Antioxidant and HPLC Quantification of Different Parts of *Cichorium intybus L.* Plant

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A research article measuring the antioxidant potential and quantification of bioactive moieties present in different parts of chicory plant.

It's related to food science and nutrition.

ABSTRACT

Medicinal plants, including chicory (*Cichorium intybus L.*), have been utilized for centuries in traditional medicine due to their bioactive compounds. Chicory contains various phytochemicals such as inulin, tannin, alkaloids, flavonoids, coumarins, and sesquiterpene lactones, alongside essential nutrients like potassium, phosphorus, and vitamins A, K, and B6. It has antioxidant, anti-inflammatory, and anticancer effects. Its roots, rich in inulin, are used as a coffee substitute, while leaves and flowers are consumed in salads. It is a herbaceous shrub named "Kasani" cultivated all around the globe, and in Pakistan. The seeds, roots, stems, and leaves of chicory were procured from the fields manually cleaned and washed to remove dirt. After drying, it was ground into a fine powder and stored in air-tight containers for analysis. Proximate, HPLC quantification, antioxidant, and phytochemical profiling were performed. Results showed the different treatments explicated significant ($p \geq 0.001$) variation among moisture content, crude protein, fat, crude fiber, ash, and nitrogen-free extract. Maximum moisture content was observed in roots, while seeds exhibited higher levels of crude fat, ash, and protein. The antioxidant potential varied across different treatments, with the combination of seeds, leaves, stems, and roots showing the highest total polyphenol content and DPPH scavenging activity. Phytochemical analysis revealed the presence of various bioactive compounds, with chicoric acid being predominant in leaves and caffeoylquinic acids abundant in seeds. This study highlights chicory's diverse bioactive compounds and underscores its potential health benefits. It emphasizes chicory's significance as a valuable source of therapeutic properties.

Keywords: antioxidants, chicory, HPLC, phytochemicals.

Introduction

Historically, plants have been used to treat various ailments and as a source of therapeutic remedies in traditional medicine systems. These medicinal plants were the major resources that further helped in the discovery and development of antioxidants and bioactive moieties with varied therapeutic potential. There is a wide range of bioactive components that are present including polyphenols, flavonoid contents, alkaloids, terpenoids, and essential oils. The therapeutic potential of these substances was investigated and observed that they possess antioxidant, anticancer, antibacterial, antifungal, and anti-inflammatory properties and are utilized for the treatment of various physiological malfunctions (Zengin et al., 2020).

Chicory, or *Cichorium intybus L.*, is a member of the Asteraceae species and a Mediterranean vegetation. Six different species belonging to the genus *Cichorium* are also grown extensively throughout Asia and Europe. Out of the six varieties, *Chicorium intybus* has been employed as a homemade remedy for many ailments since ancient times (Singh & Chahal, 2018). It is herbaceous shrub generally referred to as "Kasani" cultivated all around the globe, particularly in Pakistan (David & Sears, 2007). Studies on the chicory plants and their pharmaceutical and anti-oxidative properties were conducted and 100 different compounds were characterized and analyzed (Street et al., 2013).

Inulin, tannin, alkaloids, monomeric flavonoids, coumarins, and sesquiterpene lactones are among the key phytochemicals that are predominantly present in the chicory plant (Nwafor et al., 2017; Varotto et al., 2000). Apart from its bioactive constituents, it also has considerate amount of macro and micro nutrients including potassium, phosphorus, zinc, iron, copper, carotenoids, and vitamins A, K, and B6 (Street et al., 2013). Fresh chicory root generally on dry weight comprises of 68% inulin, 5% cellulose, 14% sucrose, 4% ash, 6% proteins, and 3% additional constituents (Singh & Chahal, 2018). It was also observed that chicory root extract yields 98% inulin and 2% of other compounds. The flowers and leaves of the plant are consumed in salad, while the roots are considered as a coffee replacement (Mona et al., 2009). Chicory extracts are further utilized to enhance the flavour of both alcoholic and nonalcoholic beverages through fermentation (Bais & Ravishankar, 2001).

Research Methodology

Procurement of Raw Material

The chicory plant including seeds, roots, stems, and leaves were procured from the fields near Faisalabad. Plant was further identified by the taxonomist from Botany Department in G.C University Faisalabad and confirmed that its *Cichorium intybus L*.

All the analytical and HPLC grade standards and reagents were purchased from Merck (Merck KGaA, Darmstadt, Germany) and Sigma-Aldrich (Sigma-Aldrich Tokyo, Japan).

