Total antioxidant capacity and profiling of polyphenolic compounds in jute leaves by HPLC-DAD

1,*Ali, M.M., 2Ahmed, K.S., 2Hossain, H., 3Roy, B., 4Rokeya, B., 5Rahman, M.T., 2Jahan, I.A. and 6Rahman, M.M.

1Department of Biochemistry, Bangladesh Jute Research Institute (BJRI), Dhaka-1207, Bangladesh
2Chemical Research Division, BCSIR Laboratories, Dhaka, Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka-1205, Bangladesh
3Department of Chemistry, Hajee Mohammad Danesh Science & Technology University, Dinajpur, Bangladesh
4Department of Pharmacology, Bangladesh University of Health Science, Mirpur-1, Dhaka, Bangladesh.
5Jute Seed Production and Research Centre, BJRI, Nashipur, Dinajpur, Bangladesh
6Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka-1205, Bangladesh

Abstract

Jute leaves (Corchorus spp.) have been used as a medicinal plant for the treatment of various diseases. The study was investigated on the antioxidant activities and HPLC profiling of polyphenolic compounds in ethanol extract of Corchorus olitorius (C. olitorius) and Corchorus capsularis (C. capsularis) leaves. The total antioxidant capacity was evaluated by phosphomolybdenum method and Identification and quantification of polyphenolic compounds were performed using HPLC-DAD system. The results indicated that eight polyphenolic compounds were found in the C. capsularis leaves but C. olitorius leaves contain six polyphenolic compounds. In fact, major identified polyphenolic compounds of C. capsularis leaves were caffeic acid (CA), 55.93±0.13; trans-ferulic acid (FA), 58.02±0.18; rutin hydrate (RH), 32.16±0.08; ellagic acid (EA), 53.65±0.11 and quercetin hydrate (QU), 46.17±0.09 mg/100 g of dry extract respectively. Whereas in C. olitorius leaves which were rutin hydrate (RH), 152.17±0.51; ellagic acid (EA), 143.27±0.58 and quercetin hydrate (QU), 292.83±0.73 mg/100 g of dry extract respectively. The results showed that C. capsularis leaves contained high level of total antioxidant capacity (214.32±1.95 mg of ascorbic acid/g of dry extract) than that of C. olitorius (165.66±1.30 mg of ascorbic acid/g of dry extract) leaves. The overall data suggested that C. olitorius and C. capsularis leaves contain a significant amount of several polyphenolic compounds that could be used as a natural antioxidant for functional foods.

1. Introduction

Jute (Corchorus spp.) is a cash crop in Bangladesh being cultivated in 10% of agricultural land area (Islam, 2019). It is cultivated in many other countries like as India, Myanmar, Nepal, China, Taiwan, Thailand, Vietnam, Cambodia, Brazil, etc. C. olitorius jute namely is Tossa Jute and C. capsularis jute namely is White Jute (Islam, 2013).

Demand for medicinal plants is increasing in both developed and developing countries due to the growing recognition of natural products being equally effective, safe, non-narcotic, affordable and has no side effects.

One such medicinal plant part is jute leaves (Islam, 2013). Young shoots and leaves are eaten as vegetable and food ingredients and have long been used as medicinal folk remedies in East Asia and Africa. Health-flourishing effects of plant-derived secondary metabolites in human health, including antioxidative, anticarcinogenic, antibiotic, and pharmacological effects, are well documented (Lee et al., 2015). C. olitorius leaves are used in the treatment of fever, tumors, pectoral pains, dysentery, aches, enteritis, cystitis, piles and dysuria (Adegoke and Adebayo-Tayo, 2009). C. capsularis leaves are also used in ayurvedic for ascites, piles, cystitis, dysuria, fever and gonorrhoea (Islam et
Leaves of *C. olitorius* have a large quantity of antioxidants compounds connected with various biological properties, which include diuretic, analgesic, antipyretic, antimicrobial activities, antitumor (Zakaria *et al.*, 2006), phenolic antioxidative compounds (Azuma *et al.*, 1999), hypoglycemic (Abo *et al.*, 2008) and gastroprotective (Al Batran *et al.*, 2013). On the other hand, *C. capsularis* leaves illustrated several pharmacological effects such as anticancer (Furumoto *et al.*, 2002), antioxidant (Zakaria, 2007), anti-inflammatory, antinociceptive, antipyretic (Zakaria *et al.*, 2009) and antimicrobial (Mondal *et al.*, 2017).

