BULLETIN OF PHARMACEUTICAL SCIENCES

Assiut University
ISSN - 1110-0052

Articles in Press

Current Issue

Journal Archive

- **Volume 46 (2023)**
  - Issue 1
- **Volume 45 (2022)**
- **Volume 44 (2021)**
- **Volume 43 (2020)**
- **Volume 42 (2019)**
- **Volume 41 (2018)**
- **Volume 40 (2017)**
- **Volume 39 (2016)**
- **Volume 38 (2015)**
- **Volume 37 (2014)**
- **Volume 36 (2013)**
- **Volume 35 (2012)**
- **Volume 34 (2011)**
- **Volume 33 (2010)**
- **Volume 32 (2009)**
- **Volume 31 (2008)**
- **Volume 30 (2007)**
- **Volume 29 (2006)**
- **Volume 28 (2005)**
- **Volume 27 (2004)**
- **Volume 26 (2003)**
- **Volume 25 (2002)**

Facts & Figures	
Number of Volumes	46
Number of Issues	78
Number of Articles	1,025
Article View	111,227
PDF Download	162,050
View Per Article	108.51
PDF Download Per Article	158.1

Tutorial Videos
Author Guide Video
Reviewer Guide Video
Editor Guide Video

Most Visited Articles

PERFORMANCE OF CURCUMIN IN NANOSIZED CARRIERS NIOSOMES AND ETHOSOMES AS POTENTIAL ANTI-INFLAMMATORY DELIVERY SYSTEM FOR TOPICAL APPLICATION
DEVELOPMENT AND OPTIMIZATION OF ALBENDAZOLE NANOSUSPENSION AS LOCAL ADJUVANT THERAPY FOR TREATMENT OF ENTEROBIASIS
EFFECT OF ESSENTIAL OILS ON TRANSDERMAL PERMEATION OF METOPROLOL SUCCINATE
Formulation, bioavailability and pharmacokinetic properties of combined paracetamol/orphenadrine in tablets
COMPATIBILITY STUDY OF FAMOTIDINE WITH SOME PHARMACEUTICAL EXCIPIENTS USING DIFFERENT TECHNIQUES

Current Issue: Volume 46, Issue 1, June 2023, Pages 1-668

DESIGN AND EVALUATION OF ANTIUROLITHIATIC EFFERVESCENT HERBAL TABLETS CONTAINING HYDROALCOHOLIC EXTRACT OF BRYOPHYLLUM PINNATUM

Pages 1-11

Banshongdor Mawlieh; Kangkan Kalita; Bhargab Jyoti Sahariah; Apurba Talukdar; Nilutpal Sharma Bora

View Article PDF 1.09 MB

COMPLICATIONS ASSOCIATED WOUND HEALING IN DIABETIC PATIENTS: DOES NANOTECHNOLOGY HAVE ANY SUPERIOR THERAPEUTIC ADVANTAGES?

CYTOTOXIC AND ANTIMICROBIAL EFFECTS OF SELECTED EGYPTIAN ASTERACEAE SPECIES AS WELL AS GC-MS METABOLITE PROFILING OF SENECIO CRUENTUS LIPOPHILIC FRACTION

ULTRASONIC - ASSISTED EXTRACTION AND MICROENCAPSULATION OF BIOACTIVE COMPOUND FROM PIGEON PEA SEED

APPLICATION OF ASPERGILLUS ORYZAE ASU44 (OL314732) AND THEIR KOJIC ACID AS PESTICIDES AGAINST COTTON APHID, APHIS GOSSYPII

QUALITATIVE PHYTOCHEMICAL SCREENING, ANTIOXIDANT AND WOUND HEALING ACTIVITIES OF PISTACIA PALAESTINA BOISS. EXTRACTS

THE PHYTOCHEMICAL PROFILE OF MANGIFERA RUFOCOSTATA KOSTERM AND ITS ANTIOXIDANT ACTIVITY

Sutomo Sutomo; Arnida Arnida; M. Ikhwan Rizki; Deni Setiawan; Anindita Nawinda; Monica Fajariawati

View Article PDF 675.18 K

RESIDUAL SOLVENTS ANALYSIS IN METRONIDAZOLE RAW MATERIAL USING HEAD SPACE GAS CHROMATOGRAPHY

Pages 105-115

Derouicha Matmour; Khalil Fateh Eddine Hassam; Yassine Merad; Nassima Hamdi ZianI

View Article PDF 1.59 MB

APPLICATION OF FAST NON- INVASIVE SOLID STATE ANALYSIS ON COUNTERFEIT TRACING OF PHARMACEUTICAL DRUG EXCIPIENTS

Pages 117-127

Hassan Refat H. Ali; Reem Y. Shahin

View Article PDF 896.72 K

STUDY OF RELATED IMPURITIES PROFILE BY HPLC: CASE OF FIVE SAMPLES OF FLUCONAZOLE ACTIVE PHARMACEUTICAL INGREDIENT

Pages 129-140

Derouicha Matmour; Nadjib Hamoum; Khalil Fateh Eddine Hassam; Amel CHENAFA; Khadidja Yanallah; Yassine Merad; Nassima Hamdi Ziani

View Article PDF 1000.55 K

UTILIZATION OF THE STABILITY-INDICATING RP-HPLC METHOD FOR DIETRY SUPPLEMENT CALCIUM OROTATE QUANTIFICATION IN CAPSULE DOSAGE FORM

Pages 141-156

Swathi Koduru; Hemant Kumar T; Chaitanya Mitta; Swathi Kalepu; Ravindar Bairam

View Article PDF 1.02 MB

DEVELOPMENT OF RP-HPLC METHOD FOR SIMULTANEOUS DETERMINATION OF NEBIVOLOL HYDROCHLORIDE, VALSARTAN AND HYDROCHLOROTHIAZIDE IN CO-ADMINISTRATED ANTIHYPERTENSIVE AGENTS AND HUMAN PLASMA

Pages 157-172

M. Rizk; Maha M. Abou El-Alamin; Shereen Mowaka; Mariam Mohamed

View Article PDF 1.32 MB

STANDARDIZATION AND GC-MS ANALYSIS OF KERSEN (MUNTINGIA CALABURA L.) FRUIT ETHANOL EXTRACT AS AN HERBAL RAW MATERIAL

CHROMATOGRAPHIC ISOLATION, IDENTIFICATION AND CHARACTERIZATION OF SOME CHEMICAL CONSTITUENTS OF PETROSELINUM CRISPUM LEAVES AND EVALUATING AS HEPATOPROTECTIVE AGENTS

SYNTHESIS, CHARACTERIZATION AND ANTIBACTERIAL EVALUATION OF NOVEL B- LACTAM AND THIAZOLIDIN-4-ONE DERIVATIVES HAVING THIADIAZINYL RING

SECONDARY METABOLITES FROM THE STEM BARK OF POLYALTHIA STENOPETALA (HOOK. F. & THOMSON) RIDL. AND THEIR ACETYLCHOLINESTERASE ACTIVITY

BIOSYNTHESIS, CHARACTERIZATION, AND ANTIMICROBIAL ASSESSMENT OF METAL NANOPARTICLES FROM DRYOPTERIS MANNIANA (HOOK.) C. CHR LEAF EXTRACT

SYNTHESIS, BIOLOGICAL EVALUATION AND MOLECULAR DOCKING OF DIARYLIMIDAZOLE DERIVATIVES AS NEW POTENTIAL ANTI-INFLAMMATORY AGENTS TARGETING COX-2 ENZYME

EVALUATING THE EFFECTS OF PERITONSILLAR INFILTRATION OF BUPIVACAINE AND DEXAMETHASONE ON POST-TONSILLECTOMY PAIN REDUCTION IN KIDS

GLUTEN CONTENT IN PHARMACEUTICALS MARKETED IN THE GAZA STRIP

THE EFFECT OF MELATONIN, METFORMIN AND URSODEOXYCHOLIC ACID ON NON-ALCOHOLIC FATTY LIVER DISEASE: A RANDOMIZED, DOUBLE-BLINDED CONTROLLED TRIAL

ASSESSMENT OF PENTOXIFYLLINE EFFECTS ON LIVER STEATOSIS UTILIZING DIXON-BASED MRI TECHNIQUE; RANDOMIZED CONTROLLED STUDY

EVALUATING HOSPITAL PHARMACY PRACTICE: MEDICATION PRESCRIBING, TRANSCRIBING, AND ADMINISTRATION IN TABUK REGION, SAUDI ARABIA

EVALUATION OF THE EFFICACY AND TOXICITY OF NEO-ADJUVANT SHORT COURSE RADIATION THERAPY CONCURRENTLY WITH CONTINUOUS INFUSION 5-FLUOROURACIL IN THE MANAGEMENT OF LOCALLY ADVANCED RECTAL CANCER PATIENTS

Radwan Torky; Mariam Mohsen Khalil; Taha Zaky; Mostafa Elsayed; Abeer Fayek; Maha Salah

View Article PDF 1.33 MB

DISPENSING ANTIBIOTICS WITHOUT PRESCRIPTION IN THE ARAB WORLD: A NARRATIVE REVIEW OF THE PREVALENCE, APPROPRIATENESS, FACILITATORS AND PREVENTIVE INTERVENTIONS

Pages 399-420

Hala Zl Alagha

View Article PDF 1.04 MB

ASSOCIATION BETWEEN ANTIBIOTIC RESISTANCE, BIOFILM FORMATION AND LASB GENE IN PSEUDOMONAS AERUGINOSA ISOLATED FROM DIFFERENT CLINICAL SPECIMENS

