Journal of Herbal Drug
journal homepage: www.jhd.iaushk.ac.ir

Antioxidant activity of Sage (Salvia officinalis), Red Cabbage (Brassica oleracea), Walnut Leaf (Juglans regia L.), Yellow Sweet Clover (Melilotus officinalis) and Hawthorn (Crataegus oxyacantha) at different temperatures

Mohammad Momen Heravi, Shahla Daneshmehr*, Ali Morsali

Department of Chemistry, Mashhad Branch, Islamic Azad University, Mashhad, Iran;

Email: daneshmehr@mshdiau.ac.ir*

ARTICLE INFO

Type: *Original Research*

Topic: *Medicinal Plants*

Received *February 14th 2014*

Accepted *May 20th 2014*

Key words:

- ✓ *Cancer*
- ✓ *Free Radical*
- ✓ *Scavenging Activity*
- ✓ *Medicinal Plant*

ABSTRACT

Background & Aim: Medicinal plants can be a good replacement for common cancer treatment including chemotherapy, radiation therapy and surgery because they don't have many side effects. The aim of this study was to investigate the effect of temperature on the free radical scavenging in the presence of medicinal plants.
Experimental: For determination of free radical scavenging activity by using the stable 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay at different temperatures, two investigations were carried out: first ethanolic extracts of Sage (Salvia officinalis), Red Cabbage (Brassica oleracea), Walnut Leaf (Juglans regia L.), Yellow Sweet Clover (Melilotus officinalis) and Hawthorn (Crataegus oxyacantha) one by one and then the mixtures of each pair of plants in order to determine plant-plant interactions.
Results: Because of Herb-Herb interactions, the most free radical scavenging percentages are related to plants in single forms not mixtures. The results demonstrated that with increasing temperature free radical scavenging increased in the presence of Sage, while it decreased in the presence of Hawthorn. The highest free radical scavenging percentages at temperatures ranging from ambient to body and fever are related to Sage at 25˚C, then Walnut Leaf at 37˚C and finally, Hawthorn at 40˚C.
Recommended applications/industries: The results indicated that for preventing herb-herb interactions, medicinal plants as tea, food and fruit are used alone.

1. Introduction

Cancer has existed for all of human history (Hajdu *et al*., 2011). It is a disease in which abnormal cells divide and to be multiply in a malignant tumor. In a healthy organism, always between the rate of cell division and cell death is a balance (Munari *et al*., 2014; Markert 1968). Reactive oxygen species (ROS) are a byproduct of normal metabolism. Additionally, ROS are produced in cells as a response to several factors, including oxidative and thermal stresses, ultraviolet light, chemical agents, and ionizing radiation. Oxidative stress can cause DNA damage, cell functions inhibition, lipid and protein peroxidation, and disturbance of glutathione levels (Yoo *et al*., 2008). In