Preparation of Raw Materials

The seeds of the chicory were cleaned manually to remove broken pieces. Than seeds, leaves, stem and roots were washed with tap water to remove particles of dirt and foreign material. After cleaning, all parts of chicory plant were completely dried at room temperature. The dried plant parts were than further grounded to fine powder utilizing a small laboratory grinder (Panasonic, Japan, Model MJ-W176P) and were passed through sieve for refining and were stored separately in air-tight plastic jars till further analysis.

Proximate analysis

The seeds, leaves, roots and stems of the chicory plant were divided in to separate combinations T_1 Chicory seeds (CSD), T_2 Chicory leaves (CLV), T_3 Chicory stems (CST), T_4 Chicory roots (CRT), T_5 CSD+CLV (Chicory seed + Chicory leaves), T_6 CSD + CST (Chicory seed + Chicory stem), T_7 CSD + CRT (Chicory seed + Chicory root), T_8 CLV + CST (Chicory leaves + Chicory stem), T_9 CLV + CRT (Chicory leaves + Chicory roots), T_{10} CST + CRT (Chicory stem+ Chicory root), T_{11} CSD + CLV + CST + CRT (Chicory seed + Chicory leaves + Chicory stem + Chicory roots).

Moisture content of all the combinations was measured following AACC Method No. 44-01. AACC Method No. 46-10 was used to measure the crude protein in different parts of chicory plant using Kjeldahl's equipment (Model: Technik GmbH D-40599, Behr Labor, Germany). Employing the Soxhlet equipment (Model: HT2 1045 Extraction unit, Hoganas, Sweden), specimens of chicory were examined for crude fat according to AACC Method No. 30-10. Crude Fiber was measured using (Model: Labconco corporation, Kansas, USA), following the procedure of AACC Method No. 32-10. The ash percentage of chicory isolates was assessed as indicated in AACC Method No. 08-01 (AACC, 2000).

Preparation of Extract

Bioactive compounds from all the eleven treatments with different combinations of roots, stems, leaves and seeds were extracted with methanol:water (70:30 v/v) following a 1:10 sample-to-solvent ratio and water, Whatman No. 1 filter paper was used to separate the extract from the residue. Later, extracts were concentrated utilizing rotary evaporator and were stored at 4°C until tested and analyzed.

Antioxidant and phytochemical profiling of chicory

Following Singleton *et al*. (1999)'s methodology, the total polyphenols (TP) were estimated using the Folin-Ciocalteu procedure. The 1,1-diphenyl-2-picrylhydrazyl (1,1-diphenyl-2-picrylhydrazyl) free radicals capturing capability of chicory isolates were determined using Muller *et al*. (2011) technique. Whereas, Total flavonoids were estimated following the procedure of Ordon-ez et al. (2006).

Quantification through HPLC

Implementing the method of Bocchini et al., (2001) several chicory isolate preparations HPLC quantitative measurement method for determination. The HPLC Shim-Pack CLC-ODS C18 column (15 cm x 4.6 mm, size distribution at 5.0 μm) with ultra violet to visible monitor was utilized to carry out the operation. The 20-L specimen was submitted using an autosampler (WISP Model 710). The interior column's temperatures being kept constant at 25 ° c. A mobile phase made up of DDHO2: Methanol (1:1) was used to estimate the amount of allicin in experimental samples at 254 nm although the rate of circulation was fixed at 1.0 mL per minute.

Statistical Analysis

The information was collected utilizing a completely randomised methodology and then statistical evaluation was completed applying the Statistical Package for the Social Sciences (SPSS) (Costat-2003, Co-Hort, v 6.1.). According to the guidelines provided by Steel et al., (1997) the level of significance was established (ANOVA) using 2-factor factorial CRD where feasible.

Results and Discussion

Proximate Analysis

The results of the different treatments explicated significant ($p \geq 0.001$) variation among moisture content, crude protein, fat, crude fiber, ash and nitrogen free extract. The results varying proximate composition of different part of *C. intybus* illustrated in (Table 1) showed maximum moisture in the T_4 (CRT) 9.75±0.56% followed by T_9 (CLV + CRT)