Pages 421-431

Shimaa M. Ghanem; Gamal F. M. Gad; Rehab Mahmoud Abd El-Baky; Nancy G. F. M. Waly

View Article PDF 796.06 K

IN- VITRO EVALUATION OF NANOCURCUMIN AGAINST MULTI-DRUG RESISTANT BACTERIA

Pages 433-448

Noha Mohammed Safwat Ibrahim; Ehsan A. B. Hassan; Sherein G. Elgendy; Hebatallah M. Hassan; Abeer S. Hassan; Niveen G. El-Gindy

View Article PDF 1.53 MB

THERAPEUTIC PHARMACOLOGICAL PROPERTIES OF CITRULLUS COLOCYNTHIS FRUIT PULPS METHANOLIC CRUDE EXTRACT AGAINST POTASSIUM OXONATE-INDUCED HYPERURICEMIC GOUT RAT MODEL

Pages 449-463

Heba Mokhtar El-Kady; Hosny A. Hassan; Amal A.M. Mohamed; Lourin G. Malak; Sary Kh. Abd El-Ghaffar

View Article PDF 1.1 MB

INVESTIGATION OF THE PREVALENCE OF CANDIDURIA IN PATIENTS WITH HEMATOLOGIC MALIGNANCIES IN HOMS – SYRIA

Pages 465-472

Rafah Alali; Walid Khaddam; Sundus Yaseen

View Article PDF 689.87 K

STUDY THE ANTI-INFLAMMATORY EFFECTS OF TAMSULOSIN BY THE EVALUATION OF INFLAMMATORY CELLS AND LUNG HISTOPATHOLOGY IN AN AIRWAY INFLAMMATION MODEL IN RATS

PRESCRIBING PATTERNS AND PHARMACOLOGICAL KNOWLEDGE OF ANALGESICS AMONG COMMUNITY PHARMACISTS IN JEDDAH, SAUDI ARABIA

THERAPEUTICAL INTERVENTIONS FOR MYALGIC ENCEPHALOMYELITIS/CHRONIC FATIGUE SYNDROME; A REVIEW OF PHASE IV CLINICAL TRIALS

Publication Information

Publisher
Assiut University, Faculty of Pharmacy

Frequency
Quarterly

Print ISSN

1110-0052

Search

Advanced Search

Indexing and Abstracting

...

Volume & Issue: Volume 45, Issue 1, June 2022, Pages 1-492
Number of Articles: 40

UPDATED REVIEW ON EXTRACTION, ISOLATION AND QUANTITATIVE ESTIMATION OF ERGOT ALKALOIDS

Pages 63-74

I. Theja; P. Sowmya; B. Ramya Kuber

View Article PDF 1 MB

UNRAVELLING THE ANTIOXIDANT AND ANTI-CANCEROUS PROPERTIES OF THE CHEMICAL CONSTITUENTS PRESENT IN METHANOL EXTRACT OF GREEN ALGAE CHAETOMORPHA ANTENNINA

Pages 75-87

Akanksha Dubey; Jayanthi Sivaraman

View Article PDF 1.07 MB

EFFECT OF UV-C STRESS ON TOTAL PHENOLICS, TOTAL FLAVONOIDS AND KHELLIN CONTENTS IN AMMI VISNAGA (L.) LAM. FRUITS

Pages 89-97

Iman S. A. Khallaf; Rania A. A. Hussein; Osama M. M. Ali; Gehad S. Remeih; Aya S. Mortada; Khaled M. Mohamed

View Article PDF 630.32 K

BOTANICAL STUDY AND FATTY ACIDS CHARACTERIZATION OF THE LEAVES OF DYPSIS PEMBANA (H.E. MOORE) BEENTJE &J. DRANSF. FAMILY ARECACEAE CULTIVATED IN EGYPT

Pages 99-118

Mohamed Salah Abdelrahim; Afaf Mohamed Abdel-Baky; Enaam Younis Backheet; Soad Abdel Latief Bayoumi

View Article PDF 2.42 MB

COMPARISON OF THE EFFECT OF SALVIA OFFICINALIS EXTRACT AND VITEX AGNUS-CASTUS EXTRACT ON ANXIETY IN POSTMENOPAUSAL WOMEN: A RANDOMIZED, TRIPLE-BLIND, PLACEBO-CONTROLLED TRIAL

Pages 119-128

Afsaneh Zeidabadi; Masoumeh Emamghoreishi; Naeimeh Tayebi; Marzieh Akbarzadeh

View Article PDF 794.79 K

NEUROPHARMACOLOGICAL ACTIVITIES OF METHANOLIC EXTRACT OF LEAVES OF VISCUM CAPITELLATUM SMITH.

NOVEL HIV-1 NONNUCLEOSIDE REVERSE TRANSCRIPTASE INHIBITORS

Pages 201-222

Hossam. M. Abdel-Aziz; Ahmed M. Ali; Atef A-M. Abdel-Hafez; Adel F. Youssef

View Article PDF 1.14 MB

FACILE HPLC/UV METHOD FOR DETERMINATION OF METFORMIN AND 1-CYANOGUANIDINE USING NOVEL HALOGENATED STATIONARY PHASE

Pages 223-231

Ali Abdel-Hakim; Aliaa I. Shallan; Mohamed A. Hammad; Maha M. Abou El- Alamin

View Article PDF 655.64 K

MICROSCOPIC, MICROBIAL AND MOISTURE CONTENT EVALUATION OF THE HERBAL PRODUCTS AFFECTING THE URINARY SYSTEM MARKETED IN SYRIA

Pages 233-248

Zahraa Ali; Emad Alhaddad; Ramez Roustom

View Article PDF 1.05 MB

ASSESSING THE QUANTITY AND QUALITY OF OZONATED OLIVE OIL AND STUDYING ITS SHELF-LIFE STABILITY

Pages 249-268

Sarab Jbara; Ahmad Safwan Shehadeh; Saleh Trefi; Yaser Bitar

View Article PDF 2.1 MB

A VALIDATED HPLC METHOD FOR SEPARATION AND DETERMINATION ASPARTAME AND ACESULFAME-K IN FOOD PRODUCTS

Pages 269-274

Nermeen Mahmoud Barakat; Mohammed Al-Azem; Nazira Sarkis; Saleh Trefi

View Article PDF 1.01 MB

EFFICACY OF ARIPIPRAZOLE AND RISPERIDONE IN TREATMENT OF CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER: A DOUBLE-BLIND CLINICAL TRIAL STUDY

Pages 281-288

Firoozeh Dreakhshanpour; Anahita Deylamsalehi; Seyed Shahab Jazayeri Moghadda; Najmeh Shahini

View Article PDF 754.33 K

INFLAMMATORY STATUS IN WOMEN WITH POLYCYSTIC OVARIAN SYNDROME IN GAZA STRIP

Pages 289-297

Mohammed Taha

View Article PDF 659.2 K

PRESCRIBING FREQUENCY, TRENDS, AND PATTERNS OF ANTIMICROBIAL THERAPY IN PATIENTS WITH ACUTE TONSILLITIS: A REVIEW

Pages 299-310

Nimra Zaman; Komal Zaman; Faryal Zaman; Bushra Zaman

View Article PDF 698.14 K

THE IMPACT OF COVID-19 PANDEMIC ON ADMINISTRATION AND ECONOMICS OF COMMUNITY PHARMACIES IN EGYPT

Pages 311-325

Mena Emad; Mahmoud El-badry; Sahar B. Hassan

View Article PDF 939.86 K

EFFECT OF COPPER SULPHATE POLLUTION AND ITS ANTIDOTE PENICILLAMINE ON SERUM AND BRAIN TISSUES MARKERS OF ALBINO RATS

Pages 327-337

Medhat M. Fawzy; Sara M. Ahmed; Tarek Khamis; Ahmed Hamed; Doaa M. Abdel-Fattah

View Article PDF 762.98 K

ANTI-INFLAMMATORY, ANALGESIC AND ULCEROGENIC POTENCY OF CURCUMIN IN COMPARISON WITH CELECOXIB AND PREDNISOLONE

Pages 339-350

Saydat S. Abd-El Megid; Tarek Khamis; Ahmed H. Arisha; Eman O. Abd-El Rahman; Doaa M. Abd-El Fattah

View Article PDF 1.26 MB

THE DIAGNOSTIC VALUE OF SERUM FERRITIN IN ASSESSING IRON STATUS IN SYRIAN HEMODIALYSIS PATIENTS

Pages 351-357

Marwa Hamdan; Sulaf Alwassouf

View Article PDF 739.84 K

PRODUCTION OF CELL WALL-HYDROLYZING ENZYMES AND GC-MS EXTRACT ANALYSIS OF BYSSOCHLAMYS LAGUNCULARIAE, A NEW RECORD ISOLATED FROM EGYPT

Osama A. Al-Bedak; Mohamed A. Abdel-Sater; Hagar M.K. Galal; Sedky H.A. Hassan

View Article PDF 1.05 MB

SOME VIRULENCE GENES OF STAPHYLOCOCCUS AUREUS ISOLATED FROM INFECTED VASCULAR ACCESSES IN HEMODIALYSIS PATIENTS AT ASSIUT UNIVERSITY HOSPITALS

Ehsan A. Hassan; Mona Hussein Abdel-Rahim; Thanaa Hassan Mohamed Hassan; Nashwa Mostafa A. Azoz; Mona Embarek Mohamed

