INTRODUCTION

The genus *Corchorus* (jute), which belongs to the family of Tiliaceae, involves about 50-60 species allocated in the tropics, subtropics, and warm temperate areas of the world. On the other hand, there is an assumption that the origin of *Corchorus olitorius* and most other species are from Africa. Jute cultivation is thought to have started 200 in years past in the tropics. *C. olitorius* is an important green leafy vegetable in many areas including Egypt, Southern Asia, Japan, India, China, Lebanon, Palestine, Syria, Jordan, Tunisia, and Nigeria. It is a leading leaf vegetable in Nigeria, Cameroon, Sudan, Kenya, Uganda, and Zimbabwe. It is also cultivated as a leafy vegetable in the Caribbean, Brazil, India, Bangladesh, China, and the Middle East. The plant is widely grown in the tropics for the viscosity of its leaves. *C. olitorius* is tall, annual herbs, reaching a height of 2–4 m. The plant could be unbranched or with only a few side divisions. The leaves alternately distributed, simple, lanceolate, finely serrated, or lobed margin. The flowers are small (2–3 cm in diameter) and yellow, and it has five petals. The fruit of the plant contains many seeds inside in the form of a capsule [1]. It is a cultivated plant here in Iraq.

Linnaeus was the first scientist who describes the *Corchorus genus* in 1753. The ancient Greeks used to call a potherb as “Korkhoros,” from the common name *Corchorus* is obtained [2].

*Corchorus species* (Tiliaceae family) is one of the main genera containing cardiac glycosides, especially in the seeds [3]. It has been used pharmaceutically and in cosmetic fields [4]. Different parts of *C. olitorius* have been utilized to relieve pain, aches, chronic cystitis, dysentery, enteritis, and pectoral pain [5]; the leaves have been used in case of gonorrhea, chronic cystitis, fever, and tumors [6]; and the seeds were utilized as demulcent, diuretic, and purgative and also used in chronic cystitis, in cases of cardiac diseases such as heart failure due to its content of cardenolides cardiac glycosides [7,8]. Studies done by Adogoke and Adebayo-Tayo [9] and Barku et al. [10] demonstrated that the methanolic extract of the *C. olitorius* leaves shows a considerable antibacterial activity and high susceptibility against *Escherichia coli* with a high zone of inhibition, while Ilhan et al. [7] proved that the petroleum ether extract of *C. olitorius* leaves exerts a good activity against *E. coli*. In general, phytochemical verification that performed on the leaves of the plant revealed the presence of sterols, triterpenes, carotenoids, coumarins, saponins, tannins, flavonoid, carbohydrates, and *cardiac glycosides* in the seeds of the plant [11,12]. From these chemical groups, flavonoids and phenolic acids are the most important.

The flavonoids have 15 carbon skeleton (benzopyran) C6-C3-C5 backbone structure and it is composed of two benzene rings, namely, ring A and ring B connected by heterocyclic ring called ring C. It is subdivided to many classes such as flavones, flavonols, flavanones, flavanols, isoflavones, and others, depending on the degree of oxidation, type, and manner of substitution of ring C; the difference between individual flavonoids depends on type and manner of substitution on rings A and B. It appears in nature as aglycones or glycosides in which the carbohydrates such as D-glucose and galactose attached to carbon number 3 or 7 and as methylated compounds. Flavonoids have several biological activities such as antioxidant, hepatoprotective, antibacterial, anti-inflammatory, antitumor, and antiviral activity [13-15]. Flavonoid is potential as antibacterial agents against *Staphylococcus epidermidis* and...
METHODS

Collection of plant materials

C. olitorius leaves were harvested from a farm in al-Utafiyah district in Baghdad City, during July, and the seeds were collected in September 2017. The plant was identified and authenticated by Prof. Dr. Sukaena Abass, Department of Biology, College of Sciences, University of Baghdad. Leaves were washed thoroughly, dried under shade, and ground in a mechanical grinder to a fine powder, and the seeds were cleaned from unwanted materials, dried in an oven at 40°C for 2 days, and ground in a mechanical grinder to a fine powder.