addition, ROS contribute to the development of cancer, diabetes, atherosclerosis, inflammatory diseases, and ageing (Beal, 1995; Harman, 1956 & 1992; Lee *et al*., 2005). ROS are divided into free radical species, such as superoxide anion radical, hydroxyl radical, and non-free radical that are involved in oxidative reactions, such as singlet oxygen (Esmaeili *et al*., 2010). ROS free radicals contain unpaired electrons, which usually show a high degree of reactivity with biological macromolecules such as proteins, lipids, and DNA (Halliwell & Gutteridge, 1999). Free radicals can oxidize DNA bases (especially guanine), leading to mutations (Harman, 1956 & 1992). Oxidative damages can be reduced through enzymatic mechanisms such as superoxide dismutase (SOD) and catalase (CAT) or by antioxidants presented as natural products (Boo *et al*., 2012). The antioxidants realize the balance of formation and destroying the free radicals. They are able to trap or to block, to scavenge, to remove free radicals by substitution, addition or electron transfer reactions (Popescu *et al*., 2011; Rizea *et al*., 2012). As part of a healthy lifestyle and a well-balanced, wholesome diet, antioxidant supplementation is now being recognized as an important means of improving free radical protection (Rock *et al*., 2012). Many synthetic drugs protect against oxidative damage, but some have adverse side effects (Munari *et al*., 2014). An alternative solution to overcome ROS is to consume natural antioxidants from food, beverages, and traditional medicines containing natural antioxidants such as L-ascorbic acid, tocopherol, and polyphenols (Van Wyk & Wink, 2004 & 2008; Yazdanparast & Ardestani, 2007; Wink & Abbas, 2013). The use of medicinal plants is perhaps the oldest method of coping with illnesses throughout the world and physicians and patients have looked for the natural drugs, nontoxic remedy and suitable to the organism. Because of the quality of medicinal plants and some research results, many people have the mistaken notion that, being natural, all herbs and foods are safe. Especially in the last decade, with more intensive studies devoted to natural therapies (Dejica, 2000; Feher *et al*., 1988). Medicinal plants are commonly rich in phenolic compounds, such as flavonoids, phenolic acids, stilbenes, tannins, coumarins, lignans and lignins (Van Wyk & Wink, 2004;, Atanassova *et al*., 2011; Jeong *et al*., 2004; Hamdy Roby *et al*., 2013; Packer *et al*., 1999; Daffodil *et al*., 2014; Ali *et al*., 2008; Velioglu *et al*., 1998; Amarowicza *et al*., 2004). These compounds in various plant products (such as fruits, leaves, seeds, and oils) have multiple biological effects including antioxidant activity and radical scavenging in the last several years (Lugasi *et al*., 1998; Kähkönen *et al*., 1999; Mensor *et al*., 2001; Singh *et al*., 2002; Parejo *et al*., 2002). Sage (Salvia officinalis), Red Cabbage (Brassica oleracea), Walnut Leaf (Juglans regia L.), Yellow Sweet Clover (Melilotus officinalis) and Hawthorn (Crataegus oxyacantha) are medicinal plants , are economically and nutritionally important vegetable consumed widely around the globe and they are good source of health-promoting compounds that show preventive effect against cancer, atherosclerosis, nephritis and diabetes mellitus (Singh *et al*., 2009; Taveira *et al*., 2009; Jaiswal *et al*., 2012; Miliauskas *et al*., 2004).

DPPH (2, 2-diphenyl-1-picrylhydrazyl) radical scavenging assay is mostly applied to rapidly examine the antioxidant capacity of samples. This method is widely used, as its reliability on giving information about the main property of antioxidant potential for many medicinal plants (Kedare & Singh, 2011; Huang *et al*., 2009; Fu *et al*., 2010).

DPPH can accept an electron or hydrogen radical to become a stable and diamagnetic molecule. It can be oxidized difficulty, and then irreversibly. When DPPH reacts with antioxidant compounds, it can donate hydrogen, so it is reduced. Fig 1. Many studies investigated interaction between herb-drug, food-drug, herb-herb, nutrient-drug and drug-drug (Sørensen, 2002; San Miguel *et al*., 2005; Williamson, 2003 & 2005; Evans & McLeod, 2003; Tarirai *et al*., 2010; Cheng *et al*., 2010; Manek *et al*., 2011; Fasinu *et al*., 2012; Zeping *et al*., 2005; *Izzo & Ernst, 2001;* Zhou *et al*., 2010) and other

research results showed that the radical scavenging activities of all the plants extracts increased with increasing concentration (Ghasemi *et al*., 2011; Heo *et al*., 2014; Anissi *et al*., 2014; Zhang *et al*., 2014; Krishnaiah *et al*., 2011; Turkmen *et al*., 2006). Therefore, this work investigates the effects of temperature on free radical scavenging percentage with same concentration at temperatures ranging from ambient to body and fever.

2. Materials and Methods

2.1. Chemical and reagent

The reagent 2,2-Diphenyl-1-picrylhydrazyl (DPPH) was supplied by Sigma (St. Louis, USA). All other reagents (acetonitrile, Hydrochloric acid and ethanol) were purchased from Merck.

