

Innovative beverages of coffee and tea based on dandelion (*Taraxacum officinale*) roots and leaves

Aly R ABDEL-MOEMIN and Alaa OSAMA ABORAYA
Nutrition and Food Science, Faculty of Home Economics, Helwan University, Egypt

ABSTRACT

The utilisation of dandelion in the Egyptian food industry has not been fully exploited. The aim of this study was to promote the utilisation of dandelion as a natural, cheap and largely available plant in the Egyptian.fields. Furthermore, to produce coffee and tea substitutes for regular coffee and tea to reduce the cost of the product with healthy option for consumers who aimed to reduce their caffeine consumption. Chemical composition of dandelion roots and leaves, total phenolics, trolox equivalent antioxidant capacity (TEAC) and ferric reducing antioxidant power (FRAP) assays were analysed. Coffee substitute beverages have been made from dandelion roots or blended with traditional Arabic coffee or with instant coffee. Dandelion tea was also made from dandelion leaves on its own or blended with hibiscus. The study included the acceptance test for the beverages made for taste, odour, astringency, aftertaste, appearance and consistency for coffee products. The results indicate that the total phenolics were 14 and 4.3 mg/g fresh weight/gallic acid equivalents (F.W.GAE) for roots and leaves respectively. Dandelion roots showed average values of 164 µmol Trolox/g and 170 µmol Fe^{+2}/g for TEAC and FRAP respectively. Dandelion leaves were 47 µmol Trolox/g and 14 µmol Fe^{+2}/g for TEAC and FRAP respectively. Acceptance test indicates that roots blended with light Arabic coffee and dandelion leaves blended with hibiscus beverages were the most accepted among panellists. The study showed that dandelion roots could be very useful when mixed with regular daily coffee. The antioxidants in dandelion extracts possess free radical scavenging activity and oxidant reducing power, and the high positive correlation between antioxidant capacities and total phenolics.

Key words: dandelion root, dandelion leaves, natural substitutes for coffee, 5-point hedonic scale, acceptance test-TEAC, FRAP

INTRODUCTION

Coffee drinking is one of the most popular beverages in the world due to its distinctive aromatic flavours and delightful taste (Dorea and da Costa 2005). A good quality cup of coffee is depended on many factors, for example the quality of green beans, the roasting settings, the period since the beans are roasted, and the type of water used for brewing. More than 800 volatile compounds have been identified in roasted coffee; where of around 30 compounds are responsible for the main impression of coffee aroma (Baggenstoss et al. 2008).

Most coffee beverage consumed around the world is produced by the species *Coffea arabica* L. (Arabic coffee, Arabian coffee, arabica coffee) and *C. canephora* Pierre ex Froehner (robusta coffee). The former one is considered to be more important due to its sensory characteristics (Bertrand et al. 2003) and, therefore, reaches higher prices in the international market (Gielissen and Graafland 2009).

Tea (originating from *Camellia sinensis* (L.) Kuntze) is the most widely consumed beverage in the world, next only to water (Schmidt et al. 2005). The international market for tea is expected to grow from $6.8 billion to $10 billion by end of 2010 (Sloan 2005). Tea leaves contain about 35% polyphenols by dry weight which exhibits a wide range of biological activities. Green tea, that is popular in Asia, is a rich source of flavonoids such as catechin (C), epicatechin (EC), epigallocatechin (EGC) and their gallate esters CG, ECG, EGCG. In black tea, which is more popular in Egypt, Africa, Europe and the U.S., the catechins are converted to complex condensation products, such as theaflavins (TFs) and thearubigins (TGs), which give the brew its rich properties (Abdel-Moemin 2004).

Dandelion *(Taraxacum officinale* agg. F. H. Wigg.) is a common weed in the Egyptian fields; it grows wild in the fields. Dandelion is better known as a folk remedy than a conventional medicine. Its choleretic, diuretic, antirheumatic, anti-inflammatory, appetite-stimulating and laxative properties are well known anecdotally as a treatment for liver and gallbladder disorders, digestive complaints, arthritic and rheumatic disorders as well as eczema and other skin conditions (Hagymasi et al. 2000).

Key ingredients in dandelion are phenolic acids such as

**Correspondence to:*
E-mail: dralymoemin@yahoo.co.uk

caffeic acid, chlorogenic acid, p-hydroxyphenyl acetic acid (Duke 1992, Barnes et al. 2002). Fatty acids for example, linoleic acid, linolenic acid, palmitic acid, oleic acid) (Duke 1992, Barnes et al. 2002).

Terpenoids sesquiterpene lactones of the eudesmanolide type (e. g. taraxacolide glucoside) and germacranolide type (e. g. taraxinic acid glucoside). Triterpenes (e. g. taraxol, taraxerol, Is-amyrin, faradiol) (Blumenthal 2000, Hagymasi et al. 2000).

Phytosterols for example, sitosterol, stigmasterol, taraxasterol (Blumenthal 2000, Hagymasi et al. 2000). Dandelion root is also an excellent general bitter to consider such as glycoside, taraxacin; carbohydrates, inulin, pectin, mucilage; choline (Barnes et al. 2002, Blumenthal 2000); beta-carotene (Duke 1992); minerals (e.g. calcium, chromium, cobalt, iron, magnesium, potassium, selenium, zinc); sugars (e. g. glucose, fructose, sucrose) and vitamins A, B, C and D (Duke 1992, Hagymasi et al. 2000).

The British Herbal Pharmacopoeia (BPH) recommends 0.5 to 2 g of root or 4 to 8 mL of root tincture, both 3 times/day (Hoffmann 2003). The German Commission E Monographs recommend doses of 3 to 4 g of root twice daily or 10 to 15 drops of tincture 3 times/day (Blumenthal et al. 2000). BPH recommends 3 to 5 g of leaf or 5 to 10 mL of leaf tincture, both 2 times/day (Hoffmann 2003). Commission E recommends 4 to 10 g of leaf or 2 to 5 mL of tincture, both 3 times/day (Blumenthal et al. 1998).