View Article PDF 1.25 MB

AN OVERVIEW OF B CELL IMMUNOMODULATORY ROLE IN NORMAL PREGNANCY AND PREECLAMPSIA

Wegdan A Mohamed; Alshimaa G. Abdel-Hakim; Mahmoud Zakherah; Omnia El-Badawy; Ehsan A. Hassan

View Article PDF 659.86 K

T FOLLICULAR REGULATORY CELL (TFR) IN SYSTEMIC LUPUS ERYTHEMATOSUS AND ITS RELATION TO DISEASE ACTIVITY

Yasmien H. Abdel-moneam; Mona H. Abdel-Rahim; Helal F. Hetta; Omar M. Herdan; Khalid M. Hassanein

View Article PDF 634.29 K

ALTERATIONS IN NEUTROPHIL-LYMPHOCYTE RATIO AND C-REACTIVE PROTEIN IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS ADMITTED TO HOSPITAL WITH AN ACUTE EXACERBATION

Manal A. Mahmoud; Aliae AR. Mohamed Hussien; Hoda A. Makhlouf

View Article PDF 700.39 K

DETECTION OF CARBAPENEM RESISTANCE AMONG ESCHERICHIA COLI AND KLEBSIELLA PNEUMONIAE IN CHEST INTENSIVE CARE UNIT AT ASSIUT UNIVERSITY HOSPITALS, EGYPT

Pages 419-426

Marwa M. Mahmoud; Khaled M. Hassanein; Tahani Obaid Alshammari; Gaber El-Saber Batiha; Helal F. Hetta

View Article PDF 631.58 K

ASPERGILLUS NIGER AS A BIO-LAB FOR EXTRACELLULAR SYNTHESIS OF SILVER NANOPARTICLES AND ITS ANTIBACTERIAL ACTIVITY

Pages 427-436

Tariq Ahmad; Walid Khaddam; Lina Alnaddaf

View Article PDF 879.95 K

ANTIMICROBIAL AND SYNERGISTIC EFFECTS OF MISWAK, NANO-SILVER DRUG, AND CHLORHEXIDINE ALONE AND THEIR COMBINATIONS UPON CERTAIN ORAL MICROBIOTA

Pages 437-449

Sakeenabi Basha; Amal Adnan Ashour; Nayef H. Felemban; Enas T. Enan; Mohammed Fareed Felemban; Amal Ahmad Alyamani; and Sanaa M. F. Gad El-Rab

View Article PDF 1.32 MB

INVESTIGATING BACTERIA ISOLATED FROM DIABETIC FOOT ULCERS AND STUDYING THEIR SENSITIVITY TO ANTIBIOTICS –SYRIA

Pages 451-458

Lara Atassi Al Abbas; Walid Khaddam; Fahd Shreibati

View Article PDF 638.92 K

HEPATOPROTECTIVE EFFECTS OF VITAMIN C AGAINST METHOTREXATE INDUCED ACUTE LIVER INJURY: AN EXPERIMENTAL STUDY

Pages 459-468

Ali Al-Gareeb; Ghaith F. Mohammed

View Article PDF 802.37 K

HEALTH RISK EVALUATION OF TOXIC POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN THE STREET DUST OF BASRA, IRAQ

Pages 469-479

Abdullah S. Asia; Hameed M. Hasan; Baiwn S. Roaa

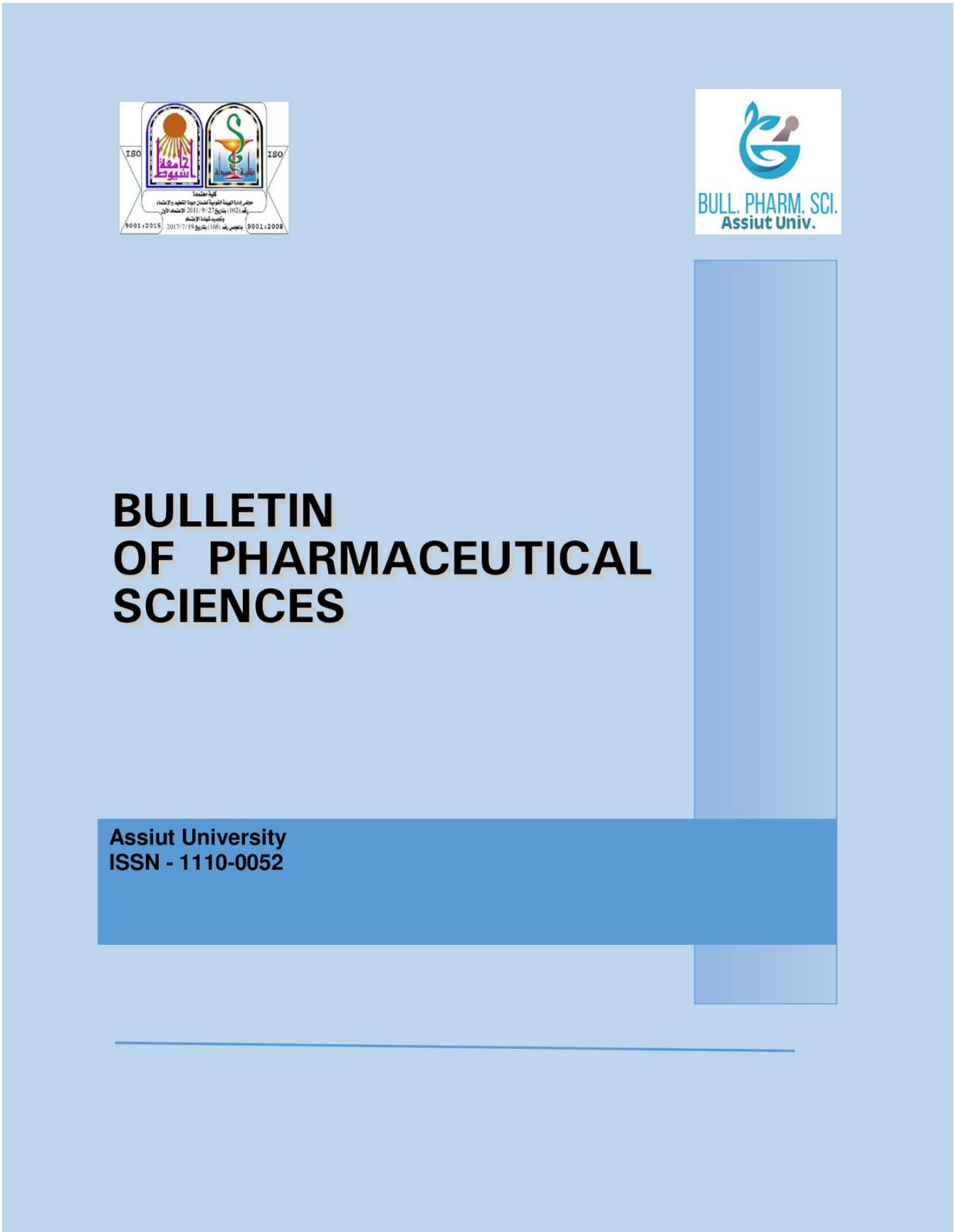
View Article PDF 856.56 K

THE EFFECTS OF NITRIC OXIDE WITHIN THE DORSAL HIPPOCAMPUS ON SPATIAL LEARNING AND MEMORY IN MALE NMRI STRESSED MICE

Pages 481-492

Mohammad Sahraei; Atusa Mashhadi; Hossein Meftahi

View Article PDF 830.96 K



Articles in Press

Current Issue

Journal Archive

+ **Volume 46 (2023)**

− **Volume 45 (2022)**

Issue 2
Issue 1

+ **Volume 44 (2021)**
+ **Volume 43 (2020)**
+ **Volume 42 (2019)**
+ **Volume 41 (2018)**
+ **Volume 40 (2017)**
+ **Volume 39 (2016)**
+ **Volume 38 (2015)**
+ **Volume 37 (2014)**
+ **Volume 36 (2013)**
+ **Volume 35 (2012)**
+ **Volume 34 (2011)**
+ **Volume 33 (2010)**
+ **Volume 32 (2009)**
+ **Volume 31 (2008)**
+ **Volume 30 (2007)**
+ **Volume 29 (2006)**
+ **Volume 28 (2005)**
+ **Volume 27 (2004)**
+ **Volume 26 (2003)**
+ **Volume 25 (2002)**
+ **Volume 24 (2001)**

Bull. Pharm. Sci., Assiut University, Vol. 45, Issue 1, 2022, pp. 139-151.

Bulletin of Pharmaceutical Sciences
Assiut University
Website: http://bpsa.journals.ekb.eg/
e-mail: bullpharm@aun.edu.eg

BULL. PHARM. SCI. Assiut Univ.