2.2. Plant materials and preparation of extracts

Fresh plants including: sage (Salvia officinalis), hawthorn (Crataegus oxyacantha), walnut leaf (Juglans regia L.), red Cabbage (*Brassica oleracea*), yellow sweet clover (Melilotus officinalis) were collected from Azerbaijan mountains located at northwest of Iran. The gathered samples were dried at ambient temperature and under sunlight for 5 days. Dried plants were milled with sample mill (300 Waufn S2, Germany) and in turn extracted with two solvents: HCl (1.5M) and ethanol (95%). A 2gr of each samples were extracted by dissolving in 85mL ethanol and 15mL HCl. Flasks were kept in a shaking incubator (Boekel Jitterbug Microplate, Cole-Parmer, USA) at 1000 rpm and 40^{o}C for 1 h. The extracts were concentrated at 40^{O}C for 15 min. The infusions were filtered through Whatman filter paper twice, until a clear extract was obtained.

2.3. Instrumentation

All spectrophotometric data were acquired using Perkin Elmer Lambda 25 UV-Vis spectrophotometer. Glass cuvettes (1 cm × 1 cm × 4.5 cm) were used for UV-Vis absorbance measurements. The temperature in the cell was controlled by using JULABO Heating Immersion Circulator.

2.4. DPPH radical scavenging assay

Radical scavenging activity of plant extracts against stable DPPH was determined spectrophotometrically. DPPH shows a strong absorption band at 517 nm. The solution of DPPH in Acetonitrile (6×10^{-5} M) was prepared daily, before UV-Vis measurements. 3 ml of this solution were mixed with 1 µl extract solution (extract: ethanol, 1:10 v/v).

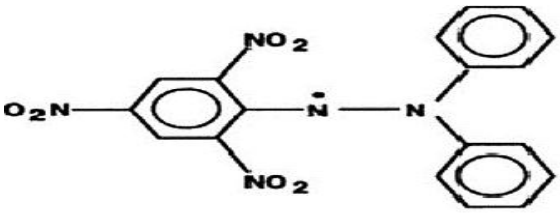
For pair interactions, 1 µl extract solution consists of 0.5 µl of each extract.

The experiments were repeated for three times. The percentage of DPPH radical scavenging by the samples was calculated according to formula, % scavenging = $[\{A_i - A_f\}/A_i]\times 100$, where A_i control is the absorbance of DPPH radical, A_f sample is the absorbance of DPPH radical with extract after 30min.

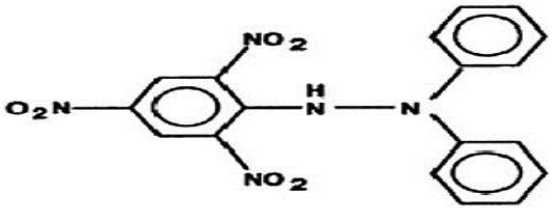
3. Results and discussion

Comparing results of free radical scavenging percentage in the presence of ethanolic extracts of Sage, Red Cabbage, Walnut Leaf, Yellow Sweet Clover and Hawthorn one by one and mixtures of each pair of plants with same concentration at temperatures ranging from 25˚C to 40˚C, on the basis of data were measured by UV-Vis spectroscopy, are summarized in Table 1. The results provided in Table 1 show that the highest free radical scavenging percentage was the ethanolic extract of Sage at 25˚C and with increased temperature decreased free radical scavenging percentage, while the lowest free radical scavenging percentage of Sage extract related to 40˚C. Walnut leaf extract was more effective than 3 other single extracts against free radical and different temperatures have no significant effects on them. However, Red cabbage extract has weak free radical scavenging at all temperatures except for 25˚C.

Fig.1. Medicinal plants



Diphenylpicrylhydrazyl (free radical)



Diphenylpicrylhydrazine (nonradical)

Fig.2. The structure of free radical and nonradical.

Table 1. Effect of temperature on the free radical scavenging.