Today, there is growing concern over the possible health effects of habitual consumption of herbal tea and coffee, which is one of the two most popular beverages in the world (IARC 1991). Therefore, the current study focused to benefit from the dandelion to reduce the cost of coffee expenses and use in an innovative way to benefit from health effects.

MATERIALS AND METHODS

Sample collection and preparation

Dandelions leaves and roots were collected from Dakahlia governorate fields on March 2013. Three 3 packs of Instant coffee (Nescafe) has been purchased from local market (Kehir Zamaan El Haram branch, Cairo, Egypt). Three samples from 3 packages of The Arabic coffee grains (Indonesian) were purchased from local coffee roaster, Egypt.

Chemicals

Unless otherwise stated, all chemicals were purchased from Sigma Co., Egypt. All chemicals were 'Analar'grade or the highest grade available. Trolox, 2,2'-azinobis (3-ethylbenothiazoline-6-sulfonic acid) diammonium salt (ABTS), Folin–Ciocalteu's phenol reagent, 2,4,6-tri(2-pyridyl)-*s*-triazine (TPTZ), sodium carbonate and gallic acid. Potassium persulfate, iron (III) chloride 6-hydrate, iron (II) sulfate 7-hydrate, acetic acid, sodium carbonate, acetic acid, sodium acetate, hydrochloric acid and methanol.

Methods

Preparation of plant material

The fresh middle sized dandelion roots or leaves were collected, cleaned, chopped, weighed lyophilized in the freeze-dryer (Snijders Scientific-tilburg, Holland, capacity 3kg Ice), weighed again and grounded into a powder and stored at -20°C until required for chemical and sensory analysis. Freeze-drying took place 2 and 3 days for roots and leaves respectively.

Proximate analysis

Three samples (5 gm) from each dandelion leaves or roots were examined for moisture, protein, lipid, carbohydrate, crude fibre and ash based on the dry matter. Moisture and dry matter were determined by using Infrared Moisture Determination Balance (FD-610-Japan) with a 5g sample at 80°C for 60 min, reading was taken every 5 minutes. The fat content was determined using the ether extraction technique according to the procedure described in the Official Method of the Association of Official Analytical Chemists (AOAC, International 2005).

The freeze-dried dandelion samples were milled and the lipids were extracted for 16 hr with petroleum ether (boiling range 30-60°C) in a Soxhlet apparatus. The lipids percentage was determined by weight difference. Ash and nitrogen contents were determined according to the AOAC methods 27.009 and 27.007, respectively (AOAC, 1980). Ash was performed by incineration in a muffle furnace (Nabertherm, D2804, lilenthial-Bremen, W-Germany) at 525 °C. The nitrogen content was estimated according to the Kjeldahl method and converted to protein percentage by using the conversion factor 5.46 (method 27.007, AOAC, 1980). The carbohydrate content was estimated by calculating its difference from the other components using the following formula (Mestrallet et al. 2004): carbohydrate content = 100% - (% protein + % lipid + % ash).

Determination of total phenols

Total phenols content were determined by Folin-Ciocalteu reagent according to Singleton and Rossi (1965) with little modification. The test is based on all phenolic compounds contained in dandelion samples oxidized by Folin-Ciocalteu reagent. This reagent is formed from a mixture of phosphotungstic acid, $H_3PW_4O_{40}$ and phosphomolybdic acid, $H_3PMo_{12}O_{40}$, which, after oxidation of the phenols, is reduced to a mixture of blue oxides of tungsten, W_8O_{23}, and molybdenum, Mo_8O_{23}. The blue colouration produced has a maximum absorption in the region of 750 nm, and is proportional to the total quantity of phenolic compounds originally present in food material.

Extraction of flavonoids

Phenolic compounds were extracted by adding one gram of ground dried leaves or roots to 100-mL of aqueous methanol (1:1) and kept at room temperature in dark place for 24 hr. The samples were centrifuged for 3 min. at 3000 rpm and the supernatant was poured and filtered into a10-mL test tube.

Gallic acid stock solution

In a 100-mL volumetric flask, 0.500 g of dry gallic acid was dissolved in 10-mL of methanol and diluted to volume with water. In order to prepare a calibration curve, amounts of 0, 1, 2, 3, 5, and 10-.mL of gallic acid stock solution were added into 100 mL volumetric flasks, and diluted to volume with water. These solutions had phenol concentrations of 0, 50, 100, 150, 250 and 500 mg/L gallic acid. The stability of gallic acid stock and standard solutions were tested (data not shown) and the loss was less than 3-5% for stock and solutions over 4 weeks at 4˚C

Since the assay measures all phenolics, the choice of gallic acid as standard is based on the availability of a stable and pure substance. In addition, the response to gallic acid has been shown to be equivalent to most other phenolics in foods on a mass basis.

Sodium carbonate solution

A 200-g of anhydrous sodium carbonate was dissolved in 800-mL of water and brings to a boil. After cooling, sodium carbonate was added, and after 24 hr, filtered and added water to up to 1L mark.

The amount of total phenolics content was determined using Folin-Ciocalteu reagent A 100-µL sample or water for blank was pipetted into separate tubes, and to each tube we added 1.6 mL water, and 100 µL of the Folin-Ciocalteu reagent, and mixed well. The tubes were left for 8 min.; 300 µL of the sodium carbonate solution (20%) was added and mixed well with tube contents. The tubes were left at room temperature in a dark place for 2 h until the blue colour developed and measured the absorbance of each solution at 750 nm (CT-2200 Spectrophotometer, E-Chrom Tech, Taiwan) against the blank (the "0 mL" solution) and plotted the absorbance vs. concentration by using gallic acid. The amount of total phenolics was calculated as gallic acid equivalents (GAE) in milligrams per gram fresh weight (mg GAE/g F.W), calculated as mean value ± SD (n = 3).

