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Screening of Potential Sources of Tannin and Its Therapeutic Application

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Abstract**—**Tannins are a unique category of plant phytochemicals especially in terms of their vast potential health-benefiting properties. Researchers have described the capacity of tannins to enhance glucose uptake and inhibit adipogenesis, thus being potential drugs for the treatment of non-insulin dependent diabetes mellitus. Thus, the present research was conducted to find out tannin content of food products. The percentage of tannin in various analyzed sources ranged from 0.0 to 108.53%; highest in *kathaa* and lowest in *ker* and *mango bark*. The percentage of tannins present in the plants, however, varies. Numerous studies have confirmed that the naturally occurring polyphenols are key factor for the beneficial effects of the herbal medicines. Isolation and identification of active constituents from plants, preparation of standardized dose & dosage regimen can play a significant role in improving the hypoglycaemic action.

Keywords**—**Tannins, Diabetes, Polyphenols, Antioxidants, Hypoglycemia.

I. Introduction

POLYPHENOLS are among a wide variety of active phytochemicals present in human diet. These are naturally occurring compounds found largely in the fruits, vegetables, cereals and beverages [1]. These molecules are secondary metabolites of plants and are generally involved in defense against ultraviolet radiation or aggression by pathogens [2]. In food, polyphenols may contribute to bitterness, astringency, color, flavor, odor and oxidative stability. Almost all polyphenols exhibit antioxidant property and this forms the basis for their purported beneficial health effects associated with conditions such as cancer, cardiovascular diseases, neurodegenerative diseases and aging [3]. Plant tannins, one of the major groups of antioxidant polyphenols found in food and beverages, have attracted a lot of attention in recent years because of their multifunctional properties beneficial to human health. Tannins are thought to interfere in the pathogenesis of degenerative diseases *via* several mechanisms: antioxidative, antiviral, antitumour, antithrombogenic, and anti-inflammatory. For e.g. certain tannins can selectively inhibit HIV replication [4]. Some monomers also lower blood glucose levels and have insulin-like effects. Tannins are either galloyl esters and their derivatives, in which galloyl moieties or their derivatives are attached to a variety of polyol-, catechin- and triterpenoid cores (gallotannins, ellagitannins and complex tannins), or they are oligomeric and polymeric proanthocyanidins that can possess different interflavanyl coupling and substitution patterns (condensed tannins) [5].

Consumption of tannin-containing food products varies from region to region. It has been reported that tannin consumption in India ranges from 1.5- 2.5 g/day, depending on the region, and about 1g/day within the USA [6]. Though tannin has undesirable effect on the body but in the long term it has beneficial properties also which provide a promising area of research. Thus, the study was conducted to estimate tannin content of some food products found in various regions of India.

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II. Materials and Methods

A. Sample Selection

In the present study, the plants having tannin proportion were identified on the basis of available literature. A list of plant sources containing tannin was prepared. Out of those, 20 sources were selected on the basis of easy and local availability. Selected 20 sources were procured from local vicinity of Udaipur, Rajasthan. Estimation of tannin was performed by titrating the material with standard potassium permanganate solution.

B. Sample Preparation

3g of the studied food product was extracted with distilled deionised water (dd H2O) into 250ml volumetric flask during 4 hours at room temperature and then the sample was filtered.

C. Tannin Estimation

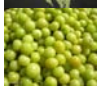
The analyses of tannin content in food products were performed according to the International Pharmacopoeia and AOAC method, after some modifications [7], [8]. 25ml of infusion were measured into 1L conical flask, then 25ml of indigo solution and 750ml distill deionised water was added. 0.1 N aqueous solution of potassium permanganate was used for titration until the blue coloured solution changes to green colour. Then few drops at time until solution becomes golden yellow were added. Standard solution of Indigo carmine is prepared as follows- 6gm Indigo carmine was dissolved in 500ml of distill deionised water by heating, after cooling 50ml of 95-97% sulphuric acid was added, the solution was diluted to 1L and then filtered. The blank tests by titration of a mixture of 25ml Indigo carmine solution and 750ml dd H_2O were carried out. All samples were analyzed in duplicates.