Temperature / Plant	25	28	31	34	37	40
Sage	96	78	56	26	25	23
Red Cabbage	66	27	18	30	18	26
Walnut Leaf	43	30	34	35	55	42
Yellow Sweet Clover	22	40	45.5	42	44	43
Hawthorn	27	31	35	37	40	55
Hawthorn & Yellow Sweet Clover	11	12	23.5	17	17	8
Sage & Yellow Sweet Clover	12	10	9.5	3.5	3	1
Sage & Hawthorn	19	17.5	21	21	12	21
Red Cabbage & Yellow Sweet Clover	22	16	14	16	17	18
Hawthorn & Red Cabbage	17	32.5	27	23.5	29	35
Walnut Leaf & Yellow Sweet Clover	22	18	14	21	31	35
Walnut Leaf & Red Cabbage	32	33	31	36	34	34
Walnut Leaf & Sage	13	25	17	27	29	31
Red Cabbage & Sage	23.5	29	19.5	25	23.5	22
Walnut Leaf & Hawthorn	17	9	8	1.6	16	18

The most scavenging percentage in mixture form is related to extract of Walnut Leaf and Red Cabbage at all temperatures. Overall, Free radical scavenging for mixtures of extracts reduced at all temperatures.

4. Conclusion

The determination of free radical scavenging percentage in ethanolic extracts of medicinal plants at different temperatures was done. Results show increasing or decreasing temperature doesn't have same effect on the free radical scavenging percentage at the presence of medicinal plants. So that, free radical scavenging in the presence of Saga increased with increasing temperature, while in the presence of Hawthorn decreased with increasing temperature but at the presence of Walnut Leaf, Red Cabbage, Yellow Sweet Clover, temperature doesn't have beneficial effects. The most free radical scavenging percentage are related to sage at 25˚C, 28˚C and 31˚C, yellow sweet clover at 34˚C, walnut leaf at 37˚C and hawthorn at 40˚C.Also this paper suggests that for preventing herb-herb interactions, medicinal plants as tea, food and fruit are used alone.

5. References

Ali, B.H., Blunden, G., Tanira, M.O. and Nemmar, A. 2008. Some phytochemical, pharmacological and toxicological properties of ginger (Zingiber officinale Roscoe): A review of recent research. *Food and Chemical Toxicology*, 46: 409-420.

Amarowicza, R., Pegg, R.B., Rahimi-Moghaddam, P., Barld, B. and Weil, J.A. 2004. Free-radical scavenging capacity and antioxidant activity of selected plant species from the Canadian prairies. *Food Chemistry*, 84: 551–562.

Anissi, J., Hassouni, M.E., Ouardaoui, A. and Sendide, K. 2014. A comparative study of the antioxidant scavenging activity of green tea, black tea and coffee extracts: A kinetic approach. *Food Chemistry*, 150: 438–447.

Atanassova, M., Georgieva, S. and Ivancheva, K. 2011. Total phenolic and total flavonoid contents, antioxidant capacity and biological contaminants in medicinal herbs. *The Journal of Chemical Technology and Metallurgy*, 46: 81-88.

Beal, M.F. 1995. Aging, energy and oxidative stress in neurodegenerative diseases. *Annals of Neurology*, 38: 357–366.

Boo, H.O., Heo, B.G. and Gorinstein, S. 2012. Analytical methods for enzyme and DPPH radical scavenging activities of natural pigments from some plants. *Food Analytical Methods*, 5: 1354–1361.

Chan, Y.C., Ali, A.S.M., Khairuddean, M., Khaw, K.Y., Murugaiyah, V. and Basiri, A. 2013. Synthesis and molecular modeling study of Cu (II) complexes derived from 2-(diphenylmethylene) hydrazinecarbothioamide derivatives with cholinesterase inhibitory activities. *Chinese Chemical Letters*, 24: 609–612.

Cheng, C.W., Fan, W., Ko, S.G., Song, L. and Bian, Z.X. 2010. Evidence-Based Management of Herb-Drug Interaction in Cancer Chemotherapy. *Explore New York*, 6: 324–329.

Daffodil, E.D., Lincy, P. and Mohan, V.R. 2014. Study of whole plant of vernonia cinerea less for in vitro

antioxidant activity. *International Journal of Pharmaceutics*, 4: 172-178.

Dejica, C. Antioxidanti si terapie antioxidanta, (Ed.), *Editura Casa Cărții de Știință Cluj-Napoca*, 2000; pp. 71-120.

Esmaeili, M.A. and Sonboli, A. 2010. Antioxidant, free radical scavenging activities of Salvia brachyantha and its protective effect against oxidative cardiac cell injury. *Food and Chemical Toxicology*, 48: 846–853.