EFFECT OF EXTRACTION TIME ON THE BIOACTIVE COMPOUNDS OF BOTTLE GOURD (LAGENARIA SICERARIA) USING GAS CHROMATOGRAPHY-MASS SPECTROMETRY

Muhammad Yusuf [1*], Sri Indriati[1], Nur Fitriani Usdyana Attahmid [2], Rahmawati Saleh[2] and Akhmad Rifai[1]

[1]*Department of Chemical Engineering, Politeknik Negeri Ujung Pandang, Makassar City, Indonesia*
[2]*Department of Agroindustry, Politeknik Pertanian Negeri Pangkep, Pangkep Regency, Indonesia*

Traditional medical systems have always been played an important role in meeting global healthcare needs. Meanwhile, bottle gourd (Lagenaria siceraria) is a vegetable that contains health-promoting secondary metabolites. Therefore, this study aims to determine the bioactive compounds profiling of Bottle gourd (Lagenaria siceraria) fruit extracts in methanol and chloroform using gas chromatography-mass spectrometry (GC-MS) with variations in extraction time of 10, 20, and 30 min using GC-MS RTX-5 capillary column. A total of 91 compounds were tentatively identified, with 55 found in methanol and 41 in chloroform extract. The 1:2 (v/v) ratio using methanol solvent at 30 min was suggested as the most suitable time for maximum extraction. Several peaks with high area percentages were discovered in the methanolic extract containing key chemical constituents such as stearic, oleic, palmitic, and linoleic acid, as well as Cholesta-4,6-dien-3-one, gamma sitosterol, and Phenol, 2,2'-methylene bis. Meanwhile, the corresponding constituents from chloroform extract include Tetracontane, Dotriacontane, Phenol, 2,2'-methylenebis, esters, and aromatic derivatives. Most of the bioactive compounds were detected between 20-30 min time of extraction. Moreover, fatty acids, methyl and ethyl esters, as well as sterols represent 40% of the total extracts and were dominated by oleic, and palmitic acid, gamma-sitosterol along with its ethyl and methyl esters. Therefore, methanol is recommended as the optimal solvent to obtain high content of phytochemical constituents and antioxidants for utilization in pharmacognosy.

Keywords: *Bottle gourd, Bioactive compounds, GC-MS, Ultra-sonication assisted extraction*

INTRODUCTION

Plants with high antioxidant levels, such as vitamin C, tocopherols, polyphenols and carotenoids, are gaining popularity in the food industry as alternatives to synthetic antioxidants which have limited use due to safety concerns[1]. Meanwhile, synthetic antioxidants have long been used for foods to prevent lipid oxidative rancidity, nutritional loss, off-flavor, quality loss, and discoloration. Aside from extending the shelf life of foods, these compounds also slow the progression of various oxidative stress-related chronic diseases in humans. Furthermore, due to the role in protecting the body from reactive nitrogen species, crystallization, reactive oxygen species, and free radicals from either normal metabolic processes or external sources, dietary antioxidants play an essential role as nutraceuticals[2–4]. Several mechanisms are presumably involved in this protection, including inhibition of free radical generation, increased scavenging capacity against free radicals, reduced capacity, and metal chelating ability. These reactions are commonly used in antioxidant activity tests. A wide range of activities is determined using antioxidant activity assays with the lipidic system as a substrate[3&5].

Bottle gourd *(Lagenaria siceraria)* is relatively easy to plant and the planting area is

Received in 4/12/2021 & Accepted in 23/1/2022

*Corresponding author: Muhammad Yusuf, E-mail: yusufitri@poliupg.ac.id

spread in various parts of the world, ranging from tropical to subtropical climates, as well as highlands to the lowlands. This plant is rich in nutrients containing calcium, iron, vitamin C, polyphenols and saponins which are beneficial for health, therefore, it is taken as daily food. Furthermore, bottle gourd is a common vegetable due to its high choline, phenolics, vitamin B complex, and vitamin C content[6], while the juice is well-known for its cardioprotective, cardiotonic, aphrodisiac, and diuretic properties, as well as an antidote to some poisons. Bottle gourd juice is also beneficial for maintaining the body's alkaline reserve due to its less acidic nature[7]. Bottle gourd contains phytochemicals that are beneficial to the body and also produce reactive oxygen species. Meanwhile, the inhibition of reactive oxygen species (ROS) production, direct or indirect scavenging of free radicals, and alteration of intracellular redox potential are all biochemical activities of natural antioxidants. Furthermore, antioxidants, such as carotenoids, flavonoids, polyphenolics, vitamin A, vitamin C, and vitamin E are abundant in vegetables and fruits, preventing free radical damage and lowering the risk of chronic diseases. Therefore, the consumption of dietary antioxidants from these sources potentially prevents cardiovascular diseases, especially atherosclerosis[8]. Meanwhile, the ability of bottle gourd juice to be used as a health drink, is dependent on the extraction and preservation of functional components such as phenolics, carotenoids, and ascorbic acid. Therefore, the processing method selected is essential due to the presence of heat-sensitive components like phenolics, carotenoids, ascorbic acid, and the perishable nature of the product. To date, no attempt has been made to investigate the effects of processing on bottle gourd juice functional components to store and improve efficiency.

Bottle gourd analysis using the ohmic thermal method with variations in temperature and time combined with Gas and Liquid chromatography-mass spectrometry was used to detect volatile and non-volatile phenolics. The ohmically blanched samples exhibited maximum extraction of phenolics and better color of BG juice compared to other samples[9], while the free radical scavenging activity of *Lagenaria siceraria* fruit ethanolic extract using the FRAP method was 1.95 mg/ml [3]. In other studies, a combination of the blanching process and sonication extraction to improve the quality of gourd juice bottle showed significant improvements in the total phenolics (TP), carotenoids, total soluble solids (TSS), and physical stability (PS). Other parameters such as titratable acidity (TA), pH, ascorbic acid (AA), browning index (BI), total plate count (TPC), as well as yeast and mold count experienced a significant decrease[10]. The formulations of blended bottle gourd juice, aonla, lemon, and ginger using response surface methodology (RSM) with minimal thermal process showed quality stability against physicochemical, sensory, and microbiology parameters[11]. Moreover, wild bottle gourd optimization using acetone, ethanol, and methanol solvents with Liquid Chromatography-Mass Spectrometry (LC/MS) analysis found the tetracyclic triterpene–cucurbitacin, as well as other pharmaceutically essential compounds[12]. Comparative study of *Lagenaria siceraria* using Soxhlet, microwave-assisted, and ultrasound-assisted extraction, showed that the ultrasonic and microwave assisted extraction methods had an effect on the high levels of polyphenols found in bottle gourd[13]. Another study performed an in-vitro analysis of wild bottle gourd against antioxidant content, antidiabetic, anti-acetylcholine esterase, and anticancer activities using Reversed-Phase-High Performance Liquid Chromatography (RP-HPLC) and FTIR spectroscopy. It was concluded that wild bottle gourd is a rich source of bioactive metabolites[14&15].

Therefore, this study aims to investigate and characterize the bioactive compounds in the different crude extracts of Bottle gourd *(Lagenaria siceraria)* to determine the physiological, pharmacological, and flavor. Meanwhile, bottle gourd is a medicinal plant and has been attributed to beneficial health effects, but there are only a few studies related to this topic. However, the effect of extraction time with sonication and solvents variations has not been reported. In general, the analysis of bioactive compounds is usually conducted using gas chromatography-mass spectrometry (GC-MS).

MATERIAL AND METHODS

Materials

Bottle gourd were collected from Malino district (South Sulawesi province, Indonesia). The plants were taxonomically identified by the Herbarium Bogoriense, Biology Research Center, Indonesian Institute of Sciences (LIPI), Bogor Indonesia (Fig. 1). The chemicals used include analytical grade hexane (emsure 99%), methanol (emsure 99.8%), and chloroform (supelco 99%) supplied by Merck Millipore (Burlington, Massachusetts, United States). Moreover, the instruments used include Shimadzu 2010 GC-MS, Elma Ultrasonic Cleaner S60H, and Buchi Rotary Rotavapor R-300.

Fig. 1: Bottle gour

Preparation of the extract

Bottle gourd was picked and washed with flowing tap water after separating the fruit into epicarp, mesocarp, and seeds. The fresh fruit was then homogenized, for example, the mesocarp was ground separately in an electric mixer grinder. To extract the sample with a ratio of 1:2, 20 ml of bottle gourd juice was mixed with 40 ml hexane (v/v) and transferred to a conical flask which was then immersed in an ultrasonic bath (Elma Ultrasonic) at 40^{o}C for 20 min. Finally, the filtrate was used for sonication extraction using methanol and chloroform solvents.

Ultra-sonication assisted extraction (UAE)

20 ml filtrate was transferred to a conical flask containing 40 ml solvent methanol or chloroform (1:2 v/v). Furthermore, all the conical flasks were immersed in an ultrasonic bath (Elma Ultrasonic) with a temperature of 40^{o}C, for 10, 20, and 30 min.

Table 1: Extraction time of bottle gourd using *Ultra-Sonication Assisted Extraction (UAE).*

Solvent	Extraction time (min)
Chloroform	10
	20
	30
Methanol	10
	20
	30

GC-MS determination

This was carried out using Shimadzu 2010 GC-MS and RTX-5 capillary column (30 mm ×0.25 mm × 0.25 µm) with a split ratio of 40:1 and a temperature of 70^{o}C, heating rate of 10^{o}C min^{-1}, up to 300^{o}C, maintained for 5 min with a total analysis time of 25 min. Helium was used as a carrier gas flowing constantly at 1.0 ml/min and the temperature of the inlet was 280^{o}C, pre-column pressure was 80 kPa, and ionization voltage of 70 eV[16].

RESULTS AND DISCUSSION

Identification of bioactive compounds by GC–MS

The phytochemical constituents of bottle gourd were extracted sequentially using two different organic solvents varying in polarity 4.1 (chloroform) and 5.1 (methanol) with a different time extraction (Table 1), while the chemical constituents were analyzed using gas chromatography–mass spectrometry. Fig. 2 illustrates the chromatograms of two crude extracts, with 100 different identified compounds (Tables 2-3), which were then classified into ten chemical groups based on the common name, retention time (Rt), and percent peak area. The chemical groups identified include esters derived from fatty acids, fatty alcohols, fatty acids (FA), amines, aromatic, phenolics, hydrocarbons, terpenes, and sterols, among others. Furthermore, the bioactive compounds were identified using NIST 2.7 and Willey 8 libraries in GC-MS. The chloroform extract contained the fewest compounds (10) after 10 min extraction time, while the highest (25) was identified in the methanol extract after 30 min (Table 2).

