Antioxidant activities and total phenolics content in some Egyptian herbs

الأنشطة المضادة للأكسدة ومحتوى الفينولات الكلي في بعض الأعشاب المصرية

اعداد

أ. إيناس محمد السيد عبدالله مرزوق

باحث دكتوراه بقسم اقتصاد منزلي – تخصص تغذية وعلوم الاطعمة – كلية التربية النوعية – جامعة بورسعيد

أ.د. يوسف عبد العزيز الحسانين

أستاذ التغذية وعلوم الاطعمة بقسم التغذية وعلوم الاطعمة، كلية الاقتصاد المنزلى، جامعة المنوفية

أ.م.د. عبير السيد الخميسي

أستاذ مساعد بقسم الاقتصاد المنزلى، كلية التربية النوعية، جامعة بورسعيد

أ.م.د. ريعان السيد عبد المنعم

أستاذ مساعد بقسم الاقتصاد المنزلى، كلية التربية النوعية، جامعة بورسعيد

الأنشطة المضادة للأكسدة ومحتوى الفينولات الكلي في بعض الأعشاب المصرية

اعداد

إيناس محمد السيد عبدالله مرزوق

قسم اقتصاد منزلي – تخصص تغذية وعلوم الاطعمة – كلية التربية النوعية – جامعة بورسعيد

أ.د. يوسف عبد العزيز الحسانين

أستاذ التغذية وعلوم الاطعمة بقسم التغذية وعلوم الاطعمة، كلية الاقتصاد المنزلى، جامعة المنوفية

أ.م.د. عبير السيد الخميسي

أستاذ مساعد بقسم الاقتصاد المنزلى، كلية التربية النوعية، جامعة بورسعيد

أ.م.د. ريعان السيد عبد المنعم

أستاذ مساعد بقسم الاقتصاد المنزلى، كلية التربية النوعية، جامعة بورسعيد

المستخلص

الهدف من هذه الدراسة هو تحديد محتوى الفينولات الكلي في العديد من الأعشاب النامية في مصر، واستكشاف العلاقة بين المحتوى الفينولي والنشاط المضاد للأكسدة. أظهرت خلاصات الأعشاب ومزيجها اختلافات كبيرة في نشاط مضادات الأكسدة (AA% = 80.11- 90.98) عندما تم حسابها بواسطة الطرق الأربعة المختلفة المستخدمة في هذه الدراسة. أظهرت البردقوش نشاطًا قويًا بسبب محتواها من الفينولات العالي (٩٣٨.٨٧ ملغ / ١٠٠ جرام) .أظهرت النعناع والزنجبيل نشاطًا مضادًا للأكسدة نسبيًا (A = 83.21، ٨٠.١١٪) والفينوليك الكلي (٣٧٦.٨٢ و ٢٩٨.٤٣ مجم / ١٠٠ جرام)، أشارت بيانات العلاقة بين محتوى الفينول الكلي والنشاط المضاد للأكسدة من الأعشاب المختارة أنه عندما تم تضمين الأعشاب المختارة في التحليل الإحصائي، كانت هناك ارتباطات موجبة (r2 سجلت ٠.٨٤١٥ ، ٠.٨٨٥٦ ، ٠.٧٢٧٣ ، ٠.٨٩٧٨) وهامة (p≤ 0.05، ٠.٠٠١ ، ٠.٠٠٥ ، ٠.٠٠١) بين مجموع الفينولات والنشاط المضاد للأكسدة للنعناع ، البردقوش ، الزنجبيل وخليطها ، على التوالي. في الختام، يمكن أن تمثل بيانات الدراسة الحالية حجر الميل نحو التوسع في استخدام مسحوق أو مقتطفات من الأعشاب المختارة كمضادات الأكسدة الطبيعية في العديد من التطبيقات الغذائية والتغذوية المختلفة.

الكلمات الرئيسية:

النعناع، البردقوش، الزنجبيل، المركبات الكيميائية النباتية، مضادات الأكسدة الطبيعية.

Antioxidant activities and total phenolics content in some Egyptian herbs

إعداد/أ.د. يوسف الحسانين، أ.م.د. عبير الخميسي، أ.م.د. ريعان عبد المنعم، أ. إيناس محمد مرزوق

Antioxidant activities and total phenolics content in some Egyptian herbs

By

Enas Marzouk

Department of Home Economics, Faculty of Specific Education, Port Said University, Port Said.

Youssef El Hassaneen

Department of Human Nutrition and Food Science, Faculty of Home Economics, Minoufiya University

Abeer El Khamisy

Department of Home Economics, Faculty of Specific Education, Port Said University, Port Said.

Rehaan Sayed-Ahmed

Department of Home Economics, Faculty of Specific Education, Port Said University, Port Said.

Abstract:

The aim of this study was to determine the contents of total phenolics in several herbs growing in Egypt and to explore relationship(s) between phenolic content and antioxidant activity. Herbs extracts and their mixture showed considerable differences in antioxidant activity (AA= 80.11- 90.98%) when it was calculated by the four different methods used in this study. Marjoram showed strong activity because of their high phenolic content (938.87 mg/100 g d.b.). Spearmint and ginger showed relatively moderate antioxidant activity (AA= 83.21 and 80.11%) and total phenolics (376.82 and 298.43 mg/100 g d.b.). Data of the relationship between total phenolic content and antioxidant activity of selected herbs indicated that when the selected herbs were included in the statistical analysis, there were positive correlations (r^2) were recorded 0.8415, 0.8856, 0.7273 and 0.8978 and significant ($p \leq$ 0.05, 0.01, 0.05 and 0.01) between total phenolics and antioxidant activity for spearmint, marjoram, ginger and their mixture, respectively. In conclusion, data of the present study could be represent the mile stone towards the extension of using the powder or extracts of the selected herbs as natural antioxidants in many different nutritional and food processing applications.