Evans, W.E. and McLeod, H.L. 2003. Pharmacogenomics - Drug Disposition, Drug Targets, and Side Effects. *New England Journal of Medicine*, 6: 538-549.

Fasinu, P.S., Bouic, P.J. and Rosenkranz, B. 2012. An overview of the evidence and mechanisms of herb–drug interactions. *Frontiers in Pharmacology*, 3: 69.

Feher, J., Csomos, G. and Verechei, A. 1988. *Free radical Reactions in medicine*, Springer Verlag, Berlin-Heidelberg-New-York, pp. 11-46, 48-137.

Fu, W., Lei, Y.F., Cai, Y.L., Zhou, D.N. and Ruan, J.L. 2010. A new alkylene dihydrofuran glycoside with antioxidation activity from the root bark of *Morus Alba* L. *Chinese Chemical Letters*, 21: 821–823.

Ghasemi, K., Ghasemi, Y., Ehteshamnia, A., Nabavi, S.M., Nabavi, S.F., Ebrahimzadeh, M.A. and Pourmorad, F. 2011. Influence of environmental factors on antioxidantactivity, phenol and flavonoids contents of walnut (Juglans regia L.) green husks. *Journal of Medicinal Plants Research*, 5: 1128-1133.

Hajdu, S.I., Thun, M.J., Hannan, L.M. and Jemal, A. 2011. A note from history: landmarks in history of cancer, part1. *Cancer*, 117: 1097–102.

Halliwell, B. and Gutteridge, J.M.C. 1999. *Free radicals in biology and medicine*, third ed., Oxford University Press, Oxford, UK.

Hamdy Roby, M.H., Sarhana, M.A., Selima, K.A.H. and Khalel, K.I. 2013. Evaluation of antioxidant activity, total phenols and phenolic compounds in thyme (Thymus vulgaris L.), sage (Salvia officinalis L.), and marjoram (Origanum majorana L.) extracts. *Industrial Crops and Products*, 43: 827–831.

Harman, D. 1956. Aging: A theory based on free radical and radiation chemistry. *Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 11: 298–300.

Harman, D. 1992. Free radical theory of aging. *Mutation Research*, 275: 257–266.

Heo, B.G., Park, Y.J., Park, Y.S., Bae, J.H., Cho, J.Y., Park, K., Jastrzebskif, Z. and Gorinsteing, S. 2014. Anticancer and antioxidant effects of extracts from different parts ofindigo plant. *Industrial Crops and Products*, 56: 9–16.

Huang, K.X., Feng, Y.B., Yao, W., Yang, L.X., Wang, F., Li, H.B., Zeng, S., Gong, J.X., Hu, M.H., Zhao, Y., Wu, X.M., Li, X.K. and Qu, J. 2009. Evaluation of lipid peroxidation inhibition and free radical scavenging abilities of 5, 6, 7-trimethoxy dihydroflavonols. *Chinese Chemical Letters*, 20: 1187–1190.

Huang, X.Z., Yin, Y., Dai, J.H., Liang, H., Dai, Y. and Bai, L. 2010. Two new ceramides from the stems of Piper betle L. *Chinese Chemical Letters*, 21: 433–436.

Izzo,A.A. and Ernst,E. 2001. Interactions between herbal medicines and prescribed drugs A Systematic Review. *Journal of Alternative and Complementary Medicine*, 61 (15): 2163-2175.

Jaiswal, A.K., Gupta, S. and Abu-Ghannam, N. 2012. Kinetic evaluation of colour, texture, polyphenols and antioxidant capacity of Irish York cabbage after blanching treatment. *Food Chemistry*, 131: 63–72.

Jeong, S.Y., Kim, D.R., Kim, K.C., Nam, D.U. and Ahn Lee, S.C. 2004. Effect of seed roasting conditions on the antioxidant activity of defatted sesame meal extracts. *Food and Chemical Toxicology*, 69: 377–381.

Kähkönen, M.P., Hopia, A., Vuorela, H.J., Rauha, J.P., Pihlaja, K., Kujala, T.S. and Heinonen, M. 1999. Antioxidant activity of plant extracts containing phenolic compounds. *Journal of Agricultural and Food Chemistry*, 47: 3954-3962.