D. Calculations

The tannin content (T %) in the sample is calculated as:

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TABLE I
THERAPEUTIC APPLICATIONS AND IMAGES OF SELECTED SOURCES

S. No.	Common & Botanical names	Uses	Images
1	Majuphal *(Quercus infectoria)*	Astringent	
2	Babul *(Acacia Arabica)*	Astringent	
3	Amla *(Emblica officinalis)*	Antioxidant, hypocholestrolemic effect. It also increases HDL cholesterol level.	
4	Red Supari *(Areca catechu)*	Improved concentration, relaxation, aphrodisiac properties, postprandial digestant and increased stamina.	
5	Supari *(Areca catechu)*	Stimulates salivary, bronchial, intestinal glands & vagus nerve	
6	Dates/ Chuhara *(Phoenix sylvestris)*	Treatment of diarrhea and genito-urinary ailments, gonorrhea, edema, liver and abdominal troubles.	
7	Munakka *(Vitis vinifera)*	Antioxidant	
8	Black Pepper/ Kali mirch *(Piper nigrum)*	Carminative, Antiperiodic	
9	Raisins/ Kismis *(Vitis vinifera)*	Heart and blood vessels, varicose veins, hemorrhoids, atherosclerosis, swelling after injury/surgery, heart attack, stroke.	
10	Harir *(Terminalia chebula)*	Detoxificant	
11	Badi Ilayachi (*Amomum xanthiodes)*	Mouth freshner, appetizer, digestive and as an antispasmodic, control nausea, vomiting, thirst, indigestion	
12	Sangiri (*Prosopis cineraria)*	Cooling anthelmintic; tonic, cures leprosy, dysentery, asthma, bronchitis, leucoderma, piles and tremors of the muscles, anti-inflammatory properties.	
13	Ker *(Cappari deciduas)*	Asthma, vomiting, hemorrhoids, intermittent fevers, arthritis, flatulence, constipation, gout intestinal worms, cardiac debility, amenorrhea and dysmenorrheal.	
14	Cinnamon/ Dalchini *(Cinnamomum zeylanicum)*	Lower LDL cholesterol. anti-oxidant activity, Fights Cancer, Anti-Clotting Actions, Anti-Microbial Activity, Blood Sugar Control	
15	Mango bark *(Mangifera indica)*	Astringent	
16	Mango seeds *(Mangifera indica)*	Stop bleeding, juice from the seeds claims to offer relief from diarrhea.	
17	Cumin seeds/ Jeera *(Cuminum cyminum)*	Carminative, Stimulant	
18	Kathaa *(Acacia catechu)*	Antipyretic, antidiarrhoeal, hypoglycaemic and hepatoprotective properties.	
19	Turmeric/ Haldi *(Curcuma longa)*	Anti-inglammatory Heaptitis, Gall bladder tonic, Indigestion	
20	Aloe vera/ Guarpatha (*Aloe vera*)	Purgative, Anticancer, Antibacterial Antiviral,	

$$T\ (\%) = \frac{(V - V0) \times 0.004157 \times 250 \times 100}{g \times 25}$$

where, V is the volume of 0.1 N aqueous solution of $KMnO_4$ for the titration of sample, V_0 – volume of 0.1 N aqueous solution of $KMnO_4$ for the titration of blank sample, ml; 0.004157- tannin equivalent in 1ml of 0.1 N Aqueous solution of $KMnO_4$; g-mass of the sample taken for analysis, g; 250 - volume of volumetric flask, ml; 100 – percent, %.

III. RESULTS AND DISCUSSION

Tannins are polyphenols that are obtained from various parts of different plants belonging to multiple species and found almost in all plants and in all climates all over the world. The percentage of tannins present in the plants, however, varies. Foods have many components other than traditional nutrients, e.g., protein, amino acids, vitamins, minerals, etc., many of which have been associated with biological activities consistent with reduced risk of several chronic diseases and other maladies [9]-[11]. Numerous studies have confirmed that the naturally occurring polyphenols are key factor for the beneficial effects of the herbal medicines. Some of the therapeutic applications of selected foods items are given in Table I [12].

Other than these therapeutic uses the above listed sources may also serve an important role in the management of diabetes due to their tannin content. Phenolic compounds have described as antihyperglycemic agents in diabetic rats [13]. They have been observed to enhance the glucose uptake through mediators of the insulin-signaling pathways, such as PI3K (Phosphoinositide 3-Kinase) and p38 MAPK (Mitogen-Activated Protein Kinase) activation and GLUT-4 translocation [14].

Table II shows the plants included in the study listed according to their parts used, common and botanical names and total tannin content in decreasing order with moisture and tannin content on dry matter basis. Different parts of the plants taken for analysis of the tannin content were categorized as fruit/pods, bark, seeds, heartwood, root and gel. In general, tannins are more abundant in the parts of the plant that are most «valuable» to it, e.g., new leaves and flowers (which are more likely to be eaten by herbivores) [15]-[17]. Numerous reports illustrate the effects of environmental and seasonal factors as well as of phonological development. Very briefly, high temperatures, water stress, extreme light intensities and poor soil quality increase the tannin content of plants [18]. Some of these plants and herbs are very commonly consumed in Rajasthan. The frequently used ones include babul, amla, supari, red supari, dates, munakka, raisins, ker, sangiri and mango seeds while some of them are used in daily cooking as spices such as black pepper, badi ilayachi, cinnamon, cumin seeds and turmeric and rest are used as medicinal herbs like majuphal, harir, mango bark, kathaa and aloe vera.

