Harborne, J. B. 1989. Methods in Plant Biochemistry: Plant phenolics. Academic Press, London.
8. Singh U P, Sharma B K, Singh D P, Bahadur A. 2002. Plant growth-promoting rhizobacteria-mediated induction of phenols in pea (Pisum sativum) following infection with Erysiphe pisi. Curr. Microbiol. 44: 396-400.
9. Miller, N. J., Ruiz, B. and Larrea, M. 2002. Flavonoids and other plant phenols in the diet: Their significance as antioxidant. J. Nutri Envt. Med. 12:39-51.
10. Fernandes, E. R., Borges, M. F., Silva, F. A., Carvalho, F. D. and Bastos, M. L. 1998. Evaluation of superoxide scavenging activity of cinnamic acid derivatives. 2nd International Electronic Conference on Synthetic Organic Chemistry (ecsoc-2).
11. Donovan, J. L., Meyer, A. S. and Waterhouse, A. L.1998. Phenolic composition and antioxidant activity of prunes and prune juice (Prunus domestica). J. Agri. Food Chem. 46: 1247-1252.
12. Lyon, G. D. and Mcgill, F. M. 1988. Inhibition of growth of Erwinia cartovora in vitro by phenolics. Pot. Res. 31 : 461-467.
13. Inoue, M. 1995. Gallic acid found in grapes seeds kills cancer cells. Biol. Pharma. Bull. 18:1526-1530.
14. Binutu, O. A. and Cordel, G. A. 2000. Gallic acid derivatives from Mezoeuron benthamiamum leaves. Pharm. Bio. 38 : 286-294.
15. Ravn, H., Andary, C., Kovacs, G. and Molgaard, P. 1989. Caffeic acid as in vitro inhibitors of plant pathogenic bacteria and fungi. Biochem System and Ecpl. 17 : 174-184.
16. Bors, W., Michel, C. and Stettmaier, K. 2001. Structure-activity relationships governing antioxidant capacities of plant polyphenols. Methods Enzymology 335 : 166-180.
17. Clifford, M.N. and Scalalbert, A. 2000. Elligitanius - nature, occurrence and dietary burden. J. Sci. Food Agric. 80:1118-1125.
18. Champbel, A., Viegas, C. A. and Sa-correia, I. 1999. Effect of cinnamic acid on the growth and on plasma membrane H+ -ATPase activity of Saccharomyces cerevisiae. Inter. J. Food Microbiol. 50: 173-179.
19. Wiesner, J., Mitsch, A., Wissner, P., Jomaa, H. and Schlitzer, M. 2001. Structure-m activity relationships of novel anti0-malarial agents. Part 2: Cinnamic acid derivatives. Bioorg. Med. Chem. Lett. 11: 423-424.
20. Graf, E. 1992.Antioxidant potential of ferulic acid. Free Rad. Biol. Med. 13 : 435-448.
21. Mehrotra, R. S. 1997. 'Plant Pathology'. Pub. Tata - McGrew Hill Publishing Co. Ltd. New Delhi. pp. 544.
22. Trevisan M. T., Pfundstein, B., Haubner, R., Wurtele, G., Spiegelhalder, B., Bartsch, H and Owen, R. W. 2006. Characterization of alkyl phenols in cashew (Anacardium occidenrale) product and assay of their antioxidant capacity. Food Chem. Toxicol. 44:188-197.
23. Paramashivappa R., Kumar, P. P., Vithayathil, P. J. and Rao, A. S. 2001. Novel method for isolation of major phenolic constituents from cashew (Anacardium occidentale) nut shell liquid. J. Agric. Food Chem. 49: 2548-2551.
24. Sobolov, V. S., Horn, B. W., Potter T. L. Deyrup, S. T. and Gloer, J. B. 2006. Production of stilbenoids and phenolic acids by peanut plant at early stages of growth. J. Agric. Food Chem. 54: 3505-3511.
25. Goli, A. H., Barzegar, M and Ali Sahari, M. 2005. Antioxidant activity and total phenolic compounds of Pistachia vera hull extracts. Food Chem. 92: 521-525.
26. Charng-Charng, Chyau, Shu-Yao-Tsai, Tei-Tzu Ko and Jeng-Leun Mau. 2002. Antioxidant properties of solvent extracts from Terminalia catappa leaves. Food Chem. 78: 483-488.

Author Information

Preeti Tiwari
V.B.S. Purvanchal University, Jaunpur

Amitabh Singh
Ganesh Dham Colony, Newada, Sunderpur, Varanasi

UP Singh
Ganesh Dham Colony, Newada, Sunderpur, Varanasi

S. Maurya
Department of Mycology and Plant Pathology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi

Mandavi Singh
Department of Anatomy, Institute of Medical Sciences, Banaras Hindu University, Varanasi-221005, India