8.97±0.75%, T_{10} (CST + CRT) 8.49±0.67%,T_7 (CSD + CRT) 8.31±0.78%, T_2 (CLV) 8.25±0.62%, T_{11} (CSD + CLV + CST + CRT) 8.02±0.72%, T_8 (CLV + CST) 7.74±0.63%, T_5 (CSD + CLV) 7.56±0.52%, T_3 (CST) 7.25±0.67%, T_6 (CSD + CST) 7.02±0.34 and minimum was recorded in T_1 (CSD) 6.88±0.56% respectively. Moreover, crude fat contents were observed as 12.52±1.12%, 1.35±0.11%, 1.39±0.12%, 1.49±0.13%, 6.93±0.54, 6.95±0.56, 7.01±0.67, 1.36±0.09, 1.41±0.12, 1.43±0.12 and 4.17±0.38 in T_1 (CSD), T_2 (CLV), T_3 (CST), T_4 (CRT), T_5 (CSD + CLV), T_6 (CSD + CST), T_7 (CSD + CRT), T_8(CLV + CST), T_9 (CLV + CRT), T_{10} (CST + CRT) and T_{11} (CSD + CLV + CST + CRT) respectively.

Similarly, protein and fibre contents in T_1 (CSD), T_2 (CLV), T_3 (CST), T_4 (CRT), T_5 (CSD + CLV), T_6 (CSD + CST), T_7 (CSD + CRT), T_8(CLV + CST), T_9(CLV + CRT), T_{10} (CST + CRT) and T_{11} (CSD + CLV + CST + CRT) were 16.92±1.32 & 37.48±2.45, 11.48±1.12 & 17.58±1.65, 7.89±0.67 & 28.65±1.26%, 5.35±0.48 & 29.56±1.67, 14.2±0.11 & 27.53±1.54, 12.4±0.11 & 33.06±2.43, 11.13±0.09 & 33.52±3.24, 9.68±0.89 & 23.11±2.12, 8.41±0.76 & 23.57±2.32, 6.61±0.54 & 29.1±2.86 and 10.4±0.08 & 28.31±2.32 correspondingly. The ash contents were recorded as 14.67±1.32% in T1 (CSD), 8.75±0.65, 11.03±1.32, 4.08±0.34, 11.7±1.12, 12.84±1.21, 9.37±0.87, 9.88±0.76, 6.41±0.56, 7.55±0.62 and 9.61±0.87% in T_2 (CLV), T_3 (CST), T_4 (CRT), T_5 (CSD + CLV), T_6 (CSD + CST), T_7 (CSD + CRT), T_8 (CLV + CST), T_9 (CLV + CRT), T_{10} (CST + CRT) and T_{11} (CSD + CLV + CST + CRT), substantially. Moreover, the individual specimens' reported NFE levels as 11.53±1.12, 52.59±4.32, 43.79±3.23, 49.77±3.46, 32.08±2.56, 27.73±2.67, 30.67±2.54, 48.23±3.34, 51.23±4.32, 46.82±3.43 and 39.49±2.87 % in T_1 (CSD), T_2 (CLV), T_3 (CST), T_4 (CRT), T_5 (CSD + CLV), T_6 (CSD + CST), T_7 (CSD + CRT), T_8(CLV + CST), T_9 (CLV + CRT), T_{10} (CST + CRT) and T_{11} (CSD + CLV + CST + CRT), respectively.

The findings of the current research work is in accordance with Jangra and Madan (2018) estimated three different parts of *C. intybus* seeds, aerial parts and roots and observed maximum amount of moisture, fiber and total carbohydrates in roots whereas, fat, ash, and protein were higher in seeds. Khalaf et al. (2018) observed that carbohydrates content were observed maximum in root followed by leaf and seed. The plant defense system is mainly dependent on the carbohydrate content. The variation in the nutritional content is due to environmental conditions like weather as well as on species of plant and the cultivation method adopted (Petropoulos et al., 2017). The nine

different varieties of *Cichorium intybus L.* including seven wild and two cultivated were estimated by Jančić et al. (2016) for the nutritional composition and found ash in range of (1.05-1.58%), fat content (0.22-0.49%), dietary fiber (2.90-6.16%) and protein as (1.63-2.78%).

Antioxidant Indices of Spices Extracts

The means regarding TPC of solvent extracts (Table 2) showed that the highest TPC 332.89±31.52 mg/100g was observed in T_{11} (CSD + CLV + CST + CRT) followed by T_1 (CSD) 310±28.23 mg/100g, T_7 (CSD + CRT) 294.50±26.97 mg/100g, T_4 (CSD + CLV) 279±26.81 mg/100g, T_5(CSD + CLV) 188.62±17.65 mg/100g, T_9 (CLV + CRT) 173.11±15.23 mg/100g, T_6 (CSD + CST) 159.78±14.23 mg/100g, T_{10} (CST + CRT) 144.27±12.17 mg/100g, T_2 (CLV) 67.23±5.23 mg/100g, T_8 (CLV + CST) 38.39±2.52 mg/100g and minimum output in T_3 (CST) 9.59±0.64 mg/100g.