Quality control

Known amounts of gallic acid were added to dandelion samples tested before and known their amounts of gallic acid, in addition to testing the reagent recoveries in order to obtain percentage of total phenolics recovery. The recovery results of added gallic acid to dandelion samples ranged from 91-102% for samples and 95% for reagent recoveries.

Antioxidant capacities

Antioxidant capacities of dandelion leaves and roots were determined by TEAC and FRAP methods, in order to do that samples were extracted as follows:

The freeze-dried dandelion sample was ground to a fine powder in a coffee mill and 0.5 g of powder of each sample was placed with 10-mL of methanol-water (8:2, v/v) in a shaking water bath at 35 °C for 24 h as described (Cai et al. 2004) with little modification.

The mixture was then cooled to room temperature and centrifuged at 3,000 rpm for 15 min. The upper layer was recovered for the determination of the antioxidant capacity and total phenolic content. All the experiments were carried out in triplicate.

Trolox equivalent antioxidant capacity assay

The TEAC assay was conducted according to the method of Re et al. (1999). Initially, to produce the radical cation $ABTS^{\bullet+}$, 7 mmol/L ABTS salt and 2.45 mmol/L potassium persulphate were mixed in a volume ratio of 1:1, the reaction mixture was allowed to stand in the dark for 16 h at room temperature and was used within 2-3 days of preparation. The $ABTS^{\bullet+}$ radical solution was diluted with ethanol. All samples were diluted, the absorbance of radical solution and samples were read at 734 nm (Li et al. 2007). The results were expressed as µmol Trolox/g dry weight of herbal material.

Ferric reducing antioxidant power assay

Measurement of ferric reducing antioxidant power of the dandelion leaves or roots extract was performed based on the method of Benzie and Strain (1996). Initially, sodium acetate buffer (300 mmol/L, pH 3.6), 10 mmol/L TPTZ solution (40 mmol/L HCl as solvent) and 20 mmol/L iron (III) chloride solution were mixed in a volume ratio of 10:1:1 to generate FRAP reaction solution, which prepared daily and warmed to 37 °C in a water bath before use. The next step was adding 100 µL of the diluted sample to 3-mL of the FRAP reaction solution. After 4 min. of reaction, the absorbance of the reaction mixture was recorded at 593 nm (Wong et al.2004). The standard curve was made using $FeSO_4$ solution, and the results were expressed as µmol Fe (II)/g dry weight of dandelion leaves or root material.

Preparation of dandelion root coffees

Six Egyptian coffee style beverage were made and served to the panellists for evaluations; light regular Arabic coffee, dark regular Arabic coffee, dandelion roots blended with light coffee, dandelion roots blended with dark coffee, dandelion roots blended with instant coffee and dandelion root coffee only. All the beverages were prepared according to Egyptian recipe of making coffee; one teaspoon (3.5g) of dandelion root mixed with cold water (sugar was added according to the panellists taste) stirred for 30 seconds in classic Egyptian

coffee pot and heated on a gentle cooker stove before comes to boiling point poured into small cup made of glass. The second experiment was made from (3.5g) 1:1 Arabic dark/ light coffee mixed with dandelion root and continued recipe as previous. The third preparation was made by from 1:1 (total weight 3.5g) instant coffee and dandelion root, by pouring boiling water on the content of the cup.

Preparation of dandelion tea leaves

Five types of teas were prepared and then served to the panellists for evaluations; regular black tea, green tea, hibiscus tea, dandelion leaves tea, dandelion leaves mixed with hibiscus. The method of preparation teas, 2g samples of dandelion leaves or dandelion leaves with hibiscus formulation were bagged into rectangular infusion tea bags (5cm × 4cm). Commercial black tea (Lipton), hibiscus tea and green tea (Isis) were used as controls all tea bags were 2g. The boiled water was then poured to the content of the each cup with stirring for 15 seconds (sugar was added according to the panellists taste).

Sensory evaluation

Sensory evaluation was carried out in two phases as acceptance tests; the phase one for coffee and phase 2 for tea evaluations. The acceptance tests were conducted on sample infusions using fifty untrained panellists and 5-point hedonic test (Meilgaard et al. 1991).

Acceptance test
Selection of panellists

The panellists (n=50) were from Faculty of Home Economics and a public coffee shop (Arabica Café, Cairo, Egypt). They were recruited according to the following criteria: (1) ages between 20 and 59y, (2) smokers and non-smokers, (3) people without food allergies and (4) people who consumed coffee and/or tea at least twice a week. The number of panellists was decided based on sensory evaluation guidelines (IFT 1981). Panellists were chosen on the basis of their willingness and commitment to participate in the sensory evaluation, and familiarity with coffee, tea, in general or herbal tea in particular. They were neither trained nor given prior information about the constituent ingredients from which the infusions were prepared, there was no evaluation fees were offered to the panellists.

Six samples were presented to the panellists in random order during the test day of coffee. Five samples of teas were served next to dandelion leaves tea or mixed dandelion leaves tea with hibiscus, green tea, black tea, and hibiscus tea were used because the closeness of colour and taste. All samples were presented with water and paper questionnaire on a plastic tray. The panellists were instructed to consume the whole sample and then rinse their mouths with water between samples to minimize any residual effect (Grosso and Resurreccion 2002). A 5-point hedonic scale was used to suit Egyptian tasters to include ranging from 1= dislike very much to 5 = like very much to evaluate acceptance from the coffee and tea samples for the attributes of colour, and flavour, astringency, aftertaste, aroma and overall acceptance from the samples (Meilgaard et al. 1991).

Procedure for serving tea to panellists

The Specialty Coffee Association of America (SCAA) Protocols Cupping (www.scaa.org/?page=resources&d=cupping-protocols) was followed with modification when cupping coffee.