Equipment and chemical

The instruments used were rotary evaporator (BÜCHI Rotavapor R-205, Swiss), sonicator (Branson Sonifier, USA), high-performance liquid chromatography (HPLC) (SYKAM Germany), and high-performance thin-layer chromatography (HPTLC) (Elle Reich/CAMAG Laboratory, Switzerland). All chemicals and solvents used were of analytical grade and obtained from Riedel-de Haen, Germany, except trifluoroacetic acid, and methanol which is HPLC grade was purchased from Sigma-Aldrich, Germany. The standard luteolin, quercetin, astragalin, isoquercetin, catechin, and 3,5-DQA were purchased from Chengdu Biopurify Phytochemicals, China (purity >97%). TLC aluminum plates pre-coated with silica gel 60 F 254 (100 mm×100 mm, 0.2 mm thick) used were obtained from E. Merck Ltd, India.

Extraction

1. 250 g of shade-dried pulverized leaves of C. olitorius were defatted by maceration with hexane for 24 h and then allowed to dry at room temperature. The defatted plant materials were extracted by Soxhlet using aqueous methanol 85% as a solvent for 24 h. The extract was filtered, and the solvent was evaporated under reduced pressure using a rotary evaporator to get a dry extract named part A. The residue was suspended in 400 ml water and partitioned successively with petroleum ether (B.P.30–60), chloroform, ethyl acetate, and n-butanol (3×300 ml) for each fraction. The first three fractions were dried over anhydrous sodium sulfate, filtered, and evaporated to dryness.

2. The same procedure was applied to the seeds; the dry extract obtained named part B.

Hydrolysis of n-butanol fractions

3 g of n-butanol fractions of leaves and seeds were hydrolyzed by 200 mL of 5% HCl for 2 h under reflux, cooled, and partitioned with 200 mL × 3 ethyl acetate. The organic layers were combined, dried over anhydrous sodium sulfate, filtered, and evaporated to dryness under reduced pressure using a rotary evaporator; this was used to separate the flavonoid aglycone part from the sugar part, which in turn would simplify the isolation and detection procedures.

Preparations of standards and samples for analysis

Standard solutions for HPLC of luteolin, quercetin, astragalin, isoquercetin, catechin, and 3,5-DQA were prepared by dissolving 0.04 mg in 1 ml of methanol HPLC grade. Dried samples were prepared for HPLC analysis by dissolving them in methanol and subjecting them to ultrasonication at 60% duty cycles for 25 min at 25°C followed by centrifugation at 7500 rpm for 15 min. The clear supernatant of each sample was evaporated under vacuum. The residues were resuspended individually, in 1 ml of methanol HPLC grade, homogenizing using vortex mixer, and passing them through 2.5 μm disposable filter, and stored at 4°C for further analysis. 20 μl of the sample was injected into the HPLC system for analysis. Standards used for HPTLC analysis (astragalin, isoquercetin, catechin, and 3,5-DQA) were prepared by dissolving 1 mg of each standard in 1 ml methanol, while the samples were prepared by dissolving few milligrams from each sample in 1 ml methanol.

Preliminary phytochemical investigation

Test for flavonoids

Few milligrams of aqueous methanol plant extracts were suspended in ethanol and few drops of 5% ethanolic KOH were added, and then, few drops of 5% HCl were added. The changes in colors were recorded.

Test for phenols

Few milligrams of aqueous methanol plant extracts were treated with few drops of 1% FeCl₃. Formation of dark greenish-blue color indicates the presence of phenols.

HPLC analysis

HPLC technique (SYKAM, Germany) was applied for the detection of different constituents found in the ethyl acetate, n-butanol, and n-butanol after hydrolysis fractions as flavonoids and phenolic acids for both leaves and seeds of C. olitorius using a mobile phase composed of solvent A: Methanol: Solvent B: 0.05% trifluoroacetic acid in water for HPLC, gradient program from A=70% (0–5 min), A=40% (5–8 min), and A=90% (8–15 min). Column used: C18-ODS (25 cm x 4.6 mm), Detector: UV-280 nm, Injection volume: 20 μL, Flow rate: 1.0 ml/min.