Kedare, S.B. and Singh, R.P. 2011. Genesis and development of DPPH method of antioxidant assay. *Journal of Food Science and Technology*, 48: 412–422.

Krishnaiah, D., Sarbatly, R. and Nithyanandam, R. 2011. A review of the antioxidant potential of medicinal plant Species. *Food and Bioproducts Processing*, 89: 217–233.

Lee, K.W., Hur, H.J., Lee, H.J. and Lee, Y.C. 2005. Antiproliferative effects of dietary phenolic substances and hydrogen peroxide. *Journal of Agricultural and Food Chemistry*, 53: 1990–1995.

Lugasi, A., Dworschák, E. and Kéry, A. 1998. Antioxidant and free radical scavenging properties of squeezed juice from black radish (Raphanus sativa L. var. niger) root. *Phytotherapy Research*, 12: 502-506.

Manek,R.A., Sheth, N.R.,Vaghasiya, J.D., Malaviya, S.V.,Jivani, N.V. and Chavda J. R. 2011. Study on Herb-herb Interaction Potential of *Glycyrrhiza glabra* with *Solanum xanthocarpum* and *Adhatoda vasica* on Mast Cell Stabilizing Activity. *International Journal of Pharmaceutics*, 7: 589-598.

Markert, C.L. 1968. Neoplasia: A Disease of Cell Differentiation. *Cancer Research*, 28: 1908-1914.

Mensor, L.L., Menezes, F.S., Leitão, G.G., Reis, A.S., Dos Santos, T.C., Coube, C.S. and Leitão, S.G. 2001. Screening of Brazilian plant extracts for antioxidant activity by the use of DPPH free radical method. *Phytotherapy Research*, 15: 127-130.

Miliauskas, G., Venskutonis, P.R. and Van Beek, T.A. 2004. Screening of radical scavenging activity of some medicinal and aromatic plant extracts. *Food Chemistry*, 85: 231–237.

Munari, C.C., Oliveira, P.F., Campos, J.C.L., Martins, S.P.L., Costa, J.C., Bastos, J.K. and Tavares, D.C. 2014. Antiproliferative activity of Solanum lycocarpum alkaloidic extract and their constituents, solamargine and solasonine, in tumor cell lines. *Journal of Natural Medicines*, 68: 236-241.

Packer, L., Rimbach, G. and Virgili, F. 1999. Antioxidant activity and biologic properties of a procyanidin-rich extract from pine (pinus maritima) bark, pycnogenol. *Free Radical Biology and Medicine*, 27: 704-724.

Parejo, I., Viladomat, F., Bastida, J., Rosas-Romero, A., Flerlage, N., Burillo, J.S. and Codina, C. 2002. Comparison between the Radical Scavenging Activity and Antioxidant Activity of Six Distilled and Nondistilled Mediterranean Herbs and Aromatic Plants. *Journal of Agricultural and Food Chemistry*, 50: 6882-6890.

Popescu, M., Ivopol, G., Dune, A., Ivopol, M. and Manea, S. 2011. Azeotropic distillation starting from fresh vegetable materials, an interesting alternative to simple extraction from vegetable dried sources. *Revista de Chimie –Bucharest*, 62: 1131-1135.

Rizea, G.D., Popescu, M., Ionescu, D., Mihele, D. and Manea, S. 2012. Comparative determinations of antioxidant free radical scavenging polyphenols in certain natural products by HPLC methods and UV-Vis spectrophotometry. *Revista de Chimie – Bucharest*, 63: 1085-1088.

Rock, C.L., Doyle, C., Demark-Wahnefried, W., Meyerhardt, J., Courneya, K.S., Schwartz, A.L., Bandera, E.V., Hamilton, K.K., Grant, B., McCullough, M., Byers, T. and Gansler, T. 2012. Nutrition and physical activity guidelines for cancer survivors. *CA: A Cancer Journal for Clinicians*, 62: 242-274.

Singh, B.K., Sharma, S.R. and Singh, B. 2009. Heterosis for mineral elements in single cross-hybrids of cabbage (Brassica oleracea var. capitata L.). *Scientia Horticulturae –Amsterdam*, 122: 32–36.