Sample infusions were three-digits coded, about 60-mL of each infusion was served in a 65-mL transparent glass cup. One sample was served at a time. Panellists were discouraged from conferring among one another during the analysis. The sample infusions were approximately 60°C to 70°C at the time of tasting. To minimize possible carry-over effects, panellists were required to rinse their mouths thoroughly with water after each tasting and wait 90 s before tasting the next sample. Panellists were not required to swallow all 60-mL of each sample; however they were to swallow small quantities in order to appreciate the full sensory character of the beverage. Panellists were allowed to repeat tasting where necessary.

The acceptance tests were carried out in two sessions, separated by a 48-hour period. This was to prevent likely panellist fatigue due to the number of samples. Each session started at 10.00AM and lasted for approximately 1.5 h. In both sessions, coffee and tea samples were presented to all panellists.

Before starting each session panellists were asked about their sugar favourites for a reason that traditionally the Egyptian panellists can not put sugar into the coffee after poured in the cup. Similarly, tea panellists were asked about the sugar before serving.

Scoring of samples

The panellists were instructed to score their acceptance for 8 attributes of the coffee infusions: appearance, consistency, colour, aroma, taste, astringency, flavour and overall acceptability. Six attributes were used in the acceptance test for tea colour, aroma, taste, astringency, flavour and overall acceptability. Where a panellist did not clearly comprehend the meaning of a certain attribute, explanation was provided. The panellists scored their acceptance of the attributes using a 5-point hedonic scale.

Statistical analysis

Means and standard deviations ± SD were calculated. Analysis of variance and Duncan test were used to determine significant differences ($\alpha = 0.05$) in acceptance test and chemical analyses (Düzgünes et al. 1987).

RESULTS

Moisture and dry matter of dandelion leaves and roots

The amount of moisture account approximately 77 and 92 % in roots and leaves respectively. The dry matter content was 23 and 7.6 % in roots and leaves respectively.

Calibration curve of gallic acids

Figure (1) shows a direct proportion of the calibration curve of gallic acid between absorbance and concentration of gallic acid ($R^2 = 0.997$).

Proximate analysis of dandelion leaves and roots

The chemical composition of dandelion (Table 1) was estimated in leaves and roots. The results showed that the fat, carbohydrate, protein, water, ash and fibre represent values are 0.3, 1.1, 2.9, 92.2, 1.0 and 2.2 respectively in dandelion leaves compared to 1.7, 10.4, 3.7, 77, 1.9 and 4.5 respectively in dandelion roots.

Total phenolics

As seen in Table (2) dandelion leaves have the lowest total phenolics content (4.3 mg/g GAE) compared to other examined food materials. The content of phenolics in dandelion roots found to be (14.0 mg/g GAE). The Arabic and instant coffee had significantly higher total phenolic contents (215 and 210 mg/g GAE) respectively. The total phenolics of black tea, green tea and hibiscus are displayed in Table (4). Results indicate that the dandelion roots exhibited average values of 164 µmol Trolox/g and 170 µmol Fe^{+2}/g for TEAC and FRAP respectively. For the dandelion leaves it was determined 47 µmol Trolox/g and 14 µmol Fe^{+2}/g for TEAC and FRAP respectively.

Coffee acceptance test

Table (3) shows the results of acceptance test of dandelion roots mixed with different Arabic and instant coffees, which include appearance, aroma, astringency, aftertaste, colour, consistency and overall acceptance. The overall acceptance means of the samples ranged from 2.85 ("4: like moderately") to 3 ("3: neither like nor dislike). Significant differences were found between ground dandelion roots coffee and the rest of coffee samples. The mixed dandelion roots with light Arabic coffee showed values around 4 ("like moderately") on a 5-point hedonic scale and had higher overall acceptance than the normal dark coffee. Dandelion roots mixed with dark coffee had an overall acceptance 3.25 (neither like nor dislike). Dandelion roots mixed with light Arabic coffee had the highest mark in aroma and astringency.
On the other hand, dandelion roots mixed with instant coffee had excellent score colour 4.5 (around 'like very much'). The dandelion roots mixed with light Arabic coffee was the most preferred colour 693 with score (4). Similarly, the dandelion roots mixed with instant coffee 587 scored (4) as an overall acceptability compared to controls LC732, DC764 and IC54.