Keywords: spearmint, marjoram, ginger**,** Phytochemical compounds, natural antioxidants

Antioxidant activities and total phenolics content in some Egyptian herbs

إعداد/أ.د. يوسف الحسانين، أ.م.د. عبير الخميسي، أ.م.د. ريعان عبد المنعم، أ. إيناس محمد مرزوق

Introduction

Antioxidants are compounds that inhibit or delay the oxidation of other molecules by inhibiting the initiation or propagation of oxidizing chain reactions. There are two basic categories of antioxidants, namely, synthetic and natural. In general, synthetic antioxidants are compounds with phenolic structures of various degrees of alkyl substitution, whereas natural antioxidants can be phenolic compounds (tocopherols, flavonoids, and phenolic acids), nitrogen compounds (alkaloids, chlorophyll derivatives, amino acids, and amines), or carotenoids as well as vitamins (carotenoids, and ascorbic acid) (Larson, 1988; Hudson, 1990; Hall and Cuppett, 1997). Synthetic antioxidants such as butylated hydroxyanisole (BAH) and butylated hydroxytoluene (BHT) have been used as antioxidants since the beginning of this century. Restrictions on the use of these compounds, however, are being imposed because of their carcinogenicity (Branen, 1975; Ito *et al*., 1983). Thus, the interest in natural antioxidants such phytochemicals has increased considerably (Loliger, 1991).

Phytochemical compounds which naturally occurring in food materials including herbs can be classified into several families include allyle sulfides, indoles, phenolic compounds, saponins and terpens. Amongst of different families of phytochemicals, phenolic compounds have been occupied the central position. The term of phenolic compound embraces a wide range of compound plant substances, which possess in common an aromatic ring bearing one or more hydroxyl substituents. They most frequently occur combined with sugar glycoside and usually located in the cell vacuole (Harborne, 1973). Phenolic acids are a group of phenolic compound, which may be identified as hydroxycarboxylic acids with phenolic hydroxyl groups (Misaghi, 1982). Phenolic acids and their derivatives are widely distributed in all plant derived food systems and in most diets. The levels vary dramatically, especially as influenced by factors such as the species, germination, ripening, storage and processing. For example, potato tubers were shown to have several kinds of phenolic acids and most of these phenolics are concentrated in the outer part (Reeve *et al*., 1969; Come., 1971; Kumar *et al*., 1991; Dao and Friedman ,1992; Onyeneho and Hettiarachchy, 1993; and Rodriguez *et al*., 1994 a-b. Many of phenolic acids exhibits their antioxidative (Majid *et al*., 1991; Deschamps *et al.*, 1991; Laranjinha *et al*., 1994 and Khoteem, 2005), anticarcinogenic (Raj *et al*., 1983; Mukhtar *et al*., (1984; Camarasa *et al*., 1987; Gali *et al*., 1991; and Harttig *et al*., 1996), and antibacterial (Herald and Davidson, 1983; Nakane *et al*., 1990; Nowosielska *et al*., 1991; Ghaly, 2004 and Khoteem, 2005) effects.

The antioxidant activity of several plant materials including herbs has recently been reported (Al-Saikhan *et al.*, 1995; Yen and Duh, 1995; Oomah and Mazza, 1996; Wang *et al.*, 1996; Cao *et al.*, 1996; Amarowicz *et al.*, 1996; Ghaly, 2004 and

Khoteem, 2005); however, information on the relationship between antioxidant activity and phenolic content and composition of many food plant products is not available. Therefore, the aims of this study was to determine the contents of total phenolics in several herbs growing in Egypt and to explore relationship(s) between phenolic content and antioxidant activity.

Materials and Methods

Materials

Plant materials: Three herbs ginger (*Zingiber officinale*), marjoram (*Majorana hortensis*) and spearmint **(***Mentha spicata* L.) were obtained from Haras Company for Herbs Trading, Bab El-Khlek, Cairo, Egypt.. All samples were either ground or homogenized before they were freeze-dried to ensure equal moisture content.

Experimental animals: Normal male albino rats (145±10g) were obtained from Research Institute of Ophthalmology, Medical Analysis Department, Giza, Egypt.

Standards: Gallic, β-hydroxytoluene and α-tocopherol were obtained from Sigma chemical Co, St Louis, MO,. Sodium tungstate and phosphomolybdic acid were obtained from Fischer, UK. All chemicals, reagents and solvents were of analytical grade and purchased from Al-Gomhoryia Company for Trading Drugs, Chemicals and Medical Instruments, Cairo, Egypt.

Folin-Ciocalteu reagent: One gram of sodium tungstate, 20 g of phosphomolybdic acid, and 750 ml of distilled water are transferred to a 1000 ml flask fitted with a reflux condenser. The solution is refluxed for 10 h; transferred to a graduated flask of 1000 ml capacity and made up to the mark with distilled water.