Singh, R.P., Murthy, K.N.C. and Jayaprakasha, G.K. 2002. Studies on the antioxidant activity of promegranate (Punica granatum) peel and seed extracts using in vitro models. *Journal of Agricultural and Food Chemistry*, 50: 81-86.

Sorensen. J.M. 2002. Herb – Drug, Food – Drug, Nutrient – Drug, and Drug – Drug Interactions: Mechanisms Involved and Their Medical Implications. *Journal of Alternative and Complementary Medicine*, 8: 293-308.

Tarirai, C., Viljoen, A.M. and Hamman, J. H. 2010. Reviews: Herb–drug pharmacokinetic interactions reviewed. *Expert Opinion on Drug Metabolism and Toxicology*, 6: 1515-1538.

Taveira, M., Pereira, D.M., Sousa, C., Ferreres, F., Andrade, P.B., and Martins, A. 2009. In vitro cultures of Brassica oleracea L. var. costata DC: Potential plant bioreactor for Antioxidant Phenolic Compounds. *Journal of Agricultural and Food Chemistry*, 57: 1247–1252.

Teresa San Miguel, M. Alfredo Martínez, J. and Vargas , E. 2005. Food–drug interactions in the summary of product characteristics of proprietary medicinal products. *European Journal of Clinical Pharmacology*, 61: 77-83.

Turkmen, N., Sari, F. and Velioglu, Y.S. 2006. Effects of extraction solvents on concentration and antioxidant activity of black and black mate tea polyphenols determined by ferrous tartrate and

Folin–Ciocalteu methods. *Food Chemistry*, 99: 835–841.

Van Wyk, B.E. and Wink, M. 2004. *Medicinal Plants of the World*, Timber Press, Portland, OR, Cambridge.

Velioglu, Y.S., Mazza, G., Gao, L. and Oomah, B.D. 1998. Antioxidant activity and total phenolics in selected fruits, vegetables, and grain products. *Journal of Agricultural and Food Chemistry*, 46: 4113–4117.

Williamson, E.M. 2005. Review, Interactions between herbal and conventional medicines. *Expert Opinion on Drug Safety*, 4: 355-378.

Williamson, E.M. 2003. Drug interactions between herbal and prescription medicines. *Drug Safety*, 26: 1075-1092.

Wink, M. and Abbas, S. 2013. *Epigallocatechin gallate (EGCG) from green tea (Camellia sinensis) and other natural products mediate stress resistance and slows down aging processes in Caenorhabditis elegans. In: Tea in health and disease prevention*. Elsevier, London, pp. 1105–1116.

Wink, M. and Van Wyk, B.E. 2008. *Mind-altering and poisonous plants of the world*, Timber Press, Portland, OR, London.

Yazdanparast, R. and Ardestani, A. 2007. In vitro antioxidant and free radical scavenging activity of Cyperus rotundus. *Journal of Medicinal Food*, 10: 667–674.

Yoo, M.K., Lee, H.C., Lee, H., Moon, B. and Lee, Y.C. 2008. Relative antioxidant andcytoprotective activities of common herbs. *Food Chemistry*, 106: 929–936.

Zeping, H., Xiaoxia, Y., Paul Chi Lui, H., Sui Yung, C., Paul Wan Sia, H., Eli, C., Wei,D., Hwee Ling,K. and Shufeng, Z. 2005. Herb-drug interactions: a literature review. *Drugs*, 65: 1239-1282.

Zhang, X.J., Liu, L.J., Song, T.T., Wang, Y.Q. and Yang, X.h. 2014. An approach based on antioxidant fingerprint–efficacy relationship and TLC bioautography assay to quality evaluation of Rubia cordifolia from various sources. *Journal of Natural Medicines*, 68: 448–454.

Zhou, X., Poon, J., Kwan, P., Zhang, R., Wang, Y., Poon, S., Liu, B. and Sze, D. 2010. *Novel Two-Stage Analytic Approach in Extraction of Strong Herb-Herb Interactions in TCM Clinical Treatment of Insomnia*. Vol. 6165. Lecture Notes in Computer Science. Springer Berlin Heidelberg. pp. 258-267.