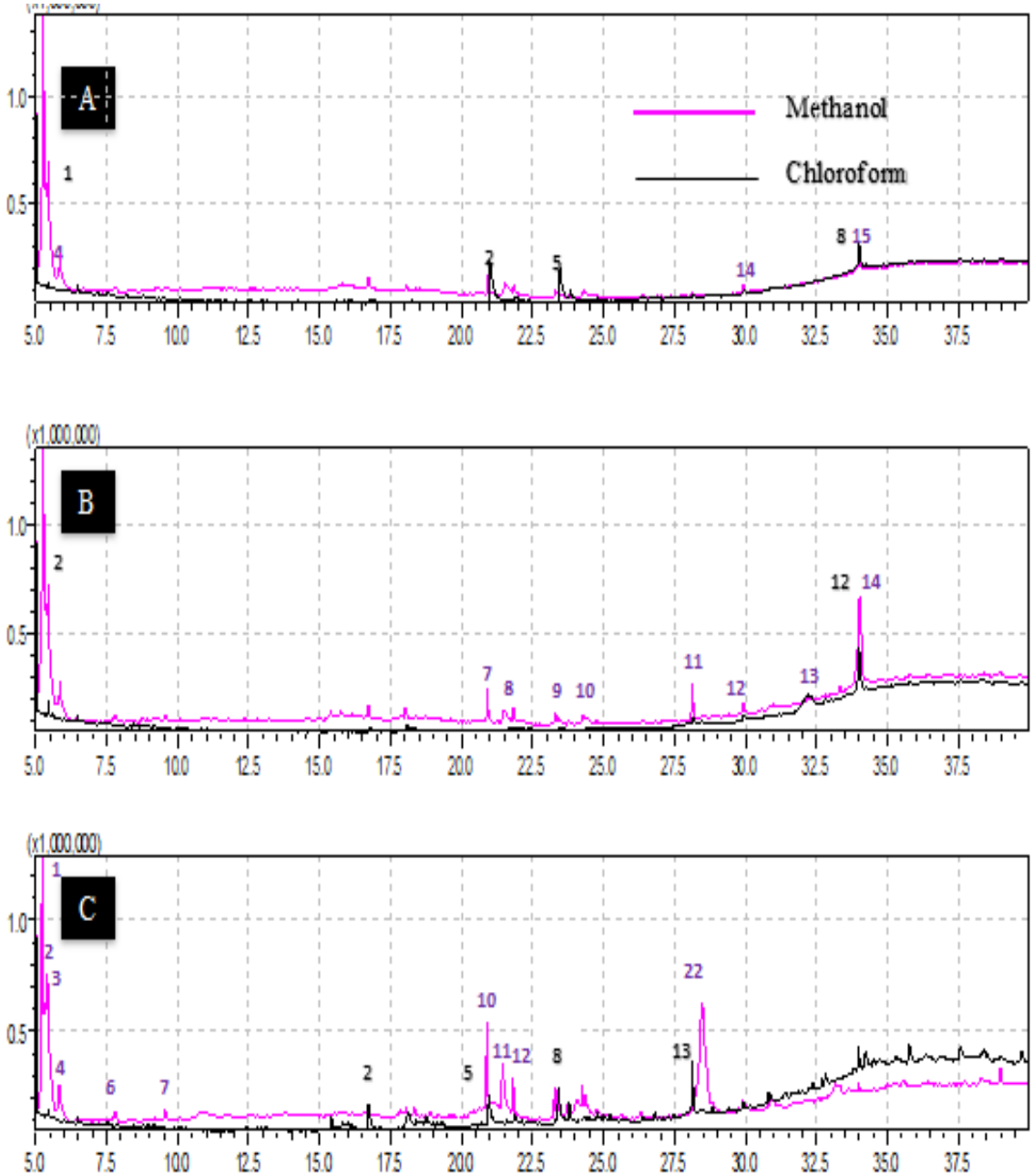


Fig. 2: Chromatograms of different crude extracts. (A) methanol and chloroform in 10 min time extraction; (B) methanol and chloroform in 20 min time extraction; (C) methanol and chloroform in 30 min time extraction.

Resource properties of bottle gourd

Terpenes

Terpenes were detected using methanol solvents in extraction times of 10 and 30 min as shown in Table 2. Furthermore, Table 3 shows that terpenes were detected in all bottle gourd extracts using chloroform solvents. The total terpenes using both solvents in 10, 20 and 30 min extraction time represented by 2,6,10,14,18,22-tetracosahexaene, and 2,6,10,15,19,23-hexamethyl-, (all-e), were the most dominant and represented 1.55 and 0.47% of total peak area for methanol extracts as well as 16.27, 4.88, and 5.47% for chloroform extracts. Meanwhile, 2,6,10,14,18,22-tetracosahexaene, and 2,6,10,15,19,23-hexamethyl-, (all-e) have been detected in several plants. These bioactive compounds were identified as strong drugs with biomedical activities to strengthen the body's resistance, resist fatigue, improve human immunity, protect the liver, and were considered substances with great potential in the nutraceutical and pharmaceutical industries in functional and therapeutic applications[17].

Table 2: GC–MS detection of bioactive compounds from bottle gourd using methanol solvent in 10, 20, and 30 min time of extraction.

Peak	R_t	Area (%)	Bioactive compound
(a) Extraction time 10 min			
Terpenes			
15	33.992	1.55	2,6,10,14,18,22-Tetracosahexaene,2,6,10,15,19,23-hexamethyl-, (all-E)
Esters			
6	16.716	1.63	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester
8	20.918	2.86	Hexadecanoic acid, methyl ester
10	21.843	1.26	Hexadecanoic acid, ethyl ester
11	23.308	0.77	9,12-octadecadienoic acid (z,z)-, methyl ester
12	23.393	0.41	8,11,14-docosatrienoic acid, methyl ester
13	24.291	0.46	Linoleic acid ethyl ester
Fatty alcohols			
7	18.058	0.59	1-hentetracontanol
Fatty acids			
9	21.524	3.18	n-Hexadecanoic acid
Aromatic			
2	5.261	51.86	Ethylbenzene
3	5.433	28.62	P-Xylene
4	5.852	4.18	Benzene, 1,2-dimethyl
Others			
1	5.054	0.73	Cyclotrisiloxane, hexamethyl
5	9.226	0.84	Cyclotrisiloxane, hexamethyl
14	29.924	1.06	Bis(2-ethylhexyl) phthalate
(b) Extraction time 20 min			
Aromatic			
1	5.262	37.59	Ethylbenzene
2	5.333	7.23	Benzene, ethyl-
3	5.433	22.15	P-xylene
4	5.853	1.99	Benzene, 1,2-dimethyl-
Esters			
5	16.712	0.91	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester
7	20.901	2.80	Hexadecanoic acid, methyl ester
8	21.826	1.02	Hexadecanoic acid, ethyl ester
9	23.290	0.85	9,12-octadecadienoic acid (z,z)-, methyl ester
10	24.272	0.63	Linoleic acid ethyl ester
Fatty alcohols			
6	18.018	1.40	1-tetradecanol, acrylate
Phenolics			
11	28.119	2.99	Phenol, 2,2'-methylenebis
Fatty acids			
12	29.913	0.79	1,2-benzenedicarboxylic acid
Sterols			
13	33.314	0.72	Cholesta-4,6-dien-3-one
15	38.965	0.59	Stigmast-5-en-3-ol, oleat
Others			
14	34.021	18.35	Tetrakis (2,3-ditert-butylphenyl)-4,4'-biphenylene diphosphonat

Table. 2: Continued

(c) Extraction time 30 min			
Aromatic			
1	5.229	20.11	Ethylbenzene
2	5.310	7.24	Benzene, ethyl-
3	5.400	19.44	P-xylene
4	5.823	1.79	Benzene, 1,2-dimethyl-
5	5.942	0.76	Octane, 2,4,6-trimethyl
6	7.794	0.36	Octane, 3,5-dimethyl
Hydrocarbons			
7	9.563	0.37	Undecane
Fatty acids			
8	16.703	0.25	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-pro
11	21.437	4.56	n-hexadecanoic acid
17	24.025	2.13	6-octadecenoic acid, (z)
19	24.353	1.35	9,12-octadecadienoic acid (z,z)
23	29.910	0.42	1,2-benzenedicarboxylic acid
Esters			
9	18.339	0.33	Tetradecanoic acid, methyl ester
10	20.883	4.32	Hexadecanoic acid, methyl ester
12	21.811	1.60	Hexadecanoic acid, ethyl ester
13	23.273	1.71	9,12-octadecadienoic acid (z,z)-, methyl ester
14	23.367	1.46	8,11,14-docosatrienoic acid, methyl ester
15	23.446	0.37	9-octadecenoic acid, methyl ester
16	23.742	0.51	Octadecanoic acid, methyl ester
20	24.450	0.37	9-octadecenoic acid (z)-, ethyl ester
21	24.742	0.25	Octadecanoic acid, ethyl ester
18	24.255	1.56	Ethyl (9z,12z)-9,12-Octadecadienoate
Sterols			
22	28.460	26.82	Stigmast-5-En-3-Ol, (3.Beta.,24s)
25	38.976	1.45	Stigmast-5-en-3-ol, oleat
Terpenes			
24	33.986	0.47	2,6,10,14,18,22-tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-e)

Table 3: GC-MS detection of bioactive compounds from bottle gourd using chloroform solvent in 10, 20, and 30 min time of extraction.