Preparation of herbs extracts

Powders of the selected herbs were used for their different types extracts as follow: A 20 g from dried plant powder plus 180 ml methanol (80%, v/v) were homogenized and transferred to a beaker and stirred at 200 rpm in an orbital shaker (Unimax 1010, Heidolph Instruments GmbH & Co. KG, Germany) for 1 h at room temperature. The extract was then separated from the residue by filtration through Whatman No. 1 filter paper. The remaining residue was re-extracted twice, and then the two extracts were combined. The residual solvent of was removed under reduced pressure at 45°C using a rotary evaporator (Laborata 4000; Heidolph Instruments GmbH & Co. KG, Germany) and the extract could be ready for the basil diet blending purpose.

Methods

Determination of antioxidant activity and total phenolics

Extraction

Ground samples (100 g) were extracted with 80% aqueous methanol (750 ml) on an orbital shaker for 120 min at 70 ^{0}C. The mixture was subsequently filtered (Whatman No. 5) on a Buchner funnel, and the filtrate was assayed for antioxidant activity.

Determination of antioxidant activity

Antioxidant activity of plant extyracts and standards (α-tocopherol, BHA, ans BHT; Sigma Chemical Co., St. Louis, Mo) was determined according to the β-carotene bleaching method following a modification of the procedure described by Marco (1968). For a typical assay, 1mL of β-carotene (Sigma) solution, 0.2 mg/mL in chloroform, was added to round-bottom flasks (50 mL) containing 0.02 mL of linoleic acid (J.T. Baker Chemical Co., Phillipsburg, NJ) and 0.2 mL of Tween 20 (BDH Chemical Co., Toronto, On). Each mixture was then dosed with 0.2 mL of 80% MeOH (as control) or corresponding plant extract or standard. After evaporation to dryness under vacuum at room temperature, oxygenated distilled water (50 ml) was added and the mixture was shaken to form a liposome solution. The samples were then subjected to thermal autooxidation at 50 ^{0}C for 2 h. The absorbance of the solution at 470 nm was monitored on a spectrophotometer (beckman DU-50) by taking measurements at 10 min intervals, and the rate of bleaching of β-carotene was calculated by fitting linear regression to data over time. All samples were assayed in triplicate. Various concentrations of BHT, BHA, and α-tocopherol in 80% methanol was used as the control.

Antioxidant activity was calculated in four different ways. In the first, absorbance was plotted against time, as a kint curve, and the absolute value of slope was expressed as antioxidant value (AOX). Antioxidant activity (AA) was all calculated as percent inhibition ralative to control using the following equation (Al-Saikhan et al., 1995).

$$AA= (R_{control} - R_{sample}) / R_{control} \times 100$$

Where: $R_{control}$ and R_{sample} were the bleaching rates of beta-carotene in reactant mixture without antioxidant and with plant extract, respectively.

The third method of expression based on the oxidation rate ratio (ORR) was calculated according to the method of Marinova et al., (1994) using the equation:

$$ORR = R_{sample} / R_{control}$$

Where: $R_{control}$ and R_{sample} are the same in the previous equation.

In the fourth method, the antioxidant activity coefficient (AAC) was calculated as described by Mallet et al., (1994).

$$(AAC) = (Abs_{S\ 120} - Abs_{C\ 120}) / Abs_{C\ 0} - Abs_{C\ 120}) \times 1000$$

Where: $Abs_{S\ 120}$ was the absorbance of the antioxidant mixture at time 120 min, $Abs_{C\ 120}$ was the absorbance of the control at time 120 min, $Abs_{C\ 0}$ was the absorbance of the control at zero time.

β-carotene bleaching (BCB) assay

For *β*-carotene bleaching (BCB) assay, antioxidant activity (AA) against time (every 10 min thereafter for 120 min) for the all tested vegetables processing by-product extracts was measured/constructed according to Marco, (1968). The AA was all calculated as percent inhibition (bleaching rates of *β*-carotene in reactant mixture of plant part extracts) relative to control (bleaching rates of *β*-carotene in reactant mixture of without plant part extracts) such as described by Al-Saikhan *et al.,* (1995).

Determination of total phenolics

Total phenolics were determined using Folin-Ciocalteu reagent (Singleton and Rossi, 1965). Two hundred milligrams of sample was extracted for 2 h with 2 mL of 80% MeOH containing 1% hydrochloric acid at room temperature on an orbital shaker set at 200 rpm. The mixture was centrifuged at 1000g for 15 min and the supernatant decanted into 4 mL vials. The pellets were combined and used for total phenolics assay. One hundred microliters of extract was mixed with 0.75 mL of Folin-Ciocalteu reagent (previously diluted 10-fold with distilled water) and allowed to stand at 22 0C for 5 min; 0.75 ml of sodium bicarbonate (60g/L) solution was added to the mixture after 90 min at 22 ^{0}C, absorbance was measured at 725 nm. Results are expressed as ferulic and equivalents.

Statistical Analysis

All measurements were done in triplicate and recorded as mean ±SD. Statistical analysis was performed with the Student *t*-test and MINITAB-12 computer program (Minitab Inc., State College, PA).