HPTLC analysis

HPTLC, ethyl acetate for the leaves, and n-butanol after hydrolysis for the seeds fractions were analyzed also for its flavonoids and phenolic acid contents utilizing HPTLC (Elle Reich/CAMAG Laboratory, Switzerland), using silica gel GF254 plates developed in a mobile phase composed of ethyl acetate:formic acid:acetic acid:water (100:11:11.27 V/V) examined at 254 and 366 nm wavelength. The percentage of the compound in the plant was calculated depending on the following equation:

\[
\text{Percentage} = \frac{\text{Area of sample} \times 100}{\text{Area of standard}}
\]

Gas chromatography (GC)/mass analysis

The petroleum ether fraction of the C. olitorius leaves was analyzed using GC/mass (Agilent Single Quadrupole GC/mass, USA) Column used: Agilent 190915-433UI, HP-Sms Ultra Inert, 60–325°C (350°C): 30 m×250 μm×0.25 μm, Initial pressure: 7.037 psi, Flow rate: 0.9 ml/min.

• Conditions used for GC/mass spectrum (MS) analysis were as follows:

Injection temperature: 275.0°C, Injection mode: Splitless, Column temperature: 60.0°C, pressure: 7.037 psi, column flow: 0.9 ml/min, average velocity: 34.772 cm/s, holdup time: 1.4379 min.

Average velocity: 34.772 cm/s, holdup time: 1.4379 min, total elution time: 4.20 min, ion source: EI, source temperature (°C): 230, quad
temperature (°C): 150, start time: 0.00 min, end time: 6.62 min, ACQ mode: scan, sample inlet unit: DI (direct sample injection). The oven temperature programs for column and injector are shown in Table 2.

1. Molecular ion peak at m/z 516 [M]+ of the isolated 3,5-DCQA and its fragmentation is shown in Fig. 14.
2. Molecular ion peak at m/z 448 [M]+ of the isolated astragalin and its fragmentation is shown in Fig. 16.

GC/MS fragmentation chromatogram of the isolated compounds
The mass peaks of the isolated compounds were described as follows:
1. Molecular ion peak at m/z 516 [M]+ of the isolated 3,5-DCQA, astragalin, isoquercetin, catechin, quercetin, and luteolin showed in Figs. 3-8, respectively.
2. Molecular ion peak at m/z 448 [M]+ of the isolated catechin showed in Figs. 9.
3. Molecular ion peak at m/z 448 [M]+ of the isolated astragalin showed in Figs. 10 and 11, and preparative TLC used for isolation of flavonoids and phenolic compounds and observed at 254 nm wavelength is shown in Fig. 12.

RESULTS
Preliminary examination of the ethyl acetate fraction results is shown in Table 3.

The HPLC results of analyzed fractions of leaves and seeds are demonstrated in Tables 4 and 5. The identification of compounds by HPLC is usually performed by comparing the obtained retention times with the ones of related standards. Their chromatograms are shown in Figs. 1 and 2 compared with that of standard 3,5-DCQA, astragalin, isoquercetin, catechin, quercetin, and luteolin shown in Figs. 3-8, respectively.

HPTLC results are shown in Figs. 10 and 11, and preparative TLC used for isolation of flavonoids and phenolic compounds and observed at 254 nm wavelength is shown in Fig. 12.

HPTLC for isolated flavonoids and phenolic compounds is shown in Fig. 13.

The GC/MS for the petroleum ether fraction is shown in Fig. 14.

Detection was done by examination under UV light with wavelengths, namely, 254 nm. The purity of each band was checked by analytical TLC until a single spot on TLC plate is obtained for identification with a reference standard.

