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Tannin Contents of Selected Plants Used in Jordan

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ABSTRACT

This study aimed at measuring the tannin contents of different plant species that are traditionally used in the Jordanian diet. Thirty nine selected plants belonging to 21 families and 37 genera were analyzed in this study. Tannin contents had not been determined in many of these species. Fresh samples were oven-dried and their tannin contents were chemically determined using Folin-Denis reagent method. The absorbance was measured by spectrophotometry at 760-nm wavelength and tannin content was calculated using a tannin-standard curve. Results showed that tannin contents of the analyzed species were highly variable, ranging from 25 mg/kg in plums and verbena to 42961 mg/kg in rosemary (on dry matter basis). It is therefore expected that due to variability in tannin content, different nutrition-health effects may result, a matter which requires other studies to clarify these effects.

Keywords*:* Tannins, Plants, Jordan.

INTRODUCTION

Tannins are a group of water-soluble polyphenols of intermediate to high molecular weight. Tannins are highly hydroxylated molecules and can form insoluble complexes with carbohydrates, proteins and digestive enzymes, thereby reducing food digestibility. They can also bind cellulose and many mineral elements (Santos-Buelga and Scalbert, 2000; Bravo, 1998; Butler, 1989).

Tannins are two major types, nonhydrolyzable or condensed (catechins) and hydrolysable tannins (or tannic acid). Condensed tannins are widely distributed in vegetables, fruits, cocoa and certain grains (Al-Mamary *et al*., 2001; Chung *et al*., 1998b). On the other hand, hydrolysable tannins are present only in trace amounts in commonly consumed foods (Chung *et al*., 1998b). Tannins are abundant in many plant parts including the fruit, cortex, leaves, roots and other parts (Chung *et al*., 1998b). In human diets, tannins are present in plant's beverages, legumes, some cereals, fruits and berries, herbs and condiments (Butler, 1989). Tannin-containing foods such as tea and red wine remain popular and contribute nutritionally significant amounts of tannins (Butler, 1989).

Humans have a unique "taste" for tannins. Although the astringency associated with dietary tannins can be harsh and unpleasant, modest astringency levels have a pleasurable effect on human palate (Butler, 1989). The unpleasant astringent sensation results from tannin binding to proline-rich salivary proteins and proteins lining the oral cavity. The strong complexing with the tannins, immediately on their introduction to the digestive tract, acts as a primary defense mechanism against dietary tannins (Santos-Buelga and Scalbert, 2000; Butler, 1989).

Condensed tannins are widely recognized as

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antinutritional factors. Addition of condensed tannins to diets of experimental animals usually results in diminished weight gain, lowered efficiency of feed utilization and increased fecal nitrogen. These effects have been interpreted in terms of inhibition by tannin of the digestion of dietary protein. Recent studies suggest that inhibition of digestion is much less significant than inhibition of the utilization of digested and absorbed nutrients (Butler, 1989; House and Van Campen, 1994). These recognized nutritional inhibitors were reported to inhibit nonheme iron absorption and adversely affect protein utilization by decreasing its digestibility. Tannins from different plant species have variable effects on iron utilization (House and Van Campen, 1994; Bressani *et al*., 1982). There are other possible interactions of tannins with vitamin A and zinc in the body (Santos-Buelga and Scalbert, 2000; Layrisse *et al*., 2000).

It has been found that cooking has the ability to decrease the negative effects of tannin on proteins (Bressani *et al*., 1982). This alleviation of negative effects is partly due to complexing of the proteins of foods with tannins during cooking (Butler, 1989).

Incidence of certain cancers, particularly esophageal cancer, has been related to excessive intake of high-tannin foods and beverages such as herbal tea, mate and khat (Salunkhe *et al*., 1990) and betel nut (Chung *et al*., 1998b). However, other reports indicated that the carcinogenic activity associated with tannin consumption might be related to other components associated with tannins (Chung *et al*., 1998b). On the other hand, many other reports indicated negative association between tannin consumption from tea and other food sources of tannins and mutagenesis (Chung *et al*., 1998b; Salunkhe *et al*., 1990; Morton, 1989; Shamberger, 1984; Ferguson *et al*., 1985). This anticarcinogenic potential of tannins was related to their antioxidative properties and protection against cellular peroxidation damage and inhibition of generation of superoxide radicals (Bravo, 1998; Chung *et al*., 1998b; Sasaki *et al*., 1989). In addition, some tannins were found to have antimicribial activity as well as some physical effects such as reduction of blood pressure and modulation of immunoresponses (Cowan, 1999; Scalbert, 1991).