The mean values indicate that the maximum TFC was noticed in T_1 135 mg/100g trailed by T_{11}, T_5, T_6, T_7, T_2, T_8, T_9, T_3, T_{10} andT_4 as 98.29, 88.63, 77.42, 67.24, 42.86, 31.05, 21.47, 19.25, 9.66 and 0.09 mg/100g, respectively (Table 2).

DPPH activity in (Table 2) illustrate the mean values in T_{11} 36.42 IC50 µg/ml, T_1 29± 1.35 IC50 µg/ml, T_5 26.81±1.78 IC50 µg/ml, T_2 24.62±1.46 IC50 µg/ml, T_7 23.31±2.12 IC50 µg/ml, T_9 21.31±1.78 IC50 µg/ml, T_4 18±1.23 IC50 µg/ml, T_6 (CSD + CST) 15.11±1.12 IC50 µg/ml, T_8 12.92±1.23 IC50 µg/ml, T_{10} 9.61±0.89 IC50 µg/ml and T_3 1.23±0.56 IC50 µg/ml.

Polyphenols can be extracted from plant materials by various methods using different solvents and extraction techniques. The extraction procedure is of prime importance in the analysis of polyphenols (Aires, 2017). The polyphenols and antioxidant activity of chicory aerial plant (stem and leaves) ethanolic extract were estimated by Iqbal et al. (2021) and observed TPC as 0.44 mg GAE/g, TFC as 0.77 mgQE/g and DPPH as 0.12 mg AAE/g. The phenolic contents of the plants are highly associated with its antioxidant potential. Similarly, El-Mehy (2018) conducted a research to evaluate the TPC and TFC content in Chicory leaf and root with different concentrations and solvents and observed maximum content in leaf. The addition of water in alcohol enhance the efficiency and extractability of alcohol, providing assistance in the formation of hydroxyl bond between phenolic compound and water (Dai & Mumper, 2010). Later, Choudhary et al. (2021) investigated different parts including roots, leaves and seeds of *Cichorium intybus L.* and observed total flavonoid varied from 1.60± 1.69 to 1.37 ± 0.796 mg/gdw (CA) and total

phenolic content as 1.94± 0.895 to 1.66± 0.506 mg/gdw (QE) of methanolic extract. Similarly Eray et al. (2020) observed maximum TPC and TFC in roots in comparison with leaves and shoots.

1.4.3. Phytochemical or Bioactive Molecules in chicory plant

Mean values in Chicoric acid illustrated in treatments *i.e* T_2 (CLV), T_5 (CSD + CLV), T_6 T_8 (CLV + CST) and T_{11} (CSD + CLV + CST + CRT) showed 2.97±113µg/g, 1.43±0.09µg/g, 1.42±0.12 µg/g, 1.46±0.11 µg/g and 0.73±0.03 µg/g whereas it was not detected in other treatments, respectively (Table 4). The mean values in (Table 4) illustrate caffeoylquinic acids in T_1 (CSD), T_2 (CLV), T_4 (CRT), T_5 (CSD + CLV), T_6 (CSD + CST), T_7 (CSD + CRT), T_8 (CLV + CST), T_9 (CLV + CRT), T_{10} (CST + CRT) and T_{11} (CSD + CLV + CST + CRT) as 9.6±8.54, 1.35±0.32, 0.5±0.02, 5.47±0.21, 4.8±0.32, 5.05±0.43, 0.67±0.04, 0.92±0.03, 0.25±0.02 and 2.87±0.01 µg/g, whereas in T_3 (CST) it was not detected, respectively.

The mean values indicate that the maximum Chlorogenic acid was noticed in T_2 (CLV) 26.66±2.32 µg/g trailed by T_9 (CLV + CRT) 23.67±2.12, T_4 (CRT)20.68±2.14,T_8 (CLV + CST) 14.18±1.12, T_5 (CSD + CLV)13.33±1.12, T_{11} (CSD + CLV + CST + CRT) 12.26±1.09, T_{10} (CST + CRT) 11.19±1.11, T_3 (CST) 1.71±0.12 and T_6 (CSD + CST) 0.85±0.02µg/g, whereas it was not-detected in T_1 (CSD), respectively. The means regarding p-Coumaric acid showed that the highest p-Coumaric acid in 27.81±2.13µg/g was observed in T_4 (CRT) followed by CRT4.74±0.32 µg/g, T_9 (CLV + CRT) 19.3±1.12, T_7 (CSD + CRT) 13.91±1.12, T_2 (CLV) 10.77±1.05, T_{11} (CSD + CLV + CST + CRT)9.8±0.89, T_8 (CLV + CST) 5.69±0.43, T_5 (CSD + CLV)5.39±0.45, T_3 (CST) 0.61±0.02 and minimum values were recorded in T_6 (CSD + CST) 0.3±0.02, whereas not detected in T_1 (CSD), respectively.