Identification of isolated flavonoid and phenolic derivatives from ethyl acetate fraction of leaves and n-butanol after hydrolysis fraction of seeds
The isolated flavonoid and phenolic derivatives were identified by different spectroscopic and chromatographic techniques listed below:

Table 1: The oven temperature programs for column and injector

| Rate    | Temperature (°C) | Hold time (min) |
|---------|-----------------|-----------------|
| 0.0     | 60.0            | 3.00            |
| 5°C/min | 150.0           | 2.00            |
| 5°C/min | 280.0           | 5.00            |

Table 2: DI temperature program

| Rate (°C/min) | Final temperature (°C) | Hold time (min) |
|--------------|------------------------|-----------------|
| 80           | 150                    | 0.0             |
| 40           | 300                    | 1.0             |

Table 3: Preliminary examination of the aqueous methanol extract for phenols and flavonoids

| Phytochemicals | Leaf extract | Seeds extract |
|----------------|--------------|---------------|
| Flavonoids     | +            | +             |
| Phenols        | +            | +             |

Table 4: Retention times of the detected compounds in minutes in all leaf fractions corresponding to the related standards

| Ethyl acetate before hydrolysis | n-butanol before hydrolysis | n-butanol after hydrolysis | Standard compound | Retention time in a min for standards |
|--------------------------------|-----------------------------|---------------------------|-------------------|--------------------------------------|
| -                              | 4.11                        | 4.09                      | 3.5-DCQA          | 4.1                                  |
| -                              | 5.27                        | 5.26                      | Luteolin          | 5.18                                 |
| 6.52                           | 6.52                        | 6.52                      | Quercetin         | 6.56                                 |
| 7.32                           | 7.32                        | 7.32                      | Isoquercetin      | 7.28                                 |
| 8.13                           | 8.13                        | 8.16                      | Astragalin        | 8.35                                 |
| 11.98                          | 11.98                       | 11.98                     | Catechin          | 11.9                                 |

Table 5: Retention times of the detected compounds in minutes in all seeds fractions corresponding to the related standards

| Ethyl acetate before hydrolysis | n-butanol before hydrolysis | n-butanol after hydrolysis | Standard compound | Retention time in a min for standards |
|--------------------------------|-----------------------------|---------------------------|-------------------|--------------------------------------|
| -                              | 4.12                        | 4.11                      | 3.5-DCQA          | 4.1                                  |
| -                              | 5.27                        | 5.27                      | Luteolin          | 5.18                                 |
| 6.52                           | 6.25                        | 6.52                      | Quercetin         | 6.56                                 |
| 7.32                           | 7.32                        | 7.32                      | Isoquercetin      | 7.28                                 |
| 8.13                           | 8.13                        | 8.13                      | Astragalin        | 8.35                                 |
| -                              | 11.98                       | 11.98                     | Catechin          | 11.9                                 |

3,5-DCQA: 3,5-dicaffeoylquinic acid

Asian J Pharm Clin Res, Vol 11, Issue 11, 2018, 408-417

Hasan and Kadhim
3. Molecular ion peak at m/z 464 [M]+ of the isolated isoquercetin and its fragmentation is shown in Fig. 17.

4. Molecular ion peak at m/z 290 [M]+ of the isolated catechin and its fragmentation is shown in Fig. 18.

**IR spectroscopy**

The IR spectral analysis of the isolated compounds illustrates the characteristic band frequencies for each compound as follows:

1. The IR spectral analysis (Fig. 19) of the isolated 3,5-DCQA showed the peaks at 3500–3140 (broadband), 3064, 2966, 2910, 2852, 1712, 1683, 1365, 1350, 1269, 1624, 1559, 1442, 922, 854, 781, 729, and 684/cm.

2. The IR spectral analysis (Fig. 20) of the isolated astragalin showed the peaks at 3626–3444, 3101, 2994, 2904, 1666, 1396, 1359, 1286, 1249, 1606, 1437, 902, 854, 833, 731, 705, and 688/cm.