Reactive oxygen species (ROS) could be characterized as signaling molecules and lead to oxidative-induced damage to cell membranes, protein denaturation, DNA mutations and lipid peroxidation (Beckers and Spoel, 2006), which are related to some chronic diseases, like cancer, inflammation, cardiovascular diseases and others (Pietta, 2000). Antioxidants may be defined as complex determined compounds that function as defensive shields against several diseases (Nath *et al.*, 2013). Phenolic compounds are an important group of plant-based biologically active compounds that strengthen the organism and prevent disease (Sun *et al.*, 2002; Gharras, 2009). Plant polyphenols are secondary metabolites characterized by one or more hydroxyl groups binding to one or more aromatic rings (Zhou *et al.*, 2019). Phenolic compounds have a particularly strong antioxidant effect (Hider *et al.*, 2001; Scalbert *et al.*, 2005; Pandey and Rizvi, 2009). Numerous epidemiologic literature has verified an important correlation between the consumption of phenolic compound-rich food and a decreased risk for developing cardiovascular and other diseases (Weichselbaum *et al.*, 2010; Spencer, 2010).

Hence, in this study, we attempted to investigate the total antioxidant capacity and HPLC profiling of bioactive polyphenolic compounds in 80% ethanol extract of two varieties of jute leaves growing in Bangladesh.

### 2. Materials and methods

#### 2.1 Plant material

The two varieties of jute Leaves, *C. olitorius* (O-9897) and *C. capsularis* (CVL-1) were collected from Jute Seed Production and research centre, Bangladesh Jute Research Institute, Nashipur, dinajpur during June 2017. The leaves were properly washed to remove dirt and other impurities. After that, the leaves were dried under the shade. The dried leaves were powder by pulverizes. The sample was then saved in an airtight container and storage in the refrigerator until extraction.

#### 2.2 Extraction

The two varieties of shade dried leaves were extracted in an orbital shaker with 80% ethanol for 24 hrs at room temperature to obtain ethanol extract of jute leaves. The extract was initially filtered in a cotton plug to get rid of the plant debris and next through Whatman filter paper no 1. The solvent was removed using a rotary vacuum evaporator (R-215, Buchi, Switzerland) under reduced pressure. The concentrated filtrates were kept in the bottle at -20°C prior to further analysis.

#### 2.3 Chemicals and reagents

All the standards were purchased from Sigma-Aldrich (St. Louis, MO, USA) and reagent was collected from Scharlau (Spain) and Merck (Germany).

#### 2.4 Total antioxidant capacity

The total antioxidant capacity of the *C. olitorius* and *C. capsularis* leaves sample extract were evaluated by the phosphomolybdenum assay method (Prieto *et al.*, 1999) which is based on the reduction of Mo (VI) to Mo (V) and the subsequent formation of a green phosphate-Mo (V) complex in acidic condition. 0.3 mL of each extract (1 mg mL⁻¹) was allowed to mix with 3.0 mL of the reagent solution (0.6 M H₂SO₄, 28 mM Na₃PO₄, 4 mM ammonium molybdate). This reaction mixture was incubated at 95°C for 90 mins. After letting the solution cool back to room temperature, the absorbance was measured at 695 nm with a double beam UV/Visible spectrophotometer (Specord 205, Analytikjena, Germany) against a blank solution. The total antioxidant capacity was determined and expressed as mg ascorbic acid equivalents per gram of dry extract using the equation obtained from a standard ascorbic acid calibration curve.

#### 2.5 Identification and quantification of polyphenolic compounds by HPLC

Identification and quantification of selected phenolic compounds in the 80% ethanol extract were determined by HPLC-DAD analysis as described by Hossain *et al.* (2016) with some modifications. It was carried out on a Dionex UltiMate 3000 system equipped with quaternary rapid separation pump (LPG-3400RS) and photodiode array detector (DAD-3000RS). The separation was performed using Acclaim® C18 (5 μm) Dionex column (4.6 x 250 mm) at 30°C with a flow rate of 1 mL/min and an injection volume of 20 μL. The mobile phase consisted of acetonitrile (solvent A), acetic acid solution pH 3.0 (solvent B), and methanol (solvent C) with the
Identification and quantification of polyphenols in Jute leaves (mg of ascorbic acid/g of dry extract)