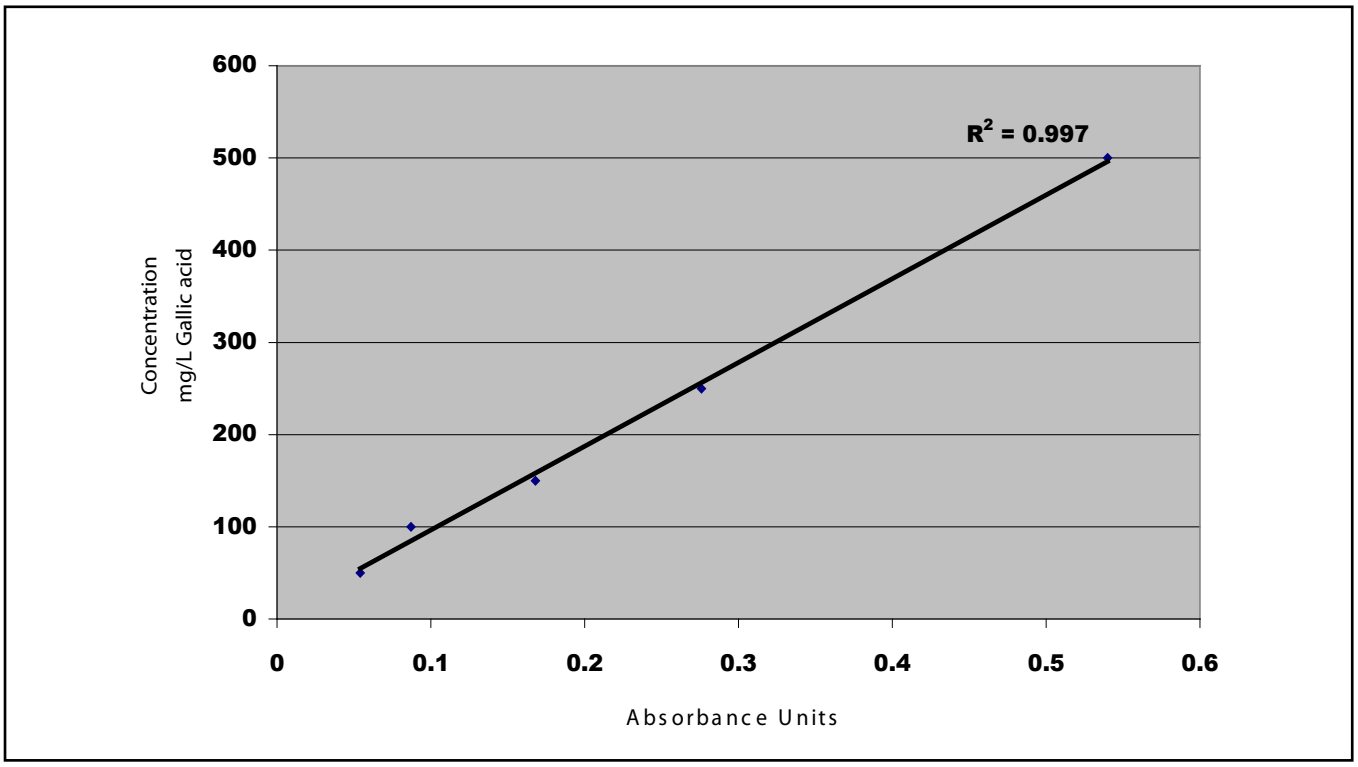

Figure 1: Calibration curve of gallic acids; concentrations and absorbance

Table 1: Chemical analysis of dandelion leaves and roots/100g

Nutrient	*Fat*	*Carbohydrates*	*Protein*	*Moisture*	*Ash*	*Fibre*
Leaves	0.3±0.7[a]	1.1±1.2 [a]	2.9±1.8 [a]	92.2±2.3[a]	1.0±1.0[a]	2.2±0.7[a]
Roots	1.7±1.6[b]	10.4±2.3[b]	3.7±1.4[b]	77±1.1[b]	1.9±2.4[b]	4.5±1.5[b]

Results of the chemical analysis of dandelion are the outcome from 3 repeated measurements. Mean followed by ±SD with the same letter within each column are not significantly different.

Table 2: Total phenolics content in dandelion roots and leaves, black tea, hibiscus, Arabic coffee and instant coffee mg/g FW/GAE

Black tea	*Green tea*	*Hibiscus*	*Instant coffee*	*Arabic coffee*	*Dandelion*	
					Roots	*Leaves*
40±0.70	80±0.45	44± 0.9	210± 0.40	215±0.20	14±0.73	4.3±0.67

Results of total phenolics are the outcome of 3 repeated measurements.

Figure 2: A = Dark regular roasted Arabic coffee; B = Ground dandelion roots; C = Light regular roasted Arabic coffee

Figure 3: D = Light regular Arabic coffee; E = Dark regular Arabic coffee; F = dandelion roots mixed with light coffee; G = dandelion roots mixed with dark coffee; H = dandelion roots mixed with instant coffee; I = Dandelion roots coffee only prepared according to Egyptian recipe Arabic coffee

Figure 4: J = Regular black tea; K = Green tea; L = Dandelion tea leaves; M = Hibiscus tea; N = dandelion mixed with hibiscus tea leaves

Table 3: Sensory evaluation of dandelion roots mixed with coffees (5 marks scale)

Attributes Samples	*Appearance*	*Aroma*	*Astringency*	*Aftertaste*	*Colour*	*Flavour*	*Consistency*	*Overall acceptability*
LC732	4.5 ±0.30^{b}	4 ±1.4^{ab}	4.5 ±0.8^{b}	4.5 ±2.8^{b}	4 ±1.6^{a}	4±0.65^{a}	4.5 ±1.8^{b}	4.5 ±0.4^{b}
DC764	4 ±1.2^{ab}	3 ±2.1^{d}	3 ±0.1^{d}	3 ±1.6^{d}	3 ±1.1^{d}	2.5±3.6^{d}	3.5 ±0.1^{a}	3 ±1.3^{d}
DLC693	4 ±1.6^{ab}	4.5±1.1^{a}	4.5 ±3.2^{a}	3.5 ±1.1^{c}	4 ±0.4^{a}	4.0±0.5^{a}	3 ±3.4^{d}	4 ±1.1^{ab}
DDC636	3.5 ±2.3^{c}	3.5±0.6^{c}	3.5 ±1.3^{c}	3.25±0.7^{abc}	3.75±2.2^{abc}	3.25±1.6^{c}	3.75 ±2.6^{abc}	3.25±2.7^{c}
IC546	4.5 ±0.5^{b}	4.5±2.3^{b}	4 ±0.8^{ab}	4.5 ±1.2^{b}	4.5 ±3.0^{b}	4.5 ±2.1^{b}	5 ±0.3^{a}	4.5 ±3.4^{b}
DIC587	4 ±1.7^{ab}	4 ±1.1^{ab}	3 ±1.9^{d}	3±1.5^{c}	4.5 ±2.1^{a}	3.75±2.1^{c}	4 ±1.8^{ab}	4 ±0.4^{ab}
DRO602	2.75 ±0.1^{de}	3 ±1.6^{d}	2.5 ±1.2^{e}	2.5 ±2.2^{d}	3 ±0.9^{c}	2.6 ±2.1^{d}	2 ±0.5^{f}	2.5 ±1.2^{e}

Mean followed by ±SD with the same letter within each column are not significantly different at α =0.05. DLC: dandelion roots mixed with light Arabic coffee; DDC dandelion roots mixed with dark Arabic coffee; DIC dandelion roots mixed with instant coffee; DRO: Dandelion roots only; LC: light Arabic coffee; DC; dark Arabic coffee; IC instant coffee

Table 4: Sensory evaluation of tea dandelion leaves with other teas (5 marks based on 5-point hedonic scale)