3. The IR spectral analysis (Fig. 21) of the isolated isoquercetin showed the peaks at 3562–3504, 3147, 3076, 2947, 2848, 1662, 1357, 1294, 1230, 1599, 1452, 1440, 906, 862, 810, 792, 763, and 694/cm.

4. The IR spectral analysis (Fig. 22) of the isolated catechin showed the peaks at 3649–3564, 3057, 2997, 2852, 1637, 1398, 1280, 1217, 1606, 1413, 871, 837, 769, and 698/cm.

The IR spectra of the isolated 3,5-DCQA, astragalin, isoquercetin, and catechin are shown in Figs. 19-22.

**DISCUSSION**

Plants are generally a good source of many important pharmaceutical compounds. Specifically, the plants rich in secondary metabolites. Plant-derived drugs played an important role in the benefits of human health and wellness.
The preliminary phytochemical analysis confirmed the presence of phenols and flavonoids.

The HPLC results show the presence of flavonoids (in both forms as aglycones and as glycosides) and phenolic acid in the leaves and seeds of the plant, such as luteolin, quercetin, isoquercetin, astragalin, catechin, and 3,5-DCQA.

The compound 3,5-DCQA does not appear in the HPLC chromatogram of ethyl acetate fractions of the leaves; but appeared as a peak having a small area under the curve in the n-butanol after hydrolysis fraction of seeds. This is due to the low concentration of the compound, and the difference in absorption scales used in analyzing the ethyl acetate fraction (absorption scale 0–1000) and the rest of fractions (absorption scale 0-100).

HPLC result revealed that astragalin, isoquercetin, and quercetin are the major compounds in the leaves and seeds of Colitortis.

Luteolin appeared in the n-butanol and n-butanol after hydrolysis but not the ethyl acetate fraction for both the leaves and seeds of the plant.

HPTLC results revealed the presence of astragalin, isoquercetin, and 3,5-DCQA in the ethyl acetate fraction of the leaves and the presence of catechin in the hydrolyzed n-butanol fraction of the seeds.

The explanations for the obtained IR spectral analysis are shown in Table 7.

Regarding MS fragmentation, chromatogram of the isolated compounds is explained as follows:

1. Molecular ion peak at m/z 516 [M]+ that corresponds to a molecular formula of 3,5-DCQA (C25H24O12). Ion peaks were also observed at m/z 353 due to loss of one caffeic acid moiety from the original compound, 163 for caffeic acid, and 191 for quinic acid which is the result of losing the second caffeic acid moiety, and these are in good agreement with reported values of the 3,5-DCQA structure[32]. According to all the data obtained from HPLC, HPTLC, IR, and mass fragmentation, Fig 23 demonstrates the predicted chemical structure for the compound 3,5-DCQA.

2. Molecular ion peak at m/z 448 [M]+ that corresponds to a molecular formula of Astragalin (C21H20O11). Ion peaks were also observed at m/z 285 which represents the kaempferol aglycon moiety, 163 represents the sugar part (glucose), and 117 and 152 which are in good agreement with reported values of astragalin structure [33]. According to all the data obtained from HPLC, HPTLC, IR, and mass fragmentation, Fig 24 demonstrates the predicted chemical structure for the compound astragalin.

3. Molecular ion peak at m/z 464 [M]+ that corresponds to a molecular formula of Isoquercetin (C21H20O12). Ion peaks were also observed at m/z 301 which represents the quercetin aglycon moiety, 163 represents the sugar part (glucose), and 133 and 152 which are in a good agreement with reported values of isoquercetin structure [33]. According to all the data obtained from HPLC, HPTLC, IR, and mass fragmentation, Fig 25 demonstrates the predicted chemical structure for the compound isoquercetin.