Results and Discussion

Antioxidant activities of selected herbs

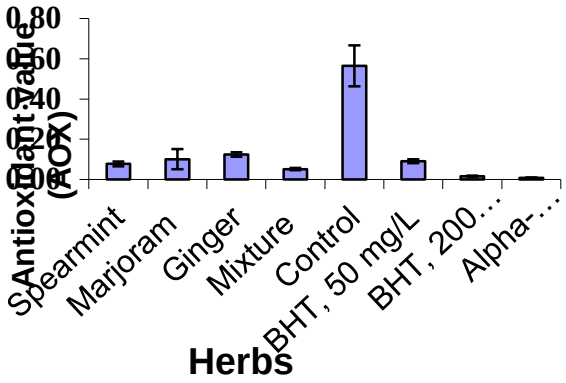
The antioxidant activities and total phenolics of three herbs and their mixture extracts are shown in Figure (1). From such data it could be noticed that the herbs extracts and their mixture showed considerable differences in antioxidant activity (AA= 80.11- 90.98%) when it was calculated by the four different methods used in this study. Marjoram showed strong activity because of their high phenolic content

(938.87 mg/100 g d.b.). Spearmint and ginger showed relatively moderate antioxidant activity (AA= 83.21 and 80.11%) and total phenolics (376.82 and 298.43 mg/100 g d.b.).

The decrease in absorbance of β-carotene in the presence of different methanolic herbs extracts (and well-known antioxidants used as standards) with the oxidation of β-carotene and linoleic acid is shown in Table (2) and Figure (9). Such data indicated that herbs mixture extract recorded the lowest decreasing followed by marjoram, ginger and spearmint extracts, respectively. The values of marjoram extracts absorbance's through 120 min are coming well i.e. closing the line of 50 mg /L of both BHT (50 mg/L) and α-tocopherol followed by ginger and spearmint extracts. These data proved the high stability of the all tested plant by-products when comparing with that more common standards BHT and α-tocopherol.

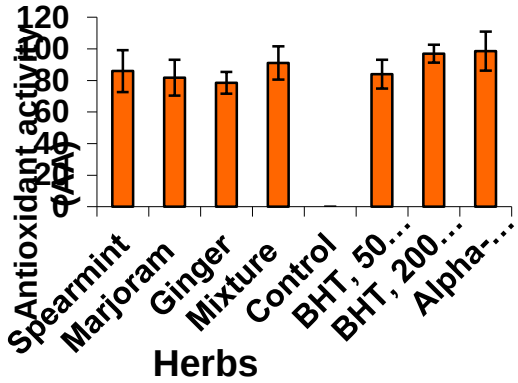
In a similar study, Velioglu *et al*., (1998) determined the antioxidant activities and total phenolics of 28 herbs products, including sunflower seeds, flaxseeds, wheat germ, buckwheat, several fruits, vegetables, and medicinal herbss and found that the total phenolics content varied from 169 to 10548 mg/100 g of dry product. Antioxidant activity of methanolic extract evaluated according to the β-carotene bleaching method expressed as AOX, AA , ORR, and AAC ranged from 0.05, 53.7, 0.009, and 51.7 to 0.26, 99.1, 0.46, and 969.3, respectively. Also, the present data are in accordance with the obtained by Ghaly, (2004) and Khoteem, (2005) who studied antioxidant activity of many spices and vegetable extracts commonly distributed in local markets.

Also, Elhassaneen *et al., (*2013) indicated that the antioxidant activities of control and enriched MPP biscuits. The antioxidant activity (AA) in control biscuits was 31.34% which increased to 37.92 and 45.12% with the incorporation of MPP by 5 and 10%, respectively. The same date and antioxidant behavior for ROSP, and PPP are recorded by Shalaby (2015) and Ahmed, (2015).



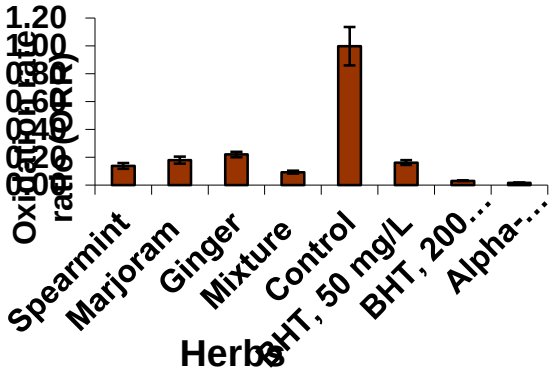
Antioxidant value (AOX*, A/h) of methanolic extracts of selected herbs.

* AOX (A/h) = The absolute value of slope (Abs was plotted against time).



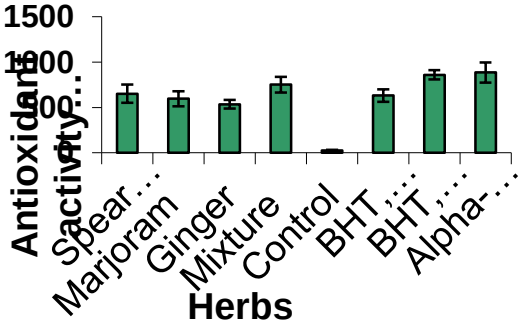
Antioxidant activity (AA*, %) of methanolic extracts of selected herbs.

* Antioxidant activity (AA, %) = (R control - R sample) / R control x 100 where: R control and R sample were the bleaching rates of beta-carotene in reactant mixture without antioxidant and with plant extract, respectively.



Oxidation rate ratio (ORR*, %) of methanolic extracts of selected herbs.

* Oxidation rate ratio (ORR) = R sample / R control



Antioxidant activity coefficient (AAC*) of methanolic extracts of selected herbs.