Similarly, Caffeic acid and gallic acid contents in T_2 (CLV), T_3 (CST), T_4 (CRT), T_5 (CSD + CLV), T_6 (CSD + CST), T_7 (CSD + CRT), T_8 (CLV + CST), T_9 (CLV + CRT), T_{10} (CST + CRT) and T_{11} (CSD + CLV + CST + CRT) were 17.07±1.13 &3.52±0.31, 1.24±0.11 &10.73±1.67, 13.93±1.11 &4.74±0.34, 8.53±0.78 & 1.76±0.12, 0.62±0.04 & 5.36±0.43, 6.96±0.65 & 2.37±0.21, 9.15±0.89 & 7.12±0.67, 9.49±0.87 & 4.13±0.32, 1.58±0.12 & 7.73±0.66, 8.06±0.78 & 4.74±0.43 and in T_1 (CSD) it was not detected, correspondingly.

HPLC is a technique that is frequently utilized for the most plant based sources for the quantification of polyphenols. The pharmaceutical properties of phenolic acids with

bioactive moieties provide them the ability to reduce physiological malfunctioning. These are the main constituents that are accountable for the high antioxidant potential of plant extracts. Iqbal et al. (2021) studied chicory plant for its phenolic compounds and observed chicoric acid was maximum in comparison with other. Similarly Mona et al. (2009) investigated the roots and leaves of chicory and found caffeic acid was maximum in leaves in comparison with roots whereas, p-coumaric acid was maximum in roots. Later Saybel et al. (2020) observed 8.3 % of chicoric acid in methanolic extract of chicory ariel part. They also observed that dominant substances were esculletin, chicoryin, and chicoryic acid. Jurgoński et al (2011) investigated roots, seeds and leaves of chicory and explicated that chicoric acid was only found in leaves and not identified in roots and seeds.

Conclusion

It is inferred as chicory plant showed promising nutritional and antioxidant potential in different parts of the plants as well as in there combination. The Total phenolic content were maximum in the combination of stem, roots, seeds and leaves. However, Chicoric acid is an active compound present in leaves only whereas, chlorogenic acid, p-coumaric acid, gallic acid and caffeic acid were not identified in seeds and caffeoylquinic acid was not identified in stems. However, it is recommended that in future effect of supercritical fluid extraction and ultra sound extraction techniques should be evaluated.

Table 1 Means for proximate analysis of chicory plant

Treatments	Moisture (%)	Crude fat (%)	Crude protein (%)	Crude fiber (%)	Ash (%)	NFE (%)
T_1	6.88±0.56k	12.52±1.12a	16.92±1.32a	37.48±2.45a	14.67±1.32a	11.53±1.12k
T_2	8.25±0.62e	1.35±0.11k	11.48±1.12d	17.58±1.65dk	8.75±0.65h	52.59±4.32a
T_3	7.25±0.67i	1.39±0.12i	7.89±0.67g	28.65±1.26f	11.03±1.32d	43.79±3.23f
T_4	9.75±0.56a	1.49±0.13f	5.35±0.48i	29.56±1.67	4.08±0.34k	49.77±3.46c
T_5	7.56±0.52h	6.93±0.54d	14.20±0.11b	27.53±1.54h	11.70±1.12c	32.08±2.56h
T_6	7.02±0.34j	6.95±0.56c	12.40±0.11c	33.06±2.43c	12.84±1.21b	27.73±2.67j
T_7	8.31±0.78d	7.01±0.67b	11.13±0.09de	33.52±3.24bj	9.37±0.87g	30.67±2.54i
T_8	7.74±0.63g	1.36±0.09j	9.68±0.89f	23.11±2.12i	9.88±0.76e	48.23±3.34d
T_9	8.97±0.75b	1.41±0.12h	8.41±0.76g	23.57±2.32	6.41±0.56j	51.23±4.32b
T_{10}	8.49±0.67c	1.43±0.12g	6.61±0.54h	29.10±2.86e	7.55±0.62i	46.82±3.43e
T_{11}	8.02±0.72f	4.17±0.38e	10.4±0.08ef	28.31±2.32g	9.61±0.87f	39.49±2.87g