4. Molecular ion peak at m/z 290 [M]+ that corresponds to a molecular formula of Catechin (C15H14O6). Ion peaks were also observed at m/z 152, 139, and 123 which are in a good agreement with the reported
Asian J Pharm Clin Res, Vol 11, Issue 11, 2018, 408-417

Hasan and Kadhim

According to all the data obtained from HPLC, HPTLC, IR, and mass fragmentation, Fig. 26 demonstrates the predicted chemical structure of the compound catechin. Also named 3-O-(glucoside)-5,6,3',4'-tetrahydroxy-flavonol

The petroleum ether fraction trapped the compounds with low polarity as mentioned in the Table 6.

This is the first phytochemical investigation done in Iraq concerning C. olitorius and comparison between flavonoids and phenolic acids contents of leaves and seeds of this plant. Further steps are needed to be done to isolate the different chemical constituents detected.

CONCLUSION

1. The results of the current study showed the presence of flavonoids such as luteolin, astragalin, isoquercetin, quercetin, and catechin and the presence of phenolic acid 3,5-DCQA in the leaves and seeds of C. olitorius L. cultivated in Iraq.

2. The results of the current study show the isolation of flavonoids (astragalin and isoquercetin) and phenolic acid 3,5-DCQA from the ethyl acetate fraction of the leaves by TLC and show the isolation of flavonoid catechin by HPLC from the hydrolyzed n-butanol fraction of the seeds.
3. The study showed the presence of several compounds such as 17-octadecynoic acid, 9-octadecanoic acid (oleic acid), hexadecenoic acid (palmitic acid), 9,12-octadecanoic acid (linoleic acid), octadecadien-1-ol, β-sitosterol, and α-tocopherol (VIT E) in the petroleum ether fraction of the leaves.

4. The study shows that no major differences were found between the flavonoids and phenolic acids contents of the leaves and seeds of C. olitorius.

ACKNOWLEDGMENT

We are deeply grateful to the College of Pharmacy, University of Baghdad, for giving us the opportunity and facilities to achieve this work.

AUTHORS' CONTRIBUTIONS

Enas J Khadim has provided the design, intellectual content, innovation, and protocol for conducting the experiment in the laboratory along with...
Table 7: The explanation of characteristic FT-IR absorption bands (in cm\(^{-1}\)) of the isolated compounds

| Functional group | Group frequency wave number (in cm\(^{-1}\)) | Assignment |
|------------------|---------------------------------------------|------------|
|                  | Measured for isolated compound 3,5-DCQA | Measured for isolated compound astragalin | Measured for isolated compound isoquercetin | Measured for isolated compound catechin |
| O-H              | Broadband 3500–3140 | 3626–3444 | 3562–3504 | 3649–3564, the additional band 3500–3200 |
|                  | O-H stretching of phenol. Carboxylic acid in most cases appears as a dimer |
| C=O-H            | 3064 | 3101, 370 | 3147, 3076 | 3057 |
|                  | C-H stretching of aromatic alkene |
| C=H              | 2966, 2910, 2852 | 2994, 2904 | 2947, 2848 | 2997, 2852 |
|                  | Asymmetric and symmetric stretching of CH\(_2\) and CH\(_3\) |
| C=O              | 1712 for ester, and 1683 for carboxylic acid | 1666 | 1662 | 1637 |
|                  | C=O-O stretching (conjugation and H-bonding) |
| O-H              | 1365, 1350 | 1396, 1359 | 1357 | 1398 |
|                  | O-H bending of phenol |
| C=O-C            | 1269, 1257 | 1286, 1249 | 1294, 1230, 1200 | 1280, 1217 |
|                  | C=O-C stretching of ether |
| C-H              | 1624, 1559 | 1606 | 1599 | 1606 |
|                  | C=O-C stretching of aromatic alkene |
| C=H and C=C      | 922, 854, 812, 781, 729, 694 | 902, 854, 833, 802, 731, 705, 680 | 906, 862, 810, 792, 763, 694 | 871, 837, 815, 769, 698 |
|                  | C-H and C=C bending of aromatic (out- and in-plane) |
| C-H              | 1087, 1033 | 1130, 1099, 1076 | 1166, 1134, 1118 | 1217, 1145 |
|                  | C-H bending of aromatic (in the plane) |