* Antioxidant activity coefficient (AAC) = (Abs S 120 - Abs C 120) / Abs C 0 - Abs C 120) x 1000 where: .Abs S 120 was the absorbance of the antioxidant mixture at time 120 min, Abs C 120 was the absorbance of the control at time 120 min, Abs C 0 was the absorbance of the control at zero time.

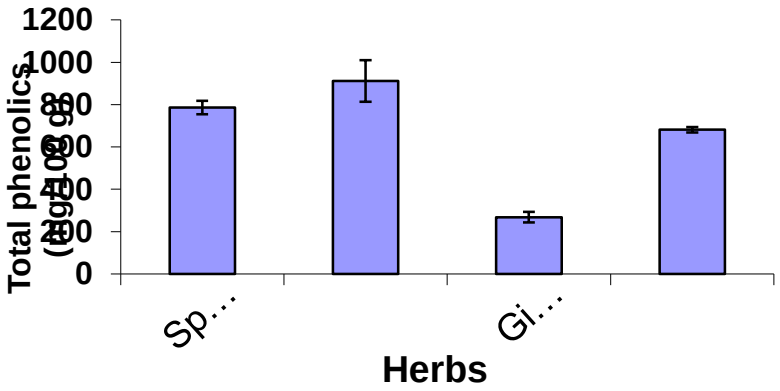


Figure 2. Total phenolics content in selected herbs

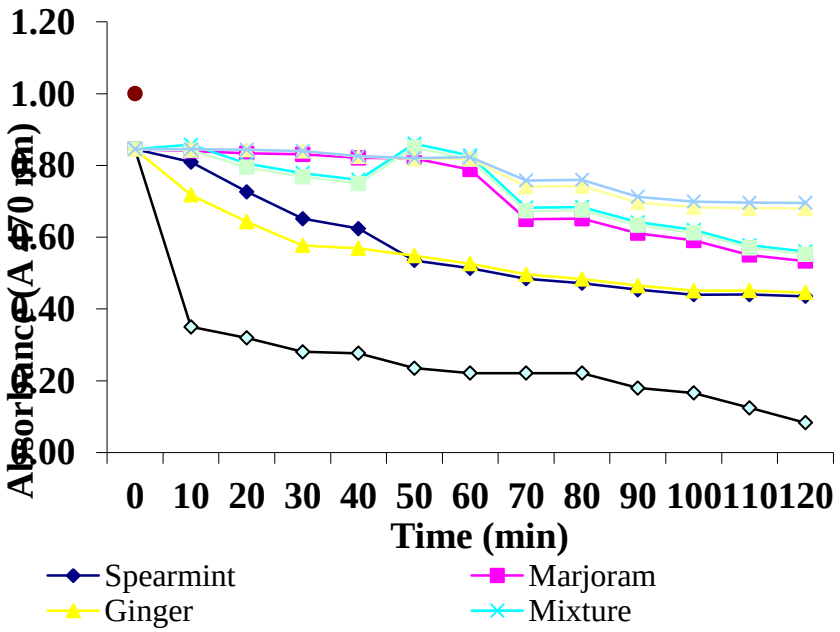


Figure 3. Antioxidant activity of methanolic extracts of selected herbs assayed by the β-carotene bleaching method (BHT α–tocopherol at 50 mg/L concentration was used as a reference)

Relationship between phenolic contents and antioxidant activity

The total phenolic content of the selected herbs extracts investigated in this study varied from 298.43-938.87 mg/100 g of dry product (Figure 2). The relationship between total phenolic content and antioxidant activity of selected herbs is shown in Table (1) and Figure (3). The results indicated that when the selected herbs were included in the statistical analysis, there were positive correlations (r^2) were recorded 0.8415, 0.8856, 0.7273 and 0.8978 and significant ($p\leq$ 0.05, 0.01, 0.05 and 0.01) between total phenolics and antioxidant activity for spearmint, marjoram, ginger and their mixture, respectively. This indicates that phenolics can play a major role in the antioxidant activity of selected herbs. In similar study, Velioglu *et al*., (1998) reported that the correlation coefficient between total phenolics and antioxidative activities of 28 herbs products, including sunflower seeds, flaxseeds, wheat germ, buckwheat, several fruits, vegetables, and medicinal herbs was statistically significant. Also, Lee *et al*., (1995) reported that phenolic compounds including flavonoids, correlated well with antioxidant activity (r^2=0.86) in 5 cultivars of fresh pepper (*Capsicum annuum*).

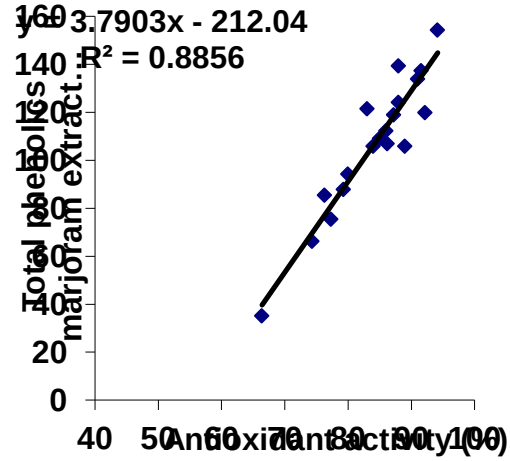
Also, many studies indicated that there was a positive and significant ($p\leq0.01$) relationship between total phenolics and antioxidant activity in different plant parts (El-Mokadem, 2010; El-Safty, 2008 and Hegazy, 2009).