Almost all analyzed sources contain tannins except Ker and Mango bark. The percentage of tannin in various analyzed sources ranged from 0.0 to 108.53%; highest in kathaa and lowest in ker and mango bark. Majuphal (106.24 mg/g),

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Kathaa (108.53 mg/g), Babul (72.74 mg/g), Amla (41.57 mg/g) and Red supari (15.24 mg/g) have been found to be very high in tannin content (Table II). However, it should be noted that it is difficult to compare the total tannin content with plants found in the literature, this is due to different method of analysis, maturity stage of the plants, the plant cultivars and the plant part used for the analysis [19].

TABLE II
TOTAL TANNIN CONTENT OF ANALYZED SOURCES

S. No	Plant Parts Used	Common & Botanical Names	Moisture Content	Total Tannin (mg/g)	Dry Basis
1	Fruit/Pods/Galls	Majuphal *(Quercus infectoria)*	8.42	106.24	108.6
		Babul *(Acacia Arabica)*	1.58	72.74	73.9
		Amla *(Emblica officinalis)*	6.33	41.57	44.37
		Red Supari *(Areca catechu)*	3.51	15.24	15.79
		Supari *(Areca catechu)*	5.05	2.32	2.44
		Dates/ Chuhara *(Phoenix sylvestris)*	5.58	2.32	2.47
		Munakka *(Vitis vinifera)*	0.09	2.32	2.32
		Black Pepper/ Kali mirch *(Piper nigrum)*	6.68	1.14	1.22
		Raisins/ Kismis *(Vitis vinifera)*	0.09	1.14	1.14
		Harir *(Terminalia chebula)*	7.20	1.38	1.48
		Badi Ilayachi (*Amomum xanthiodes)*	7.96	1.38	1.49
		Sangiri (*Prosopis cineraria)*	4.02	1.38	1.43
		Ker *(Cappari deciduas)*	2.88	0.0	0.0
2	Bark	Cinnamon/ Dalchini *(Cinnamomum zeylanicum)*	2.50	3.46	3.54
		Mango bark *(Mangifera indica)*	3.40	0.0	0.0
3	Seed	Mango seeds *(Mangifera indica)*	5.89	3.46	3.67
		Cumin seeds/ Jeera *(Cuminum cyminum)*	4.26	2.32	2.42
4	Heartwood	Kathaa *(Acacia catechu)*	12.64	108.53	124.23
5	Root	Turmeric/ Haldi *(Curcuma longa)*	6.96	1.14	1.22
6	Gel	Aloe vera/ Guarpatha (*Aloe vera*)	7.50	1.38	1.49

There are various evidences which suggest that the cellular effects of phenolic compounds may be mediated by their interaction with specific proteins that are central to intracellular signalling cascades [20]. In fact, the structure of flavonoids favours their binding to the ATP binding site of a large number of proteins. Previous studies have shown that phenolic compounds can interact such components of signalling pathways as protein kinases [*e.g.* phosphatidylinositol 3-kinase (PI3K), Akt/PKB, tyrosine kinase C (PKC), and MAP kinases] [21]-[24]. Therefore, the effect of the flavonoids can be achieved by modulating the phosphorylation state of target molecules (which, among other effects, can result in the modulation of the gene expression) and, in consequence, inhibiting or stimulating pathways/mechanisms that affect the cellular function. Therefore, this modulation can have a beneficial effect on such pathologies as cancer, proliferative diseases and inflammation [25].

The implication of food tannins on human health is a public concern, but it has preventive benefits to health also. They have been considered to be cardio-protective, anti-inflammatory, anti-carcinogenic and anti-mutagenic, among others. These protective effects are related to their capacity to: (a) act as free radical scavengers; (b) activate antioxidant enzymes [26]. The protective properties of these compounds mean that it is important to study the principal mechanisms of action of selected polyphenols. Furthermore, advances in this research may lead to the development of nutritional products (*i.e.* food supplements) and semisynthetic analogs that retain substantial protective capacity but produce minimal adverse side effects.

IV. CONCLUSION

Phenolic compounds and flavonoids are a unique category of plant phytochemicals especially in terms of their vast potential health-benefiting properties. Botanical products can improve glucose metabolism and the overall condition of individuals with diabetes not only by hypoglycemic effects but also by improving lipid metabolism, antioxidant status, and capillary function. Taking natural herbs for diabetes treatment can lower blood sugar and reduce the effects of diabetes. Plants hold definite promises in the management of Diabetes mellitus. Isolation and identification of active constituents from these plants, preparation of standardized dose & dosage regimen can play a significant role in improving the hypoglycaemic action. Herbal supplements for diabetes can be part of a treatment that focuses on nutrition, exercise and monitoring blood glucose levels.

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