3,5-DCQA: 3,5-dicaffeoylquinic acid

Fig. 18: Mass fragmentation spectra of the isolated catechin

Fig. 19: Infrared spectrum of isolated 3,5-dicaffeoylquinic acid

Fig. 20: Infrared spectrum of isolated astragalin

Fig. 21: Infrared spectrum of isolated compound isoquercetin
Fig. 22: Infrared spectrum of isolated catechin

Fig. 23: Chemical structure and mass fragmentation of isolated compound (3,5-dicaffeoylquinic acid)

Fig. 24: Chemical structure and mass fragmentation of isolated compound (astragalin). Also named 3-O-(glucoside)-5,6,'4'-trihydroxy-flavonol or kaempferol-3-O-glucoside

Fig. 25: Chemical structure and mass fragmentation of isolated compound (isoquercetin)

Fig. 26: Chemical structure and mass fragmentation of isolated compound (catechin). Also named 5,6,'4,'5- tetrahydroxy flavan-3-ol

Hasan and Kadhim
Asian J Pharm Clin Res, Vol 11, Issue 11, 2018, 408-417

MENTORSHIP. Hayder T Hasan has majorly performed the experiment in the laboratory and analysis of obtained data.

CONFLICTS OF INTEREST
The authors declare that there are no conflicts of interest regarding the publication of this article.

REFERENCES
1. Loumerem M, Alercia A. Descriptors for jute (Corchorus olitorius L). Genet Resour Crop Evol 2016;63:1103-11.
2. Benor S, Autor B. Phylogeny of the Genus Corchorus (Malvacea S. L.) and Diversity Analyses in Selected Species Evidence from Morphology, Flow Cytometry, and Molecular Data. 49(0):0-10. Available from: https://www.cuvillier.de/de/shop/publications/200.
3. Evans WC. Tease and Evans’ Pharmacognosy. 16th ed. Edinburgh London New York Philadelphia St Louis Sydney Toronto 2009- Saunders Ltd.; 2009. p. 616.

4. Assi O, Sidibe D, Kouakou P, Deigna-Mockey V, Konan Y, Coulibly A, et al. Characterization of the mucilages of four food plants, Abelmoschus esculentus, Belischimbia munni, Corchorus olitorius, and Irvingia gabonensis, from côte d’Ivoire. Biotechnol J Int 2017;19:1-10.

5. Zakaria ZA. The anti-inflammatory and antipyretic activities of Corchorus olitorius in rats.pdf. J Pharmaco toxicol 2006;1:139-46.

6. Zakaria ZA, Somecht MN. The in vitro antibacterial activity of Corchorus olitorius extracts. Int J Pharmacol 2006;2:213-5.

7. Illhan S, Savaro F, Cocol F. Antibacterial and antifungal activity of Corchorus olitorius L. (mokolokia) extracts. Int J Nat Eng Sci 2007;1:59-61.

8. Al-yousef HM, Amina M, Ahamad SR. Comparative study on the chemical composition of Corchorus olitorius L leaf and stem dry oils. Biomed Res 2017;28:4581-7.

9. Adegoke AA, Adebayo-Tayo BC. Phytochemical composition and antimicrobial effects of Corchorus olitorius leaf extracts on four bacterial isolates. J Med Plants Res 2009;3:155-9.

10. Barku VY, Opoku-Boahen Y, Owusu-Ansah E, Dayie NT, Mensah FE. Chemical composition of Corchorus capsularis in rats. Asian J Pharm Clin Res 2017;10:354-8.

11. Alaa S, Abdellah M, Hamadi L. Phytochemical screening, contribution profiling, total flavonoid and phenolics content, anti-oxidant activity of flavonoid from kepel (Ficus benghalensis). Hindawi Sci World J 2013;2013:533-48.