It was thought useful to know the tannin contents of plant foods commonly used in Jordan. Therefore, in this study, 39 plant species belonging to 21 families and 37 genera were collected and analyzed for their content of tannins.

MATERIALS AND METHODS

Plant Collection

Thirty nine plant species all used in the Jordanian diet were included in this study (Table 1). The chosen/collected plant foods had the following characteristics:

- Traditional foods commonly used by people constituting main contributors of energy such as chickpea, broad beans, lentils and wheat.
- Condiments such as turmeric and sumac.
- Some commonly-produced and consumed foods such as fruits and vegetables.
- Foods used for production of common hot and cold drinks such as tea, mint and locust.
- Wild plants grown in different Jordanian geographical areas and consumed by people at various levels such as gundelia.

Many of these plant species were purchased from Jordan local markets (groceries or herbalist shops); while others were collected as wild plants from different parts of the country (e.g., wild mint, gundelia, ziziphus, clary and fennel).

The plants were classified according to the families, genera and species based on Al-Eisawi and Takruri

(1989) and Al-Eisawi (1982).

Fresh plants and herbs of high water content were dried at 70° C using air-circulating oven and were kept in cool environment at a temperature below 4° C until being analyzed for their tannin contents.

Analysis of Tannin Contents

Tannin contents of the dried samples were chemically determined according to Pizzaro *et al*. (1994) based on the AOAC (1995) as follows:

Tannins were extracted using triplicate samples of 25-g of the dried plant or herb. The chemical determination was performed using the Folin-Denis reagent and 5-ml Na_2CO_3 which give a dark blue color with tannins.

The absorbance of the resulting color was measured by ELICO SL 150 spectrophotometer at 760-nm wavelength using a quartz cuvette (Pizzaro *et al*., 1994). Then the hydrolyzable tannin concentration was calculated using a tannin-standard curve based on the reaction of Folin-Denis reagent with known concentration of tannic acid. It is to be noted that the edible portion of each plant was used for analysis.

RESULTS AND DISCUSSION

Table (1) shows the plants included in the study listed according to their families and English, scientific and Arabic names. Table (1) also shows the use and mode of consumption of these plants.

Table (2) presents the hydrolyzable tannin contents in the plants studied (in mg/kg dry matter). It's clear from this table that there was a high variation in their total hydrolyzable tannin contents, ranging from 25 mg tannin/kg in plum and verbena to as high as 42961 mg tannin/kg in rosemary.

Some of these plants and herbs are very commonly consumed by Jordanians. The frequently used ones include Jew's mallow, figs, dates, pomegranate, plums, tomato, chard, eggplant, parsley, thyme, chickpea, broad beans, lentils, okra, cocoa, anise, wheat, sage and tea (see Table 3) (FAO, 2004; Tukan *et al*., 1998).

Some of the collected plants and herbs are wild and consumed in their seasons (e.g., gundelia and wild mint); while others may be consumed dried (e.g., thyme) or as beverages (e.g., sage) (Tukan *et al*., 1998).

It is obvious that the wide range of uses and the high content of tannins in some of them justify their tannin analysis and call for studying the possible biological effect which may be conferred by their tannins. Mint, garden rocket, gundelia, broad beans, sage, sumac, rosemary, tea and wart cress have been found to be particularly very high in their tannin contents (more than 15000-mg/kg on dry matter basis). Such high values in some of the studied plants have been also reported by other researchers. For example, Tannins of thyme, chickpeas, tea and broad beans have been reported to be respectively 8483, 2380, 20000, 12000 mg/kg dry weight (Al- Sayyed and Takruri, 2007; Santos-Buelga and Scalbert, 2000; Bravo, 1998). However, it should be noted that it is difficult to compare the polyphenol contents (including tannins) with foods found in the literature; this is due to different methods of analysis, the maturity stage of the plants, the plant cultivars and the part of plant used for analysis (Bravo, 1998).

Furthermore, it should be noted that the tannin figures shown in the present study are those of hydrolyzable tannins. It would be important to find out the content of the condensed tannins in addition to hydrolysable tannins. It has been mentioned that condensed tannins are widely distributed in vegetables, fruits, cocoa and certain grains (Al-Mamary *et al*., 2001; Chung *et al*., 1998b) and that some herbs such as tea have been reported to contain good amounts of both condensed and hydrolysable tannins (Bravo, 1998). Although it was claimed in old literature that

hydrolysable tannins may be carcinogenic in rats (IARC, 1976), more recent research proved a completely different effect of tannins (Sasaki *et al*., 1989) and that the carcinogenic effect was not proved in humans (IARC, 1976). It was argued that tannins, as polyphenols, have antioxidant properties (thus protection against cancer) (Bravo, 1998; Chung *et al*., 1998b; Sasaki *et al*., 1989), antimicrobial (Reed, 1995; Chung *et al*., 1998a) and immunological properties (Scalbert, 1991).