Attributes Samples	*Flavour*	*Aroma*	*Astringency*	*Aftertaste*	*Colour*	*Overall acceptability*
RT663	4.5±1.00^{a}	4±0.8^{a}	4.5±1.8^{b}	4.5±3.7^{b}	4.5±1.5^{ab}	4.5±0.20^{b}
GT765	4.25±1.6^{a}	3.75±2.8^{b}	4.5±2.1^{b}	4±2.0^{c}	4.5±0.3^{b}	4±4.2^{ab}
DT580	3±0.8^{ab}	3±0.15^{b}	2.5±3.6^{cd}	2.6±0.9^{c}	2.75±3.0^{d}	2.75±2.5^{d}
HT526	4.75±2.3^{a}	4.5±0.45^{a}	4.5±3.4^{b}	4±3.1^{ab}	5±3.5^{a}	4.5±2.1^{b}
DHT615	4.5±0.75^{a}	4±0.19^{a}	4±0.77^{ab}	4.5±1.6^{b}	5±1.5^{a}	4.5±2.4^{b}

Mean followed by ±SD with the same letter within each column are not significantly different at α =0.05. RT Regular black tea; GT Green tea; DT Dandelion leaves tea; HT; hibiscus tea; DHT dandelion hibiscus tea

Tea acceptance test

Table 4 shows the values of each attribute in the 5-point hedonic scale for flavour, aroma, astringency, aftertaste, colour, and over all acceptability. The dandelion leaves tea was scored less than 3 around neither like nor dislike, while when mixed with hibiscus was scored 4.5 this value approached to 'like very much'. The best attribute was the colour of dandelion leaves with hibiscus and hibiscus on its own.

DISCUSSION

The aim of the current study was to present dandelion as a natural, cheap and largely available plant in the Egyptian fields which can be used to produce either coffee or tea substitute to regular coffee and tea. The benefit will return to consumers as a low cost product and make more healthy option for consumers who want to reduce their caffeine consumption or increase intake of phytochemicals. The chemical composition of the dandelion roots and leaves, total phenolics, trolox equivalent antioxidant capacity (TEAC) and ferric reducing antioxidant power (FRAP) assays were carried out in dandelion extracts.

In this study, coffee substitute beverages were made from the dandelion roots or mixed with the traditional Arabic coffee or mixed with instant coffee. The dandelion tea was also made from dandelion leaves on its own or mixed with hibiscus, controls samples were also served as green tea for similarity of the colour to consumers, black tea as standard of daily tea drink, and hibiscus as another product mixed with dandelion leaves. The study included acceptance test for the beverages to evaluate the attributes colour, aroma, astringency, aftertaste, consistency, flavour and appearance for coffee. Appearance and consistency were included in the sensory evaluation of Arabic coffee for the reason of Egyptian culture is an important aspect for the presence of coffee foam on the surface of the coffee.

Interestingly the heath benefits of dandelion roots extracts (DRE) were recently reported by (Chatterjee et al. 2011) who found relatively resistant G361 human melanoma cell line responded to DRE when combined with the metabolism interfering antitype II diabetic drug metformin. Therefore, they concluded that the treatment with this common, yet potent extract of natural compounds has proven novel in specifically inducing apoptosis in chemoresistant melanoma, without toxicity to healthy cells.

Chemical analysis

The data about the analysis of dandelion roots and leaves specifically polyphenols and their characteristics as antioxidative

properties are scarce. The results indicate that the total phenolics were 14 and 4.3 mg/g F.W for roots and leaves respectively. A study carried out by Özcan et al. 2012 they found the total phenol contents of the leaf and roots of *Taraxacum officinale* were 2.019 and 1.997 mg GAE/L extract, respectively. These values are different in this report than our study for calculation method was based on mg/g GAE not per litre and cultivar and soil may also different.

The antioxidant capacity of dandelion leaves and roots showed that dandelion roots were 164 µmol Trolox/g and 170 µmol Fe^{+2}/g for TEAC and FRAP respectively. Dandelion leaves were 47 µmol Trolox/g and 14 µmol Fe^{+2}/g for TEAC and FRAP respectively. The strong correlation between TEAC and FRAP values suggested that the antioxidants in these plants specifically roots possess free radical scavenging activity and oxidant reducing power, and the high positive correlation between antioxidant capacities and total phenolic content may indicate to the role of phenolics activity as antioxidants (Feng et al.2010).

The antioxidant activity was clearly evident for the dandelion roots that confirmed in both assays. This can be related to different sensibilities of tests for specific metabolites present in the extracts between roots and leaves.

In a study tested the antioxidant activity as ABTS assay and radical (scavenging activity DPPH) in dandelion extract found that dandelion tested compounds in a dose dependant manner that Trolox equivalents (mmol) according to ABTS assay for the solution containing 1 mg dry extract /ml was 184 ± 4.25 and reported DPPH test expressed as IC_{50}. Dandelion was confirmed as antiradical and reported 20.396 ± 0.473 (Menghini et al. 2010). It was not clear which part of dandelion was used in the previous study.

Coffee and tea acceptance test

Panellists testing are one of the most important activities in product acceptance and development. The primary purpose of this test is to assess the personal response by current and potential customers of coffee and tea products, product ideas, or specific product characteristics (Nepote et al 2008).

The average score of acceptance test for DLC693 was higher than other tested coffee beverages; this may be explained that the colour similarity of the ground dandelion roots which mixed with light Arabic coffee were close. Consequently the DLC693 was favourably accepted. Furthermore, The flavour acceptance was higher for DLC693 and significantly different with respect to LC722.

In colour acceptance, significant differences were found between the products of dandelion leaves mixed with hibiscus compared to low average values of dandelion leaves only.