Table 1. Total antioxidant capacity of 80% ethanol extract of Jute leaves (mg of ascorbic acid/g of dry extract)

| Jute Leaves          | Total antioxidant capacity |
|----------------------|----------------------------|
| *C. olitorius*       | 165.66±1.30                |
| *C. capsularis*      | 214.32±1.95                |

3.2 Identification and quantification of polyphenols in *Corchorus olitorius* and *Corchorus capsularis* leaves

Identification and quantification of individual polyphenolic compounds in the 80% ethanolic extracts of *C. olitorius* and *C. capsularis* were analysed by HPLC. The chromatographic separations of polyphenols in standard and 80% ethanolic extracts of *C. olitorius* and *C. capsularis* are shown in Figures 1, 2 and 3 respectively. The content of each polyphenolic compound found in the 80% ethanolic extracts of *C. olitorius* and *C. capsularis* was calculated from the corresponding calibration curve and presented as the mean of five determinations as shown in Tables 2 and 3.

The analysis of the results of HPLC-DAD allowed the detection of six and eight polyphenolic compounds from *C. olitorius* and *C. capsularis* leaves respectively. The experimental results indicated that 80% ethanolic extract of *C. olitorius* leaves contained an especially high concentration of rutin hydrate, ellagic acid, and quercetin hydrate (152.17±0.51, 143.27±0.58, and 292.83±0.73 mg/100 g of dry extract, respectively) than that of *C. capsularis* (32.16±0.08, 53.65±0.11, and 46.17±0.09 mg/100 g of dry extract, respectively). It was also shown that caffeic acid and vanillin were detected both in the 80% ethanol extract of *C. olitorius* and *C. capsularis* but the concentration of caffeic acid was at the moderate amount (51.06±0.11 and 55.93±0.13 mg/100 g of dry extract) and vanillin at a lower amount (5.18±0.04 and 1.04±0.01 mg/100 g of dry extract) shown in Tables 2 and 3. It was also found that vanillin acid, *trans*-ferulic acid and rosmarinic acid (13.28±0.05, 58.02±0.18 and 3.54±0.02 mg/100 g of dry extract, respectively) were detected only in the 80% ethanol extract of *C. capsularis* leaves and on the other side kaempferol (13.32±0.07 mg/100 g of dry extract) was detected only in the 80% ethanol extract of *C. olitorius* at a lower concentration shown in Tables 2 and 3. The major identified polyphenolic compounds of *C. olitorius* were rutin hydrate, ellagic acid and quercetin hydrate. These compounds display interesting biological properties, such as antioxidant as well as anti-inflammatory and anticancer activities (Selloum et al., 2003; Vattem and Shetty, 2005; Anand David et al., 2016; Ganeshpurkar and Saluja, 2017). The previous study reported the presence of ethanol, ethanol: water (50:50) and water extract of *C. olitorius* leaves contain caffeic acid (229.56, 146.02 and 306.43 mg/kg), quercetin (52.01, 35.26 and 3.13 mg/kg) and kaempferol (18.28, 29.39 and 16.24 mg/kg) etc (Ben Yakoub et al., 2018). Which is lower than our present study. In *C. capsularis* leaves, the most abundant polyphenolic compounds were caffeic acid, *trans*-ferulic acid, rutin hydrate, ellagic acid and quercetin hydrate. These compounds have also a noticeable Pharmacological propriety such as antioxidant, anti-inflammatory and anticancer activities (Selloum et al., 2003; Vattem and Shetty, 2005; Kumar and Pruthi, 2014; Anand David et al., 2016;
In this context, Mosihuzzaman et al. (1986) showed that p-coumaric, caffeic, vanillic, ferulic acid and p-hydroxybenzoic acids were present in the 80% aqueous ethanol extract of *C. capsularis* in unretted bark and stem of jute. The antioxidant is generally used to evaluate the total antioxidant power of single compounds and complex mixtures of different plants (Huang et al., 2008). Antioxidant activity depends on the present of polyphenolic compounds (Materska and Perucka, 2005). Therefore, significant results of total antioxidant capacity of both extracts may be due present of different polyphenolic compounds.

### 4. Conclusion

The results of the present study indicated that, *C. olitorius* and *C. capsularis* leaves exhibit a significant amount of total antioxidant capacity and polyphenolic compounds.

### Conflict of interest

The authors declare no conflict of interest.

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