The data of this study with the others proved the importance of using selected herbs extracts as natural antioxidants in both therapy and food technology applications. Regarding to food technology applications, Serag El-Din, (2001) found that adding of phenolic acid (cinnamics) to vegetable oils leads to significant decrease in the rate of hydrolysis, rancidity and formation of the toxic and carcinogenic substances during the deep frying process. Also, Dewan, (2003) and Elhassaneen *et al*.,(2004) found that the washing of oils used in deep-fat frying of Tamia and potato for 12 h

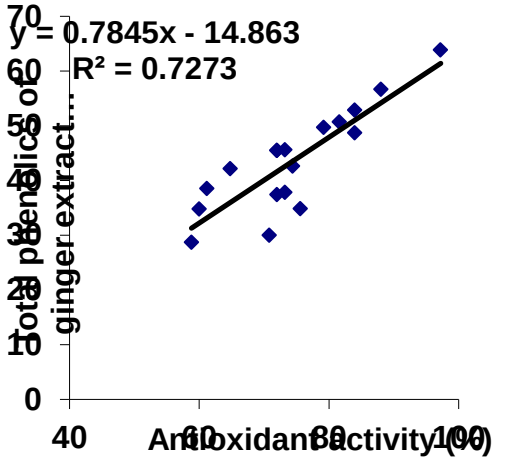
Table 1. Relationship between antioxidant activities and total phenolic contents of herbs

Herbs	n	Relationship with total phenolics	r^2
Spearmint	16	y = 1.4569x - 52.142	0.8415[a]
Marjoram	19	y = 3.7903x - 212.04	0.8856[b]
Ginger	18	y = 0.7845x - 14.863	0.7273[a]
Herbs mixture	18	y = 2.3879x - 134.12	0.8978[b]

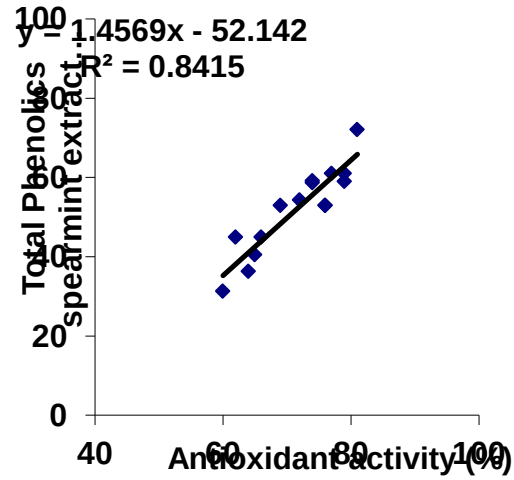
Where: y= Total Phenolics of herb extract (mg GAE/g extract), x= Antioxidant activity (%), [a] $P \geq 0.05$, [b] $P \geq 0.01$



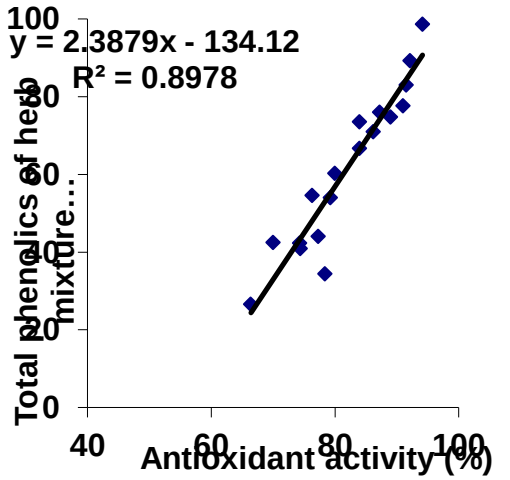
Relationship between total phenolic content and antioxidant activity of marjoram



Relationship between total phenolic content and antioxidant activity of ginger



Relationship between total phenolic content and antioxidant activity of spearmint



Relationship between total phenolic content and antioxidant activity of herb mixture

Figure (3). Relationship between phenolic contents and antioxidant activity of selected herb mixture

with water containing phenolic acids leads to significant improvement in all chemical and physical properties of that oil samples.

Also, some toxic compounds, i.e. mutagenic and carcinogenic substances formed during the deep-fat frying operation in oil samples have been removed partially after washing treatment. The effect of plant by-products treatment on the formation of PAH in charcoal broiled bread was studied by Mohammed, (2012). The addition of potato peel powder and red onion skin powder to the meatballs paste leads to significant decrease on the formation of polycyclic aromatic hydrocarbon compounds in its charcoal broiled product. Antioxidant compounds found in plant by-products such as used in the present study inhibited or delayed the oxidation of other molecules i.e. lipids, proteins, nucleic acid, and carbohydrates by inhibiting the initiation or propagation of oxidizing chain reactions (Shalaby, 2015).

Majid *et al*., (1991) found feeding of phenolic acid (ellagic) significantly increased the levels of reduced glutathione and glutathione reductase in liver and lungs of male and female mice as well as increase in inhibition of NADPH-dependent lipid peroxidation. The antioxidant activity of four phenolic acids, representative of three chemical groups present in human diet, upon low density lipoprotein peroxidation was studied *in vitro* in a low density lipoprotein (LDL) oxidation model by Laranjinha *et al*., (1994). The controlled oxidation of LDL was initiated by free radicals generated from a hydrophilic azo initiator and followed by monitoring the oxygen consumption and the fluorescence quenching of *cis*-parinaric acid previously incorporated into LDL. The hydroxycinnamic acid derivatives, chlorogenic and caffeic acids, have high stoichiometric numbers and reactivity with peroxyl radicals as compared with trolox, the water-soluble analogue of vitamin E, whereas ellagic acid (a tannic compound) compares with trolox effects. Protocatechuic acid (a hydroxybenzoic acid derivative) exhibits a complex reaction with peroxyl radicals, as indicated by UV spectroscopy, resulting in undefined inhibition periods of LDL oxidation and low reactivity with peroxyl radicals. Presumably, secondary radicals of these compounds are unable to initiate LDL oxidation.