The colour acceptance was higher for hibiscus dandelion and mixed dandelion with light Arabic coffee compared to hibiscus tea and light Arabic coffee and significantly different with respect to hibiscus tea alone. Only taste acceptance, significant differences means were found between the products in 4.5 points of the 5-point hedonic scale for IC546 and LC722 products compared to dandelion roots only DRO602 which is the overall acceptability was 2.5 probably this due to that Cairo panellists have not developed the drinking of dandelion therefore they do not have preference for this flavour. The dandelion root beverage described by panellists as which tastes bitter, earthy and nutty.

The dandelion root coffee and dandelion leaves tea are "herbal drinks", are caffeine substitute, made from the roots and leaves of the dandelion plant. The dried dandelion root beverage has some resemblance to coffee in appearance Figure 2 and taste specifically when mixed with Arabic coffee. While when mixed with instant coffee gives a bland taste that is milder than dandelion roots mixed with coffee.

Acceptance test indicates that roots mixed with light Arabic coffee was the most accepted for coffee consumers compared to the dandelion roots drink on its own or when dandelion roots were mixed with the dark Arabic coffee. The results of evaluated dandelion roots beverages specifically when mixed with light Arabic coffee scored best aroma compared to the control coffees.

The panellists showed the highest preference for the aroma of product HT 526 (4.5) and DLC 693 followed by DIC587, LC722 and DHT615, achieved average 4 values. This is may attributed to high concentration of aromatic compounds in dandelion roots such as phenolic acids, caffeic acid, chlorogenic acid, and p-hydroxyphenyl acetic acid (Duke 1992, Barnes et al. 2002). Furthermore, may the highest preference of the aroma of product HT526 due to the presence of fatty acids such as linoleic acid, linolenic acid, palmitic acid, oleic acid) (Duke 1992, Barnes et al. 2002).

The product which brewed infusions with the most preferred flavour was DHT 615 (4.5) compared to controls HT526 (4.75), followed by RT 663 (4.5), and finally GT765 control sample achieved 4.25. The product IC546 achieved value of 4.5 followed by DLC 693(4.0) and control sample LC732(4.0).

Coffee products LC732 (4.5) and DLC693 (4.5) were the most preferred in astringency followed by IC546 (4.0). Similarly, tea product RT663 (4.50), GT765 (4.5), HT526 (4.5) followed by DHT 615(4.0)

Coffee products LC732 (4.5) and IC546 (4.5) were the most favourites in appearance among panellists followed by DC764 DLC693 and DIC587 achieved (4.0). The most preferred product was in coffee consistency was the IC546 (5.0) followed by LC732 (4.5) and DIC587 (4.0).

CONCLUSIONS

Results of trolox equivalent antioxidant capacity (TEAC) and ferric reducing antioxidant power (FRAP) may indicate to the role of phenolics as basic contributor to the antioxidant activity of dandelion extracts specifically roots. The total acceptability was higher for dandelion mixed with light Arabic coffee and dandelion leaves mixed with hibiscus that they were significantly different to other beverages with respect to control used. The results showed that dandelion roots could be very useful when mixed with regular daily coffee. The three most preferred products (DHT615, DLC 693 and DIC587) contained equal proportion of dandelion with hibiscus or light Arabic coffee or instant coffee respectively. Conversely, the three least preferred products (DC764 the control, DRO602 and DT580) contained only dandelion roots or leaves only without mixing with other products.

This indicates that products with equal proportions of either dandelion roots or leaves mixed with other products brewed infusions was a more appealing in attributes such as colour, taste, consistency, appearance and aroma.

ACKNOWLEDGEMENT

We would like to acknowledge the reference books used as a guide of this work authored by Professor Afaf El Gedaily and Prof. Hanaa M El Hossni, Nutrition and Food Science Helwan University.