Peak	**R_t**	**Area(%)**	**Bioactive compound**
(a) Extraction time 10 min			
Esters			
2	20.997	37.36	Hexadecanoic acid, methyl ester
3	21.200	2.16	Beta.-n-acetylneuraminic acid, methyl ester-2-methyl-7,9-methyl-boronate-3,8-di(trimet)
4	21.919	1.57	Hexadecanoic acid, ethyl ester
5	23.466	28.37	9-Octadecenoic acid (Z)-, methyl ester
6	23.831	6.06	Octadecanoic acid, methyl ester
7	29.939	1.51	1,2-benzenedicarboxylic acid, diisooctyl ester
Terpenes			
8	33.995	16.27	2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-E)- alkohol

Table. 3: Continued

Aromatic amines			
10	35.283	2.18	1-isopentyl-4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-1h-py
Others			
1	6.470	2.53	Ethane, 1,1,2,2-tetrachloro-
9	35.050	1.99	3,3,7,11-Tetramethyltricyclo[5.4.0.0(4,11)]undecan-1-ol
(b) Extraction time 20 min			
Aromatic			
1	5.435	5.58	Ethylbenzene
Fatty acids			
3	16.782	2.28	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-pro
7	31.842	1.84	22.alpha.-hydroxy-3,4-secostict-4(23)-en-3-oic acid
Phenolics			
5	28.149	2.78	Phenol, 2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl-
Esters			
6	29.935	2.48	1,2-benzenedicarboxylic acid, diisooctyl ester
8	32.025	3.61	Decanoic acid, 8-chloro-, chloromethyl ester
14	34.400	2.86	2,5,9-Trimethyl-12-oxododeca-4,8-dienoic acid, methyl ester
Sterols			
9	32.208	11.56	Stigmast-7-en-3-ol, (3.beta.,5.alpha.,24s)-
10	32.342	3.67	Stigmast-7-en-3-ol, (3.beta.,5.alpha.,24s)-
Terpenes			
12	33.993	48.88	2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-E)
Hydrocarbons			
13	34.234	4.06	Hexacontane
15	37.556	2.58	Hexacontane
Others			
2	6.472	3.29	Ethane, 1,1,2,2-tetrachloro-
4	18.085	2.49	Spiro(tetrahydrofuryl)2.1'(decalin), 5',5',8'a-trimethyl-
11	33.817	2.04	1-Propanol, 2,3-bis[(3,7,11,15-tetramethylhexadecyl)oxy]-
(c) Extraction time 30 min			
Hydrocarbons			
1	15.419	1.74	Hexadecane, 2,6,10,14-tetramethyl-
17	34.232	6.24	Tetracontane
18	35.765	6.56	Dotriacontane
19	37.570	4.83	Tetracontane
20	39.727	3.54	Dotriacontane
Fatty alcohols			
3	18.103	6.06	1-tetradecanol, acrylate
4	18.404	3.59	1-tridecanol
6	21.583	2.41	1-octadecanol
10	24.777	1.74	1-octadecanethiol
Esters			
2	16.732	8.93	Propanoic acid, 2-methyl-, 1-(1,1-dimethylethyl)-2-methyl-1,3-propanediyl ester
5	20.957	10.31	Hexadecanoic acid, methyl ester
7	21.867	4.60	Hexadecanoic acid, ethyl ester
8	23.413	9.86	9-octadecenoic acid, methyl ester
9	23.782	5.50	Octadecanoic acid, methyl ester

Table. 3: Continued

11	25.000	2.00	Acetic acid, octadecyl ester
Aromatic			
12	26.813	1.42	1h-purin-6-amine, [(2-fluorophenyl)methyl]-
Phenolics			
13	28.124	11.46	Phenol, 2,2'-methylenebis[6-(1,1-dimethylethyl)-4-methyl-
Terpenes			
16	33.986	5.47	2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl-, (all-E)
Others			
14	30.813	2.13	Tetracosamethyl-cyclododecasiloxane
15	32.700	1.61	Tetracosamethyl-cyclododecasiloxane

Esters

Twenty-two different esters were identified with varying extraction times using methanol solvents (Table 2) and fourteen using chloroform (Table 3). Hexadecanoic acid, methyl and ethyl esters were the most dominant derivative using methanol solvent amounting to 2.86%, 2.80%, and 4.32%, while ester derived from Hexadecanoic acid, ethyl ester represented approximately 1.26%, 1.02%, and 1.60% of the total ester peak area. Meanwhile, the extract with chloroform solvent, identified Hexadecanoic acid, methyl ester (37.36% and 10.31%), 9-Octadecenoic acid (Z)-, methyl ester (28.37% and 9.86%), Propanoic acid, 2-methyl-, 1-(1,1-dimethyl ethyl)-2-methyl-1,3-propanediyl ester (8.93%), Hexadecanoic acid, ethyl ester (1.57% and 4.60%), and Octadecanoic acid, methyl ester (5.50%) as the most dominant derivatives. Other beneficial esters in the extract of bottle gourd, include Octadecanoic acid, methyl ester, and 9-octadecenoic acid, methyl ester. Octadecanoic acid, methyl ester or stearic acid, is suitable for biodiesel production[18], while 9-octadecenoic acid, methyl ester (oleic acid, methyl ester) reportedly plays an essential role in health care, especially in the treatment of cancer and other diseases[19]. In this case, 9-hexadecenoic acid was used to represent various bottle gourd extracts containing polyunsaturated fatty acids (PUFA/n-7). Besides, PUFAs have been shown to play critical roles in tissue metabolism and cellular, including thermal adaptation, electron and oxygen transport, regulation of membrane fluidity and potentially reduce the risk of coronary heart disease[20].

Fatty acids (FA)

Fatty acids are active substrates and allopathic agents with a widely known antibacterial effect[21]. Saturated fatty acids are synthesized from acetyl coenzyme A by plants and animals as long-term energy storage forms, while saturated fatty acids affect hypercholesterolemia and induce cyclooxygenase-2 expression[22]. As shown in Table 3, the fatty acid composition of bottle gourd, extracted using methanol solvents was represented by five saturated fatty acids namely n-Hexadecanoic Acid (3.18% and 4.56%), 1,2-benzene dicarboxylic acid (0.79% and 0.42%), Propanoic acid, 2-methyl-, 1-(1,1-dimethyl ethyl)-2-methyl-1,3-pro (0.25%), 6-octadecenoic acid, (z) (2.13%), and 9,12-octadecadienoic acid (z,z) (1.35%) (Table 2). Meanwhile, the fatty acid composition identified using chloroform as a solvent showed two saturated fatty acids namely Propanoic acid, 2-methyl-, 1-(1,1-dimethyl ethyl) 2-methyl-1,3-pro (2.28%), and 22.alpha.-hydroxy-3,4-secostict-4(23)-en-3-oic acid (1.84%) (Table 3). n-Hexadecanoic Acid (Palmitic acid) is a saturated long-chain fatty acid with a 16-carbon. Based on the results, palmitic and linoleic acid were the dominant fatty acids bottle gourd extracts. Meat, kernel oil, palm oil, cheese, butter, and milk all contain palmitic acid, this type of fatty acid is reportedly used in pharmaceuticals as an antioxidant, treatment for cancer, and hypercholesterolemic prevention[23]. Meanwhile, Phthalic acid or 1,2-benzenedicarboxylic acid is used in China to clean pollutants and contaminated soils[24], while Linoleic acid is a source of PUFA, useful in pharmaceutical and medicine for antihistaminic, anticoronary, antieczemic, antiacne, anticancerous, analgesic and ulcerogenic[16&25].

Fatty alcohols

Natural fatty alcohols derived from plant or animal lipids are used as detergents, plastics, and in pharmaceuticals [20&26]. The bottle gourd extracted from methanol solvent contains one saturated fatty alcohols namely 1-hentetracontanol (0.59%), while four saturated fatty alcohols namely 1-tetradecanol, acrylate (6.06%), 1-tridecanol (3.59%), 1-octadecanol (2.41%), and 1-octadecanethiol (1.74%) were identified with chloroform (Table 2-3). Saturated fat alcohols are chemical intermediates for surfactants and are widely used in pharmaceutical formulations, agrochemicals, as well as personal, and home care products[20,26].

Phenolic compounds

The GC–MS analysis of bottle gourd extracts showed the major phenolics in methanol and chloroform extracts. The percentage of total phenolics varies depending on the extraction solvent, ranging from 2.99% in methanol extract (20 min) to 2.78% and 11.46% in chloroform with an extraction time of 20 and 30 min (Table 2-3). The identified phenolics include Phenol, and 2,2'-methylenebis-6-(1,1-dimethyl ethyl)-4-methyl. Meanwhile, solubility, type of solvent, and polarity in the extraction influence phenolics recovery [27]. Furthermore, the polarity of the solvent is important in increasing solubility [28]. Phenolic compounds have been used pharmacologically as antimicrobial, against neurodegenerative pathologies, and anticarcinogenic. Another study by [29], reported that the antioxidant capacity of different *Lagenaria siceraria* (bottle gourd) extracts relates directly to the phenolic content. The study identified and isolated six phenolics compounds, including phenolic glycoside (*E*)-4-hydroxymethyl-phenyl-6-*O*-caffeoyl-β-d-glucopyranoside which has high antioxidant activity according to the in-vitro analysis. In addition, the fruit of *Lagenaria siceraria* (Molina) is a potentially rich source of natural radical scavengers [3]. Analysis of free radical scavenging activity in ethanol extract showed that the percentage of inhibition was 89.21%.