In conclusion, to get the positive health effects of tannins and avoid their negative effects, it is advised to use plants of high-tannin content in moderation. Due to the variability in tannin contents of the studied plants and the fact that potential effects of their tannins on health have not been documented, it is recommended to investigate and evaluate such effects.

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Table (1): List of plants included in the study according to their families and scientific, English and Arabic names with their uses and mode of consumption.

Family	Scientific Name	English Name	Arabic Name	Uses and Mode of Consumption
Anacardiaceae	*Rhus coriaria* L.	Sumac	سماق	Spice and seasoning.
Chenopodiaceae	*Beta vulgaris* L. Subsp.Martima L. Arcany	Chard	سلق	Stews; turnover filling; soup ingredient.
Compositae	*Matricaria aurea* Loefl. Schultz Bip.	Chamomile	بابونج	Hot drink (fresh or dried).
	Gundelia tournrfortii L.	Gundelia	عكوب	Stews; sautéed with oil; fried with eggs.
Cruciferae	*Lepidium aucheri* Boiss	Wart cress	رشاد	Raw without preparation; yogurt salad
	Eruca sativa Miller	Garden rocket	جرجير	Raw without preparation; green salad.
Fagaceae	*Querus coccifera* L.	Oak	بلوط	Boiled; baked.
Gramineae	*Triticum aestivum*, Syn.T.	Wheat	قمح	Dried; bread making
Labiatae	*Salvia judaica* Boiss	Clary	لسينة	Stuffed dish (leaves) with rice and meat.
	Mentha Spp.	Mint	نعنع	Salad ingredient (raw); cold or hot drink; spice and seasoning.
	Mentha longifolia L. Hudson	Wild mint	نعنع بري	Salad ingredient (raw); cold or hot drinks; spice and seasoning; stuffing bread.
	Rosmarinus officinalis L.	Rosemary	حصى البان	Garnish.
	Saliva fruticosa Miller Syn.: *S.triloba* L.*Fill*	Sage	ميرمية	Hot drink.
	Origanum syriacum L.	Thyme	زعتر	Hot drink; turnover filling;
	Verbena triphylla L. Herit	Verbena	مليسة	Hot drink (component of herbal tea).
Leguminosae	*Vicia faba* L.	Broad beans (dried)	فول (بني ناشف)	Boiled after soaking; eaten as snack; soaked and made to broad bean dip.
	Vicia faba L.	Broad beans (green, fresh)	فول أخضر	Stews; fried; cooked with yogurt and meat.
	Cicer arietinum L.	Chickpea	حمص	Chickpea dip; boiled after soaking and used as snack food; puffed and eaten as a snack food.
	Trigonella foenum-graecum L.	Fenugreek	حلبة	Fenugreek cake
	Lens culinaris Merik.	Lentils, whole	عدس (حب)	Boiled as rice-lentil mixture.
	Lens culinaris Medik.	Lentils, decorticated	عدس (مجروش)	Soup
	Glycyrrhiza glabra L.	Liquorice	سوس	Cold drink
	Ceratonia siliqua L.	Locust	خروب	Fruit (when ripe); drink.
Malvaceae	*Hibiscus esculentus* Linn	Okra	بامية	Stews (fresh or dried); fried.
Moraceae	*Ficus carica L.*	Figs	تين	Fruit (fresh or dried); jam.
Palmae	*Phoenix dactylifera* L.	Dates, red	بلح (أحمر)	Raw (as fruit).
	Phoenix dactylifera L.	Dates, yellow	بلح (أصفر)	Raw (as fruit).