T_1 = Chicory seeds (CSD) powder
T_2 = Chicory leaves (CLV) powder
T_3 = Chicory stems (CST) powder
T_4 =Chicory roots (CRT) powder
T_5 = CSD + CLV powder
T_6 = CSD + CST powder
T_7 = CSD + CRT powder
T_8= CLV + CST powder
T_9= CLV + CRT powder
T_{10} = CST + CRT powder
T_{11} = CSD + CLV + CST + CRT powder

Table 2. Mean values for TPC, TFC & DPPH

Treatments	TPC (mg GAE/100g)	TFC (mg QE/100g)	DPPH (IC50)
T_1	310±28.2 b	135±12.54 a	29±1.35 b
T_2	67.23±5.23 i	42.86±3.26 f	24.62±1.46 d
T_3	9.59±0.64 k	19.25±1.54 i	1.23±0.56 k
T_4	279±26.81 d	0.09±0.004 k	18±1.23 g
T_5	188.62±17.65 e	88.63±7.54 c	26.81±1.78 c
T_6	159.78±14.23 g	77.42±6.53 d	15.11±1.12 h
T_7	294.50±26.97 c	67.24±4.24 e	23.31±2.12 f
T_8	38.39±2.52 j	31.05±2.12 g	12.92±1.23 i
T_9	173.11±15.23 f	21.47±1.57 h	21.31±1.78 f
T_{10}	144.27±12.17 h	9.66±0.53 j	9.61±0.89 j
T_{11}	332.89±31.52 a	98.29±8.65 b	36.42±2.65 a

T_1 = Chicory seeds (CSD) extract
T_2 = Chicory leaves (CLV) extract
T_3 = Chicory stems (CST) extract
T_4 =Chicory roots (CRT) extract
T_5 = CSD + CLV extract
T_6 = CSD + CST extract
T_7 = CSD + CRT extract
T_8 = CLV + CST extract
T_9 = CLV + CRT extract
T_{10} = CST + CRT extract
T_{11} = CSD + CLV + CST + CRT extract

Table 3. Mean values for HPLC Quantification

Treatments	Chicoric acid (µg/g)	Caffeoylquinic acids (µg/g)	Chlorogenic acid (µg/g)	p-Coumaric acid (µg/g)	Caffeic acid (µg/g)	Gallic acid (µg/g)
T_1	ND	9.6±8.54a	ND	ND	ND	ND
T_2	2.97±1.13a	1.35±0.32f	26.66±2.32a	10.77±1.05e	17.07±1.13a	3.52±0.31g
T_3	ND	ND	1.71±0.12i	0.61±0.02i	1.24±0.11i	10.73±1.67a
T_4	ND	0.5±0.02i	20.68±2.14c	27.81±2.13a	13.93±1.11b	4.74±0.34e
T_5	1.43±0.09b	5.47±0.21b	13.33±1.12e	5.39±0.45h	8.53±0.78e	1.76±0.12i
T_6	ND	4.8±0.32d	0.85±0.02j	0.3±0.02j	0.62±0.04j	5.36±0.43d
T_7	ND	5.05±0.43c	10.34±0.12h	13.91±1.12d	6.96±0.65h	2.37±0.21h
T_8	1.42±0.12b	0.67±0.04h	14.18±1.12d	5.69±0.43g	9.15±0.89d	7.12±0.67c
T_9	1.46±0.11bc	0.92±0.03g	23.67±2.12b	19.3±1.12b	9.49±0.87c	4.13±0.32f
T_{10}	ND	0.25±0.02j	11.19±1.11g	14.21±1.12c	1.58±0.12h	7.73±0.66b
T_{11}	0.73±0.03c	2.87±0.01e	12.26±1.09f	9.8±0.89f	8.06±0.78f	4.74±0.43e

T_1 = Chicory seeds (CSD) extract
T_2 = Chicory leaves (CLV) extract
T_3 = Chicory stems (CST) extract
T_4 =Chicory roots (CRT) extract
T_5 = CSD + CLV extract
T_6 = CSD + CST extract
T_7 = CSD + CRT extract
T_8= CLV + CST extract
T_9= CLV + CRT extract
T_{10} = CST + CRT extract
T_{11} = CSD + CLV + CST + CRT extract

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