Data of the present study with that carried out by the others could be represent the mile stone towards the extension of using the powder or extracts of the selected herbs as natural antioxidants in many different nutritional and food processing applications. Synthetic antioxidants such as butylated hydroxyanisole (BAH) and butylated hydroxytoluene (BHT) have been used as antioxidants since the beginning of the last century. Restrictions on the use of these compounds, however, are being imposed because of their carcinogenicity (Reviewed in Al-Saikhan, 1995). Thus, the interest in natural antioxidants has increased considerably.

References:

1- Ahmed, (2015)
2- Al-Saikhan M. S., Howard L. R. and Miller J. C. (1995): Antioxidant activity and total phenolics in different genotypes of potato (Solanum tuberosum, L.). Journal of Food Science., 60 (2): 341-343.
3- Branen A. L. (1975): Toxicology and biochemistry of butylated hydroxy anisole and butylated hydroxy toluene. J. Am. Oil Chem. Soc. 52: 59-63.
4- Camarasa J., Laguna J.C., Gaspar A. and Lalueza P. (1987): Biochemical and histological pattern of cynarin and caffeic acid treatment in CCl sub (4)-induced hepatotoxicity. Med. Sci. Res. 15(2): 91-92.
5- Come D. (1971): Determination of phenolic acids in the skin of potato tubers: Application for studying dormancy in potato tubers. Lebensmittel Wissenschaft und Technologie, 41: 12-19.
6- Dao L. and Friedman M. (1992): Chlorogenic acid content of fresh and processed potatoes determined by ultraviolet spectrophotometry. j. Agric. Food Chem. 40: 2152-2156.
7- Deschamps D., Fisch C., Fromenty B., Berson A., Degott C. and Pessayre D. (1991): Inhibition by salicylic acid of the activation and thus oxidation of long chain fatty acids: Possible role in the development of Reye's syndrome. J. Pharmacol. Exp. Ther., 259(2): 894-904.
8- Dewan N. E. (2003): Removal of some toxic, carcinogenic and mutagenic compounds from edible oils that affected by deep-fat frying. M.Sc. Thesis, Fac. of Home Economics, Minufiya University, Shebin El-Kom, Egypt.
9- assaneen Y., Ragab S., El-Beltagi A. and Emad A. (2013): Mango peel powder: A potential source of phenolics, carotenoids and dietary fiber in Biscuits preparations 2nd International-16 th Arab Conference of Home Economics "Home Economics in the Service of Industry"10-11 September, Faculty of Home Economics, Minoufiya University, Shebin El-Kom, Egypt.
10- Elhassaneen A. E., El-Fadaly H. A. and N.E. Dewan (2004): Bioremoval od toxic substances from edible oils as affected by deep-fat frying process. Pakistan J. of Biological Science. 6 (24): 1979 - 1990.

11- El-Mokadem, K. (2010): The effect of technological treatments on phytochemical properties of some foods ". M.Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt .
12- Safty, A. (2008): Chemical, technological and nutritional studies on Marjoram (Majorana Hortensis) M. Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt
13- Gali H.U., Perchellet E.M. and Perchellet J. P. (1991): Inhibition of tumor promoter-induced ornithine decarboxylase activity by tannic acid and other polyphenols in mouse epidermis in vivo. Cancer Res. 51 (11): 2820-2825.
14- Ghaly, H. (2004): Biochemical and microbiological studies on some spices distributed in Egyptian local markets "M. Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt.
15- Hall C. A., Cuppett S. L. (1997): Structure—activities of natural untioxidants. In Antioxidant Methodology In Vino and In Vitro Concepts; Aruoma, 0. I., Cuppett, S. L., Eds.; AOCS Press: Champaign, IL. 2-29.
16- Harborne, J.B. (1973): phytochemical methods: Phenolic compounds. 33-88.
17- Harttig U., Hendricks J.D., Stoner G.D. and Bailey G.S. (1996): Organ specific, protocol dependent modulation of 7,12-dimethylbenz[a]anthracene carcinogenesis in rainbow trout (Oncorhynchus mykiss) by dietary ellagic acid. Carcinogenesis. 17 (11): 2403-2409.
18- Hegazy, W.H.R. (2009): Antioxidant activity of pomegranate (punica granatum) fruits and its relationship with phenolic composition and processing technology " M.Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minufiya University, Egypt
19- Herald P.J. and Davidson P.M. (1983): Antibacterial activity of selected hydroxycinnamic acids. J. Food Sci. 48(4): 1378-1379.
20- Hudson B. J. F. Ed. (1990): Food Antioxidants; Elsevier Applied Science: London.
21- Ito N., Fukushima S., Hasegawa A., Shibata M., Ogiso T. (1983): Carcinogenicity of butylated hydroxy anisole in F344 rats. J. Natl. Cancer Inst. 3(70): 343-347. ization of an NADPH-cytochrome P450 (cytochrome c) reduc-