Family	Scientific Name	English Name	Arabic Name	Uses and Mode of Consumption
Punicaceae	*Punica granatum* L.	Pomegranate	رمان	Fresh fruit.
Rhamnaceae	*Ziziphus lotus* L. *Lam*	Ziziphus	سدر	Raw without preparation; jam.
Rosaceae	*Crataegus aronia* L. Bose.ex DC	Hawthorn	زعرور	Fruit.
	Prunus domestica L.	Plum	خوخ	Fresh fruit; jams; sweets.
Solanaceae	*Solanum melongena* L.	Eggplant	باذنجان	Stews; stuffed with rice and meat; fried; mixed with tahina as dip.
	Lycopersicon esculentum Mill.	Tomatoes	بندورة	Fresh; cooked with other vegetables and meat.
Sterculiaceae	*Theobroma cocoa* L.	Cocoa	كاكاو	Hot drink; sweets and pastries; cake preparation.
Theaceae	*Camellia sinensis* L.	Tea	الشاي	Hot drink.
Tiliaceae	*Corchorus olitorius* L.	Jew's mallow	ملوخية	Stews (fresh or dried) with meat.
Umbelliferae	*Pimpinella anisum* L.	Anise	يانسون	Hot drink; flavoring agent.
	Coriandrum sativum L.	Coriander	كزبرة	Raw (fresh leaves); spice and seasoning (fresh leaves and dried seeds).
	Foeniculum vulgarae Miller	Fennel	شومر	Raw; bread ingredient; spice and seasoning (seeds).
	Petroselinum crispum L.	Parsley	بقدونس	Fresh leaves in salads; garnish.
Vitaceae	*Vitis vinifera* L.	Green grapes	عنب أخضر	Fruit (fresh or dried); juice; molasses; pastries (as raisins).
	Vitis vinifera L.	Red grapes	عنب أحمر	Fruit (fresh) juice; pastries.
	Vitis vinifera L.	Vine leaves	ورق عنب	Stuffed with rice and meat.
Zingiberaceae	*Curcuma longa* L.	Turmeric	كركم	Seasoning.

Table (2): Tannin contents (mg/kg) of plants on dry matter basis.

English Name	Tannin Contents (mg/kg dry matter)
Anise	973
Broad beans (dried)	351
Broad beans (green, fresh)	14916
Chamomile	4680
Chard	4641
Chickpea	1095
Clary	4405
Cocoa	535
Coriander	12281
Dates, red	1812
Dates, Yellow	1648
Eggplant	4137
Fennel	339
Fenugreek	550
Figs	1861
Garden rocket	18556
Gundelia	39172
Hawthorn	580
Jew's mallow	566
Lentils, decorticated	428
Lentils, whole	1042
Liquorice	11465
Locust	4201
Mint	40640
Oak	251
Okra	1024
Parsley	5049
Plums	25
Pomegranate	4033
Red and green grapes	618
Rosemary	42961
Sage	27423
Sumac	1843
Tea	13838
Thyme	6390
Tomatoes	2136
Turmeric	576
Verbena	25
Vine leaves	14477
Wart cress	15199
Wheat	358
Wild mint	10863
Ziziphus	1750

Table (3): Annual consumption of selected foods in Jordan (1000 tons)*.

Foodstuff	Quantity
Wheat	358.33
Tomatoes	162.9
Potatoes	157.62
Chickpea	22.9
Eggplant	12.52
Dates	10.06
Lentils	8.33
Broad beans	6.61
Tea and mate	5.24
Plums	4.65
Cocoa beans	4.48
Figs	3.72

* FOA, 2004.

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محتوى التانينات في نباتات مختارة شائعة الاستعمال للأكل في الأردن

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ملخـص

هدف هذا البحث إلى قياس محتوى التانينات في عدد من النباتات المستعملة تقليديا في الوجبات الغذائية الأردنية. لذا فقد تم تحليل 39 صنفا نباتيا تنتمي إلى 21 فصيلة و37 جنسا، علما بأن معظم هذه النباتات والأطعمة لم يسبق تقييم محتواها من التانينات محليا. تم تجفيف العينات الطازجة وقياس محتواها من التانين كيماويا باستخدام طريقة "فولين-دنيس"، حيث تم قياس الامتصاصية باستخدام جهاز المطياف على موجة طولها 760 نانوميتر ثم تم حساب التانينات باستخدام منحنٍ قياسي. بينت النتائج أن محتوى التانينات في العينات المحللة قد تباين تباينا كبيرا؛ إذ تراوح من 25 ملغم/كغم في الجرنك والمليسة إلى 42961 ملغم/كغم في حصى البان (على أساس المادة الجافة). لذا، وبسبب هذا التباين الكبير في محتوى التانينات في الأطعمة المختلفة فإنه يتوقع حدوث تأثيرات صحية وتغذوية مختلفة، وهذا يستحق مزيدا من الدراسات التفصيلية.

الكلمات الدالة: التانينات، النباتات، الأردن.

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