Hydrocarbons

The hydrocarbon content in bottle gourd differed between extraction solvents, with Undecane (0.37%) for methanol and hexacontane (4.06 and 2.58%) for chloroform with an extraction time of 20 min. Meanwhile, for the 30 min, more hydrocarbons were identified namely Hexadecane, 2,6,10,14-tetramethyl (1.74%), Tetracontane (6.24 and 4.83%), and Dotriacontane (6.56 and 3.54%), with the majority being Alkanes (5 hydrocarbons). Tetracontane and Dotriacontane have been detected in *Caralluma retrospiciens (Ehrenb)*, while *Asclepias Curassavica L* has antimicrobial, antifungal, and antibacterial effects [30&31].

Sterols

C29 sterols, also known as phytosterols, are important precursors of vitamin D, while some of the derivatives play a major role in reducing low-density lipoprotein cholesterol in-vivo[32]. Phytosterols in bottle gourd were represented by three different steroids, for an extraction time of 20 min, Cholesta-4,6-dien-3-one (0.72%) and Stigmast-5-en-3-ol, oleat (0.59%) were identified, while more components such as Stigmast-5-en-3-ol, oleat (26.82% and 1.45%) were identified at 30 min. Furthermore, chloroform sterols were identified as Stigmast-7-en-3-ol (11.56 and 3.67%) at total peak area with an extraction time of 20 min (Table 2-3), while stigmast-5-En-3-Ol, (3.Beta.,24s) or Gamma Sitosterol is the most predominant in bottle gourd using methanol solvent. Cholesta-4,6-dien-3-one and gamma sitosterol investigated from Alginate *Glycyrrhiza glabra L* and *Bidens pilosa* L are used in pharmaceuticals as an antihepatotoxic, antiviral, antioxidant, cancer preventive, and hypocholesterolemic [33,34], while Stigmast-7-en-3-ol investigated from Djulis (*Chenopodium formosanum Koidz.)*, has great potential to be developed in the industry as enriched functional foods and nutraceuticals. Based on literature studies, the phytosterols identified by GC–MS are biologically active compounds and have several health benefits, including antioxidant activities and anti-cancer [35].

Aromatic, amine and Others

Using methanol extract, two compounds from different chemical groups were identified and are listed in Table 2, namely 1 phthalate derivative (1.06%) and Tetrakis (2,3-ditert-butylphenyl)-4,4'-biphenylene diphosphonat (18.53%), while four compounds were identified from choloroform extract as shown in Table 3,

namely Ethane, 1,1,2,2-tetrachloro (2.53% and 3.29%), Spiro (tetrahydrofuryl)2.1'(decalin), 5',5',8'a-trimethyl (2.49%), and 1-Propanol, 2,3-bis [(3,7,11,15-tetramethylhexadecyl)oxy] (2.04%). In addition, six aromatic compounds were identified in the methanol extract, namely Ethylbenzene (51.86%, 37.59%, and 20.11%), P-xylene (28.62%, 22.15%, and 19.44%), Benzene, 1,2-dimethyl (4.18%, 1.99%, and 1.79%), Benzene, ethyl (4.18%, 7.23%, and 7.24%), Octane, 2,4,6-trimethyl (0.76%), and Octane, 3,5-dimethyl (0.36%) while Ethylbenzene (5.58%) and 1h-purin-6-amine, [(2-fluorophenyl) methyl] (1.42%) were found in the chloroform extract. Also one amines namely 1-isopentyl-4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-1h-py (2.18%) was found. Meanwhile, ethylbenzene, p-xylene and benzene, 1,2-dimethyl are aromatic compounds often found in cucurbitaceous plants such as *Lagenaria siceraria* fruits. Tetracosamethyl-cyclododecasiloxane is commonly used in the cosmetics and fragrance industry[36], while 3,3,7,11-Tetramethyltricyclo[5.4.0.0(4,11)] undecan-1-ol was detected in *Eucalyptus granlla* wood and is used as pesticide to protect the environment[37].

Conclusion

Several valuable compounds were found in the methanol and chloroform extracts of bottle gourd, including fatty acids and alcohols, terpenes, phenolics, hydrocarbons, amines, and esters. The solvent used affects the extracted compounds, particularly fatty acids, esters, amines, phenolics, and sterols, while the presence of antioxidants and sterols (PUFA) in bottle gourd suggests its potential as a source of nutrient in human and animal foods. Furthermore, bottle gourd potential in industrial fragrance and cosmetics was demonstrated by the high concentration of hydrocarbons, esters, and amines. The extraction time of 20-30 min is the optimal range for maximum retention of bioactive compounds. Meanwhile, the identified compounds play an essential role in the development of food functionals and pharmaceutical prospects. However, further studies are needed to identify the various biological activities for the better development of novel pharmaceuticals and food functionals.

Competing Interests

The authors declare that there are no competing interests.

Funding

The authors are grateful to Politeknik Negeri Ujung Pandang for the financial support provided through BOPTN in 2020.

Acknowledgement

The authors are grateful to Politeknik Negeri Ujung Pandang for supporting this study through the BOPTN funding scheme in 2020.

REFERENCES

1. V. J. Msukwa, C. R. Y.Munthali, B. I. Nyoka and E. Missanjo, "Phenology of sclerocarya birrea (A. rich.) hochst. Provenances", ***Emerg Sci J,*** 3, 1–13 (2019).
2. D. Bera, D.Lahiri and A.Nag, "Studies on a natural antioxidant for stabilization of edible oil and comparison with synthetic antioxidants", ***J Food Eng,*** 74, 542-545 (2006).
3. Mayakrishnan, V., Veluswamy, S., Sundaram, K. S., Kannappan, P. and N. Abdullah, "Free radical scavenging potential of Lagenaria siceraria (Molina) Standl fruits extract", ***Asian Pac J Trop Med,*** 6(1), 20–26 (2013).
4. P. H. Kien, Y. Khamphone and G. T. T. Trang, "Study of Effect of Size on Iron Nanoparticle by Molecular Dynamics Simulation", ***HighTech Innov J***, 2(3), 158–167 (2021).
5. M. C. Foti, "Antioxidant properties of phenols", ***J Pharm Pharmacol,*** 59(12), 1673–1685 (2007).
6. S. Bhat, C. S. Saini, M. Kumar and H. K. Sharma, "Effect of Thermal and Alternate Thermal Processing on Bottle Gourd (Lagenaria siceraria) Juice", ***J Food Process Preserv,*** 41, 1–9 (2017).
7. A.Upaganlawar and R. Balaraman, "Cardioprotective effects of Lagenaria siceraria fruit juice on isoproterenol-induced myocardial infarction in wistar rats: A biochemical and histoarchitecture study", ***J Young Pharm,*** 3(4), 297–303 (2011).
8. B. Uttara, A. Singh, P. Zamboni and

R.Mahajan, "Oxidative Stress and Neurodegenerative Diseases: A Review of Upstream and Downstream Antioxidant Therapeutic Options", ***Curr Neuropharmacol,* 7**, 65–74 (2009).
9. S. Bhat, , C. S. Saini and H. K. Sharma, "Changes in total phenolic content and color of bottle gourd (Lagenaria siceraria) juice upon conventional and ohmic blanching", ***Food Sci Biotechnol,*** 26, 29–36 (2017).
10. S.Bhat and H. K. Sharma, "Combined effect of blanching and sonication on quality parameters of bottle gourd (Lagenaria siceraria) juice", ***Ultrason Sonochem***, 33, 182–189 (2016).
11. R. R. Gajera and D. C. Joshi, "Development and quality evaluation of bottle gourd, lagenaria siceraria (Mol.) standl. based blend juice", ***Indian J Nat Prod Resour,*** 6, 194–199 (2015).
12. U. A. Attar and S. G. Ghane, "Optimized extraction of anti-cancer compound – cucurbitacin I and LC–MS identification of major metabolites from wild Bottle gourd (Lagenaria siceraria (Molina) Standl.)", ***South African J Bot,*** 119, 181–187 (2018).
13. M. Abbas, D. Ahmed, M. T. Qamar, S. Ihsan and Z. I. Noor, "Optimization of ultrasound-assisted, microwave-assisted and Soxhlet extraction of bioactive compounds from Lagenaria siceraria: A comparative analysis", ***Bioresour Technol Reports,*** 15, 100746 (2021).
14. U. A. Attar and S. G. Ghane, "In-vitro antioxidant, antidiabetic, antiacetylcholine esterase, anticancer activities and RP-HPLC analysis of phenolics from the wild bottle gourd (Lagenaria siceraria (Molina) Standl.)", ***South African J Bot***, 125, 360–370 (2019).
15. A. Dutta, N. Roy, K. Das, *et al.*, "Synthesis and characterization of host guest inclusion complexes of cyclodextrin molecules with theophylline by diverse methodologies", ***Emerg Sci J,*** 4(1), 52–72 (2020).
16. M.Yusuf, N. F. Atthamid, S. Indriat, R. Saleh, M. Latife and A. Rifai, "Optimization ultrasonic assisted extraction (UAE) of bioactive compound and antibacterial potential from sea urchin (diadema setosum)", ***Curr Res Nutr Food Sci,*** 8(2), 556–569 (2020).
17. W. Peng, *et al.*, "Characteristics of antibacterial molecular activities in poplar wood extractives" , ***Saudi J Biol Sci,*** 24(2), 399–404 (2017).
18. A. L. V. Cubas, M. M. Machado, C. R. S. C. Pinto, E. H. S. Moecke and A. R. A. Dutra, "Biodiesel production using fatty acids from food industry waste using corona discharge plasma technology", ***Waste Manag***, 47(ptA), 149–154 (2016).
19. C. A. Ukwubile, A. Ahmed, U. A. Katsayal, J. Ya'u, and S. Mejida, "GC–MS analysis of bioactive compounds from Melastomastrum capitatum (Vahl)Fern. leaf methanol extract: An anticancer plant", ***Sci African,*** 3, e00059 (2019).
20. E. I. Abdel-Aal, A. M. Haroon and J. Mofeed, "Successive solvent extraction and GC-MS analysis for the evaluation of the phytochemical constituents of the filamentous green alga Spirogyra longata", ***Egypt J Aquat Res,*** 41(3), 233–246 (2015).
21. L. J. McGaw, A. K. Jäger and J. Van Staden, "Antibacterial effects of fatty acids and related compounds from plants", ***South African J Bot***, 68, 417–423 (2002).
22. J. Y. Lee, K. H. Sohn, S. H. Rhee and D. Hwang, "Saturated Fatty Acids, but Not Unsaturated Fatty Acids, Induce the Expression of Cyclooxygenase-2 Mediated through Toll-like Receptor 4", ***J Biol Chem,*** 276(20), 16683–16689 (2001).
23. M. Ahmad, W. N. Baba, A. Gani, *et al.*, "Effect of extraction time on antioxidants and bioactive volatile components of green tea (Camellia sinensis), using GC/MS", ***Cogent Food Agric,*** 1, 1–11 (2015).
24. T. Ma, *et al.*, "A new procedure combining GC-MS with accelerated solvent extraction for the analysis of phthalic acid esters in contaminated soils", ***Front Environ Sci Eng China,*** 7, 31–42 (2013).
25. E. Vadivel and S. B. Gopalakrishnan, "GC-MS analysis of some bioactive constituents of Mussaenda frondosa Linn", ***Int J Pharma Bio Sci,*** 2(1), 313–320 (2011).