REFERENCES

1. Dórea JG, da Costa THM. Is coffee a functional food? Br. J. Nutr.2005; 93:773–782.
2. Baggenstoss J, Poisson L, Kaegi R, Perren R, Escher F. Coffee roasting and aroma formation: Application of different time-temperature conditions. J. Agric. Food Chem. 2008; 56:5836-5846.
3. Bertrand B, Guyot B, Anthony F, Lashermes P. Impact of the Coffea canephora gene introgression on beverage quality of C. arabica. Theor. Appl Genet. 2003;107:387–394.
4. Gielissen R, Graafland J. Concepts of price fairness: Empirical research into the Dutch coffee market. Business Ethics: A European Review 2009;18:165–178.
5. Schmidt M, Schmitz HJ, Baumgart A, Guedon D, Netsch MI, Kreuter, MH. Toxicity of green tea extracts and their constituents in rat hepatocytes in primary culture. Food Chem. Toxicol. 2005;43:307–314.
6. Sloan AE. The center-store aisles. Food Technol. 2005; 59(10):29–39.
7. Abdel-Moemin AR. To investigate the antioxidant properties of dietary flavonoids in human metabolism [dissertation] Belfast: The Queen's University; 2004.
8. Hagymasi K, Blazovic A, Lugasi A, Kristo T, Feher J, Kery A. In vitro antioxidant evaluation of dandelion (Taraxacum officinale Web.) water extracts. Acta Aliment. 2000;29(1):1-7.
9. Duke JA. Handbook of phytochemical constituents of GRAS herbs and other economic plants. Boca Raton, FL, CRC Press, 1992.
10. Barnes J, Anderson LA, Phillipson JD. Herbal medicines: A guide for healthcare professionals. (2nd ed.) London: Pharmaceutical Press (2002).
11. Blumenthal M, Goldberg A, Brinckmann J, eds. *Herbal medicine: Expanded Commission E Monographs.* Newton, MA: Integrative Medicine Communications; 2000.
12. Hoffmann D. Medical herbalism*:* The science and practice of herbal medicine. Rochester, VT: Healing Arts Press; 2003.
13. Blumenthal M, Busse WR, Goldberg A, et al. (eds). The Complete German Commission E Monographs: Therapeutic Guide to Herbal Medicines. Austin: American Botanical Council and Boston: Integrative Medicine Communications, 1998.
14. IARC. Monographs on the evaluation of the carcinogenic risks to humans: coffee, tea, mate, methylxanthines and methylglyoxal, international agency for research on cancer, Lyon. 1991; vol. 51.
15. AOAC, 2005. Official methods of analysis. 18th Edn., Method 973.18, Association of Analytical Communities, Gaithersburg, MD.
16. AOAC. 1980. Official methods of analysis. Horwitz W. (Ed.), 13th ed., 435-440. Association of official analytical chemists, Washington, DC.
17. Mestrallet MG, Carnacini L, Días MJ, Nepote V, Ryan L, Conci S, Grosso NR. Honey roasted peanuts and roasted peanuts from Argentina. Sensorial and Chemical Analyses. Grasas Aceites. 2004;55(4):401-408.
18. Singleton VL, Rossi JA. Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents. Am. J. Enol. Vitic. 1965;16:144–158.
19. Cai YZ, Luo Q, Sun M, Corke H. Antioxidant activity and phenolic compounds of 112 traditional Chinese medicinal plants associated with anticancer. Life Sci. 2004;74:2157-2184.
20. Re R, Pellegrini N, Proteggente A, Pannala A, Yang M, Rice-Evans C. Antioxidant activity applying an improved ABTS radical cation decolorization assay. Free Radic. Biol. Med. 1999;26:1231-1237.
21. Li HB,Cheng KW, Wong CC, Fan KW,Chen F, Jiang Y. Evaluation of antioxidant capacity and total phenolic content of different fractions of selected microalgae. Food Chem. 2007,102:771-776.
22. Benzie LF F, Strain JJ. The ferric reducing ability of plasma (FRAP) as a measure of antioxidant power: the FRAP assay. Anal. Biochem. 1996;239:70-76.
23. Wong CC, Li H B, Cheng KW, Chen F. A systematic survey of antioxidant activity of 30 Chinese medicinal plants using the ferric reducing antioxidant power assay. Food Chem. 2006;97:705-711.
24. IFT .Guidelines for the preparation and review of papers reporting sensory evaluation data Div., Inst of food Technologist. Food Technol. 1981;35(4):16.
25. Grosso NR, Resurreccion AVA. Predicting consumer acceptance ratings of cracker-coated and roasted peanuts from descriptive analysis and hexanal measurements. J Food Sci. 2002;67(4):1530-1537.
26. Meilgaard M, Civille GV, Carr BT. Sensory Evaluation Techniques, 2nd Ed., 135-235. CRC Press Inc, Boca Raton, Florida.1991.
27. www.sca.org/?pag=resources&d=cupping-protocols Accessed February 23, 2013.
28. Düzgünes O, Kesici T, Kavuncu O, Gürbüz F. Arastırma ve Deneme Metotları. Ankara Üniv. Zir. Fak. Yay. 1987; No: 295, Ankara.
29. Chatterjee SJ, Ovadje P, Mousa M, Hamm C, Pandey S. The efficacy of dandelion root extract in inducing apoptosis in drug-resistant human melanoma Cells, Hindawi Publishing Corporation Evid. Based Complement. 2011; 11. doi:10.1155/2011/129045.
30. Musa ÖM, Mustafa P, Ahmet Ü. The antioxidant capacity and total phenol contents of leave and roots of *Taraxacum officinale* JAP &T 2012;18(4):270-271.31.

31. Feng-Lin S, Ren-You O, Yuan Z, Qin X, Lei K and Hua-Bin L. Total phenolic contents and antioxidant capacities of selected Chinese medicinal plants J. Mol. Sci. 2010; 11:2362-2372
32. Nepote V, Mestrallet M G, Olmedo RH , Ryan LC, Conci S, Grosso NR. Chemical composition and sensory analysis of roasted peanuts coated with prickly pear and algarrobo pod syrups. GRASAS ACEITES. 2008;59(2):174-181.

Received: June 9, 2014
Accepted in final form: September 11, 2014

Inovativna pijače iz kave in čaja na osnovi regratovih (Taraxacumofficinale) korenin in listov

IZVLEČEK

Cilj raziskave je bil spodbuditi uporabo regrata kot naravno rastlino, ki je poceni in jo je veliko na voljo na egipčanskih poljih. Namen je bil tudi najti nadomestek za kavo in čaj, da bi zmanjšali stroške proizvoda in ponudili bolj zdravo različico za potrošnike, ki bodo na ta način zmanjšali količino zaužitega kofeina. Narejena je bila kemična analiza regratovih korenin in listov na vsebnost skupnih fenolov, trolox ekvivalent za antioksidativno kapaciteto (TEAC) in test (FRAP). Pijača kavnega nadomestka je bila pripravljena iz regratovih korenin ali pa mešana s tradicionalno arabsko kavo ali instant kavo. Regratov čaj je bil narejen iz regratovih listov samostojno ali pa mešan z hibiskusom. Študija je vključevala test pijače na okus, vonj, trpkost, priokus, videz in skladnost pri kavnih izdelkih. Rezultati kažejo, da je bila celokupna vsebnost fenolov 14 in 4,3 mg/g sveže mase/ekvivalentov galne kisline (FWGAE) za korenine in liste. Korenine regrata so imele povprečne vrednosti 164 μmol Trolox/g in 170 μmol Fe+2 /g za TEAC in FRAP. Regratovi listi so imeli 47 μmol Trolox /g in 14 μmol Fe +2/g za TEAC in FRAP. Test sprejemljivosti je pokazal, da regratove korenine pomešane s svetlo arabsko kavo in regratovi listi zmešani s hibiskusom, predstavljata pijači, ki so najbolje sprejete med panelisti. Študija je pokazala, da lahko regratove korenine zelo koristno uporabimo, če jih zmešamo z redno dnevno kavo. Antioksidantska aktivnost omogoča vezavo prostih radikalov in kaže visoko pozitivno korelacijo z vsebnostjo celokupnih fenolov.

Ključne besede: korenine regrata, listi regrata, naravni nadomestki za kavo, test - TEAC