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ORIGINAL ARTICLE

Phytochemical, antioxidant and mineral composition of hydroalcoholic extract of chicory (*Cichorium intybus* L.) leaves

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Abstract The phytochemical, antioxidant and mineral composition of hydroalcoholic extract of leaves of *Cichorium intybus* L., was determined. The leaves were found to possess comparatively higher values of total flavonoids, total phenolic acids. The phytochemical screening confirmed the presence of tannins, saponins, flavonoids, in the leaves of the plant. The leaf extract was found to show comparatively low value of IC_{50} for 2,2-diphenyl-1-picrylhydrazyl (DPPH) inhibition. The IC_{50} value of chicory leaves extract was found to be 67.2 ± 2.6 μg/ml. The extracts were found to contain high amount of mineral elements especially Mg and Zn. Due to good phytochemical and antioxidant composition, *C. intybus* L., leaves would be an important candidate in pharmaceutical formulations and play an important role in improving the human health by participating in the antioxidant defense system against free radical generation.

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1. Introduction

Cichorium intybus L., commonly known as chicory, belongs to family Asteraceae and widely distributed in Asia and Europe (Bais and Ravishankar, 2001). All parts of this plant possess great medicinal importance due to the presence of a number of medicinally important compounds such as alkaloids, inulin, sesquiterpene lactones, coumarins, vitamins, chlorophyll pigments, unsaturated sterols, flavonoids, saponins and tannins (Molan et al., 2003; Nandagopal and Ranjitha kumari, 2007;

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Muthusamy et al., 2008; Atta et al., 2010). It has been reported that fresh chicory typically contains 68% inulin, 14% sucrose, 5% cellulose, 6% protein, 4% ash, and 3% other compounds, while dried chicory contains approximately 98% inulin and 2% other compounds (Meehye and Shin, 1996). Leaves of chicory are good sources of phenols, vitamins A and C as well as potassium, calcium, and phosphorus (Mulabagal et al., 2009). Furthermore, chicory in rich cichoric acid may stimulate the immune system as well as prevents inflammation and bacterial infections to a limited extent (Nayeemunnisa, 2009). *C. intybus* has been traditionally used for the treatment of fever, diarrhoea, jaundice and gallstones (Afzal et al., 2009; Abbasi et al., 2009). The studies on rats have shown that *C. intybus* possesses anti-hepatotoxic and anti-diabetic activities (Saggu et al., 2014). It has been also reported that *C. intybus* possesses anti-bacterial (Nandagopal and Ranjitha kumari, 2007), anti-inflammatory (Cavin et al., 2005), hyperglycaemic and anti-ulcerogenic activities (Rifat-uz-Zaman et al., 2006). Moreover, *C. intybus* has been found to be a useful biomonitor of heavy metals such as Pb, Zn, Cu, and Cd (Aksoy, 2008). Forage chicory was used to produce a large quantity of high quality feed in the warm season under favourable conditions. *t* has been reported that grazing chicory results in reduction of some internal parasites in livestock (Heckendorn et al., 2007) and, therefore, has potential to reduce the use of anthelmintics.

Normal cellular function depends on a balance between the reactive oxygen species (ROS) produced and the antioxidant defense mechanisms available for the cell. This equilibrium is hindered by the ROS upsurge that culminates in oxidative stress (Fidan and Dundar, 2008). They are created during increased metabolic states due to partial reduction of O_2. ROS are part and parcel of life. But during chronic or recurrent stress there is increased utilization of energy and more ROS are produced. If the concentration of these ROS exceed the body's capacity to counteract them, they begin to harm cells and, in cases of chronic stress, our tissues and organs. Many plant extracts and their products have been shown to have significant antioxidant activity which may be an important property of medicinal plants associated with the treatment of several ill-fated diseases including liver toxicity. Thus, herbal plants are considered useful resources to prevent and/or ameliorate certain disorders, such as diabetes, atherosclerosis, hepatotoxicity and other complications.

Phytochemicals, the plant-derived non-nutritive compounds, are one of the different types of the dietary factors which play an important role in various functions of the human body. A huge number of natural compounds present in food materials have been reported to possess antioxidant properties due to the presence of hydroxyl groups in their structure. The antioxidants are the synthetic as well as naturally occurring compounds that avert the oxidative damage to the most important macromolecules such as lipids, proteins and nucleic acids present in human body as well as in food materials by scavenging the free radicals produced in various biochemical processes (Shui and Leong, 2004). The free radicals which are produced due to oxidative stress radicals react with lipids, proteins and nucleic acids and cause stimulation of apoptosis which leads to various neurological, cardiovascular and some other physiological disorders (Uttara et al., 2009). Bioflavonoids, phenolic acids, ascorbic acid and tocopherols are well known subclass of phytochemical compounds which possess antioxidant properties and are used for the treatment of various ailments (Bergman et al., 2001; Barnes, 2001).

A careful review of literature has shown that little data are available on the phytochemical and antioxidant properties of hydroalcoholic extract of leaves of *C. intybus*. Therefore, the present study was intended to investigate the biochemical, photochemical and antioxidant composition of leaves of *C. intybus*.

2. Materials and methods

2.1. Extract preparation

The extraction procedure for the hydro-alcoholic extract was carried out as reported by Saggu et al. (2014).

2.2. Phytochemical analysis

Chemical tests for the screening of certain phytochemical compounds were performed on the hydroalcoholic extracts of leaves of *C. intybus* using standard procedures (Harborne, 1973; Trease and Evans, 1989; Sofowara, 1993) as reported by Shad et al. (2013).

2.2.1. Tannins

Briefly, known amount of sample was boiled in distilled water and then filtered. Few drops of 0.1% ferric chloride solution were added to the filtrate and the change in colour was observed. The appearance of brownish green or a blue-black colour confirmed the presence of tannins.

2.2.2. Saponins

Briefly, known amount of sample was boiled in distilled water in a water bath and filtered. The filtrate was mixed with distilled water and shaken vigorously until a stable persistent froth. The frothing was mixed with olive oil (2 drops) and shaken vigorously. The formation of emulsion indicated the presence of saponins.

2.2.3. Flavonoids

Few drops of 1% aluminium solution were added to a portion of ethanolic extract of each sample. A yellow colouration of the solution indicated the presence of flavonoids.

2.3. Quantitative analysis of phytochemicals

2.3.1. Tannins content

The tannins content from leaves of *C. intybus* were extracted and estimated by the method described by Shad et al. (2013).

2.3.2. Saponins content

Saponins in different parts of *C. intybus* were determined by the method as described by Anhawange et al. (2004). The saponins were calculated as g/100 g dry weight.

2.3.3. Total flavonoids content

The total flavonoid contents were measured by a colorimetric assay as reported by Rohman et al. (2010). Absorbance of the

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