26. P. Roose, K. Eller, E. Henkes, R. Rossbacher and H. Höke, "Amines, Aliphatic in Ullmann's Encyclopedia of Industrial Chemistry", ***Ullmann's Encyclopedia of Industrial Chemistry***, (2015).
27. M. Dent, V. Dragovi-Uzelac, M. Peni *et al.*, "The effect of extraction solvents, temperature and time on the composition and mass fraction of polyphenols in dalmatian wild sage (Salvia officinalis L.) extracts", ***Food Technol Biotechnol,*** 51(1), 84-91 (2013).
28. M. Naczk and F. Shahidi, "Phenolics in cereals, fruits and vegetables: Occurrence, extraction and analysis", ***J Pharm Biomed Anal,*** 41(5), 1523–1542 (2006).
29. R. Mohan, R. Birari, A. Karmase, S. Jagtap and K. K. Bhutani, "Antioxidant activity of a new phenolic glycoside from Lagenaria siceraria Stand", **Fruits** ***Food Chem,***132(1), 244–251 (2012).
30. S. S. Alqahtani, H. A. Makeen, S. J. Menachery and S. S. Moni, "Documentation of bioactive principles of the flower from Caralluma retrospiciens (Ehrenb) and in vitro antibacterial activity – Part B", ***Arab J Chem,*** 13(10), 7370–7377 (2020).
31. S. Bihana, A. Dhiman, G. Singh and S. Satija, "Gas chromatography-mass spectroscopy analysis of bioactive compounds in the whole plant parts of ethanolic extract of Asclepias Curassavica L", ***Int J Green Pharm,*** 12(2), 107–114 (2018).
32. M. Francavilla, P.Trotta and R.Luque, "Phytosterols from Dunaliella tertiolecta and Dunaliella salina: A potentially novel industrial application", ***Bioresour Technol,*** 101(11), 4144–4150 (2010).
33. R. Akhtar, and A. Shahzad, "Alginate encapsulation in Glycyrrhiza glabra L. with phyto-chemical profiling of root extracts of in vitro converted plants using GC-MS analysis", ***Asian Pac J Trop Biomed,*** 7(10), 855–861 (2017).
34. Y.Shen, Z. Sun, P. Shi, *et a.l*, "Anticancer effect of petroleum ether extract from Bidens pilosa L and its constituent's analysis by GC-MS", ***J Ethnopharmacol,*** 217, 126–133 (2018).
35. C. Y. Huang, Y. L. Chu, K. Sridhar and P. J. Tsai, "Analysis and determination of phytosterols and triterpenes in different inbred lines of Djulis (Chenopodium formosanum Koidz.) hull: A potential source of novel bioactive ingredients", ***Food Chem,*** 297(1), 124948 (2019).
36. N. Fadle, "Abdalbasit Adam Mariod, Hiba Abdel Rahman Ali and Alfatih Ahmed. TLC and GC-MS analysis of fermented wood 'Nikhra' petroleum ether fraction of Combretaceae spp. Combretum hartmannianum and Terminalia laxiflora", ***Eurasian J For Sci,*** 6(3), 1–7 (2018).
37. S.Ge, W. Peng, D. Li, *et al.,"*Study on antibacterial molecular drugs in Eucalyptus granlla wood extractives by GC-MS", ***Pak J Pharm Sci,*** 28(4 Suppl), 1445–1448 (2015).
38. M. Yusuf, U.A. Fitriani Nur, L. Mahyati, and M. Imran, "Phytochemical and antibacterial properties of sea cucumber (Muelleria lecanora) from Barrang Lompo Islands, Makassar South Sulawesi", ***Food Res,*** 4(6), 1885-1895 (2020).
39. A. H. Shobier, S. A. Abdel Ghani, and K. M. Barakat, "GC/MS spectroscopic approach and antifungal potential of bioactive extracts produced by marine macroalgae", ***Egypt J Aquat Res,*** 42(3), 289–299 (2016).
40. E. Beyzi, K. Karaman, A. Gunes and S. Buyukkilic Beyzi, "Change in some biochemical and bioactive properties and essential oil composition of coriander seed (Coriandrum sativum L.) varieties from Turkey", ***Ind Crops Prod,*** 109, 74–78 (2017).

Bull. Pharm. Sci., Assiut University, Vol. 45, Issue 1, 2022, pp. 139-151.

نشرة العلوم الصيدلية
جامعة أسيوط

BULL. PHARM. SCI. Assiut Univ.

تأثير وقت الاستخلاص على المركبات الحيوية من القرع (لاجناريا سيكراريا) باستخدام كروماتوجرافيا الغاز – مقياس الطيف الكتلي

محمد يوسف*[١] – سري أندرياتى[١] – نور فطراني أسديانا أتاحميد[٢] – رحمواتي صالح[٢] – أحمد رفاعي[١]

[١] قسم الهندسة الكيميائية ، كلية الفنون التطبيقية، مدينة ماكاسار ، إندونيسيا

[٢] قسم الصناعات الزراعية ، كلية الفنون التطبيقية الزراعية ، ولاية بانجكيب ، ريجنسي بانجكيب ، إندونيسيا

لطالما لعبت الأنظمة الطبية التقليدية دورًا مهمًا في تلبية احتياجات الرعاية الصحية العالمية. وفي الوقت نفسه ، فإن القرع الزجاجي هو نبات يحتوي على نواتج الأيض الثانوية المعززة للصحة. لذلك ، تهدف هذه الدراسة إلى تحديد خصائص المركبات النشطة بيولوجيًا لمستخلصات فاكهة القرع الزجاجي في الميثانول والكلوروفورم باستخدام كروماتوجرافيا الغاز –مقياس الطيف الكتلي للغاز (GC-MS) مع اختلافات في وقت الاستخلاص تبلغ ١٠ و ٢٠ و ٣٠ دقيقة باستخدام GC – عمود شعري RTX-5 MS. تم تحديد إجمالي ٩١ مركبًا مبدئيًا ، مع ٥٥ منها في الميثانول و ٤١ في مستخلص الكلوروفورم. تم اقتراح نسبة ١: ٢ (حجم / حجم) باستخدام مذيب الميثانول عند ٣٠ دقيقة على أنها أنسب وقت للاستخلاص الأقصى. تم اكتشاف العديد من القمم ذات النسب المئوية العالية في المستخلص الميثانولي الذي يحتوي على مكونات كيميائية رئيسية مثل حامض دهني ، أوليك ، بالميتيك ، ولينوليك ، بالإضافة إلى كوليستا٤و٥–دين–٣–اون وجاما سيتوستيرول و فينول ٢ ، ٢'–ميثيلين مكرر ،. وكذلك تشتمل المكونات من مستخلص الكلوروفورم على تيتراكوتان و دوتراكونتان و دوترياكوتان و فينول ٢ ، ٢'–ميثيلين مكرر والإسترات والمشتقات العطرية. تم الكشف عن معظم المركبات النشطة بيولوجيا بين ٢٠–٣٠ دقيقة من وقت الاستخلاص. علاوة على ذلك ، تمثل الأحماض الدهنية ، واسترات الميثيل والإيثيل ، وكذلك الستيرولات ٤٠٪ من إجمالي المستخلصات وتغلب عليها حمض الأوليك والبالمتيك ، جاما سيتوستيرول مع استرات الإيثيل والميثيل. لذلك ، يوصى باستخدام الميثانول باعتباره المذيب الأمثل للحصول على نسبة عالية من المكونات الكيميائية النباتية ومضادات الأكسدة لاستخدامها في كعقاقير.