22- Khoteem A. (2005): Technological and microbiological studies on some phytochemicals induced anticarcinogenic effect. M.Sc. Thesis, Fac. Of Home Economics, Minufiya University, Egypt.
23- Kumar A., Pundhir V.S. and Gupta K.C. (1991): The role of phenols in potato tuber resistance against soft rot by Erwinia carotovora ssp. carotovora. Potato Res. 34(1): 9-16.
24- Laranjinha J., Almeida L. and Madeira V. (1994): Reactivity of dietary phenolic acids with peroxyl radicals: antioxidant activity upon low-ensity lipoprotein peroxidation. Biochem. Pharmacol. 48(3): 487-494.
25- Larson R. A. (1988): The antioxidants of higher plants. Phytochemistry. 27 (4): 969-978.
26- Lee Y., Howard L.R. and Villalon B. (1995): Flavonoids and antioxidant activity of fresh pepper (Capsicum annuum) cultivars. J. Food Science. 60 (3): 473-476.
27- Loliger J. (1991): The use of antioxidants in foods. In Free Radicals and Food Additives, Arouma, 0. I., Halliwell, B., Eds.,Taylor and Francis: London.121-150.
28- Majid S., Khanduja K.L., Gandhi R.K., Kapur S. and Sharma R.R. (1991): Influence of ellagic acid on antioxidant defense system and lipid peroxidation in mice. Biochemistry and Pharmacology journal, 42(7): 1441-1445.
29- Mallett J. F., Cerrati C., Ucciani E., Gamisana J.and Gruber, M. (1994): Antioxidant activity of plant leaves in relation to their a-tocopherol content. Food Chem. 49: 61-65.
30- Marco G. J. (1968): A rapid method for evaluation of antioxidants. J. Am. Oil Chem. Soc. 45: 594-598.
31- Marinova E. M., Yanishlieva N. and KostovaI. N. (1994): Antioxidative action of the ethanolic extract and some hydroxycoumarins of Fraxinus ornus bark. Food Chem. 51: 125-132.
32- Misaghi I.J. (1982): Physiological and biochemistry of plant pathogen interactions: Alterations in phenol metabolism caused by disease. 103-111.
33- Mohammed, N. H. (2012): Chemical and technological studies on some food products supplemented with gum arabic" M.Sc. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt.

34- Mukhtar H., Del T.B.J., Marcelo C.L., Das M. and Bicker D.R. (1984): Ellagic acid: A potent naturally occurring inhibitor of benzo(a)pyrene metabolism and its subsequent glucuronidation, sulfation and covalent binding to DNA in cultured BALB/C mouse keratinocytes. Carcinogenesis, 5(12): 1565-1571.

35- Nakane H., Fukushima M. and Ono K. (1990): Differential inhibition of reverse transcriptase and various DNA polymerase by digallic acid and its derivatives. J. Nat. Prod. Lloydia. 53(5): 1234-1240.

36- Niemann G.J., Van D.K.A., Niessen W.M.A. and Versluis K. (1991): Free and cell wall-bound phenolics and other constituents from healthy and fungus-infected carnation (Dianthus caryophyllus L.) stems. Physiol. Mol. Plant Pathol. 38(6): 417-432.

37- eneho S. N., and Hettiarachchy N. S. (1993): Antioxidant activity, fatty acids and phenolic acids composition of potato peels. Journal of the Science of Food and Agriculture 62: 345–350.

38- Oomah B. D. and Mazza G. (1996): Flavonoids and antioxidative activities in buckwheat. J. Agric. Food Chem. 44 (7): 1746- 1750.

39- Raj A.S., Heddle J.A., Newmark H.L. and Katz M. (1983): Caffeic acid as an inhibitor of DMBA-induced chromsomal breakage in mice assessed by bone-marrow micronucleus test. Mutat. Res. 124 (3-4): 247-253.

40- Reeve R.M., Hautala E. and Weaver M.L. (1969): Anatomy and compositional variation within potatoes. Am. Potato j. 46: 374-386.

41- Rodriguez S.D., Hadley M. and Holm E.T. (1994b): Potato peel waste: stability and antioxidant activity of a freeze-dried extract. J. Food Sci., 59(5): 1031-1033.

42- Rodriguez S.D., Hadley M. and Holm, E.T. (1994a): Phenolics in aqueous potato peel extraction, identification and degradation. J. Food Sci., 59(3): 649-651.

43- ag El-Din M. F. (2001):Analysis, occurrence and formation of some toxic compounds in some edible oils as the result of cooking and processing. M.Sc. Theis, Fac. Of Home Economics, Minufiya University, Shebin El-Kom, Egypt.

44- alaby, H. H. (2015): The effect of some food products mixed with plant parts on blood sugar levels of rats " Ph.D. Thesis in Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Egypt.
45- SingletonV. L.and Rossi J. A. (1965): Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. Am. J. Enol. Vitic. 16: 144-158.
46- Velioglu Y.S., Mazza G., Gao L. and Oomah B.D. (1998): Antioxidant activity and total phenolics in selected fruits, vegetables and grain products. J. Agric. Food Chem. 46 (10): 4113-4117.)
47- Yen, G. C. and Dub, P. D. (1995): Antioxidant activity of methanolic extracts of peanut hulls from various cultivars. J. Am. Oil Chem. Soc. 72 (9): 1065-1067.