12. Evans WC. Trease and Evans’ Pharmacognosy. 16th ed. Edinburgh London New York Philadelphia St Louis Sydney Toronto 2009- Saunders Ltd.; 2009. p. 616.

13. Shashank K, Pandey AK. Chemistry and biological activities of flavonoids. Hindawi Sci World J 2013;2013:533-48.

14. Ataa S, Abdellah M, Hamadi L. Phytochemical screening, contribution to the study of the antifungal effect of flavonoids from different parts of Ziziphus lotus of South-West Algeria. Asian J Pharm Clin Res 2017;10:354-8.

15. Indariani S, Hidayat A, Darusman LK, Batubara J. Antibacterial activity of flavonoid from kepel (Skelechycarps burahol) leaves against Staphylococcus epidemics. Int J Pharm Pharm Sci 2017;9:9-13.

16. Tulasi CD, Rani AS, Manjula B. Screening of phyto-chemicals, tle profiling, total flavonoid and phenolics content, anti-oxidant activity and anti-microbial activity of Ficus benghalensis linn and Ficus religiosa linn latex. Int J Pharm Pharm Sci 2015;7:480-5.

17. Tsao R. Chemistry and biochemistry of dietary polyphenols. Nutrients 2010;2:1231-46.

18. Harborne JB. Phytochemical methods; A guide to modern techniques of plant analysis. J Chem Model 1990;3:317.

19. Kurnukov AG. Phytochemistry of medicinal plants. Med Plants Cent Asia Uzb Kyrg 2013;1:13-4.

20. Al-yousef HM, Amina M, Ahamad SR. Comparative study on the chemical composition of Corchorus olitorius L leaf and stem dry oils. Biomed Res 2017;28:4581-7.

21. Masayuki Y, Shimada H, Saka M, Yoshizumi S, Yamahara J, Matsuda H. Absolute stereostructures of corchoinosides a,b and c, histamine release inhibitors from the leaves of vietnamese Corchorus olitorius L. (Tiliaceae). Chem Pharm Bull 1997;45:464-9.

22. Hiroshi K, Seiji T, Yasutoshi MS, Yosie O. Constituents of Corchorus olitorius L.pdf. Nat Med 1994;48:213-4.

23. Zeghichi S, Kallithraka S, Simopoulos AP. Nutritional composition of dietary phenolics isolated from Corchorus olitorius and Vitis vinifera. J Funct Foods 2013;5:1204-16.

24. Handoussa H, Hanafi R, Ediasty I, El-Gendy M, El Khatib A, Linscheid M, et al. Anti-inflammatory and cytotoxic activities of dietary polyphenols isolated from Corchorus olitorius and Vitis vinifera. J Funct Foods 2013;5:1204-16.

25. Shashank K, Pandey AK. Chemistry and biological activities of flavonoids. Hindawi Sci World J 2013;2013:533-48.

26. Alaa S, Abdellah M, Hamadi L. Phytochemical screening, contribution to the study of the antifungal effect of flavonoids from different parts of Ziziphus lotus of South-West Algeria. Asian J Pharm Clin Res 2017;10:354-8.

27. Shashank K, Pandey AK. Chemistry and biological activities of flavonoids. Hindawi Sci World J 2013;2013:533-48.

28. Alaa S, Abdellah M, Hamadi L. Phytochemical screening, contribution to the study of the antifungal effect of flavonoids from different parts of Ziziphus lotus of South-West Algeria. Asian J Pharm Clin Res 2017;10:354-8.

29. Indariani S, Hidayat A, Darusman LK, Batubara J. Antibacterial activity of flavonoid from kepel (Skelechycarps burahol) leaves against Staphylococcus epidemics. Int J Pharm Pharm Sci 2017;9:9-13.

30. Tulasi CD, Rani AS, Manjula B. Screening of phyto-chemicals, tle profiling, total flavonoid and phenolics content, anti-oxidant activity and anti-microbial activity of Ficus benghalensis linn and Ficus religiosa linn latex. Int J Pharm Pharm Sci 2015;7:480-5.