BAU Journal - Health and Wellbeing

Volume 5 | Issue 2
ISSN: 2789-8288

Article 3

April 2023

REVIEW ON CHEMICAL CONSTITUENTS AND BIOLOGICAL ACTIVITIES OF GENUS RUMEX

Rima Mohammad Kheir Boukhary
Ph.D., Pharmaceutical Sciences Department, Faculty of Pharmacy, Beirut Arab University, Beirut, Lebanon, boukharyrima@yahoo.com

Zeina Omeiche
Instructor, Pharmaceutical Sciences Department, Faculty of Pharmacy, Beirut Arab University, Beirut, Lebanon, zeinaomeiche@gmail.com

Mohamad Ali Hijazi
Associate Professor of Pharmacognosy and Medicinal Plants, Pharmaceutical Sciences Department, Faculty of Pharmacy, Beirut Arab University, Beirut, Lebanon, m.hijazi@bau.edu.lb

Priscilla Jawhari
Pharmacy Student, Pharmaceutical Sciences Department, Faculty of Pharmacy, Beirut Arab University, Beirut, Lebanon, Priscilajaouhary@gmail.com

Lyn Jawish
Pharmacy Student, Pharmaceutical Sciences Department, Faculty of Pharmacy, Beirut Arab University, Beirut, Lebanon, lynshawish42@gmail.com

See next page for additional authors

Recommended Citation

Boukhary, Rima Mohammad Kheir; Omeiche, Zeina; Hijazi, Mohamad Ali; Jawhari, Priscilla; Jawish, Lyn; Ajjour, Hussein; Aboul Ela, Maha; and El-Lakany, Abdalla (2023) "REVIEW ON CHEMICAL CONSTITUENTS AND BIOLOGICAL ACTIVITIES OF GENUS RUMEX," *BAU Journal - Health and Wellbeing*: Vol. 5: Iss. 2, Article 3.
DOI: https://doi.org/10.54729/2789-8288.1189

REVIEW ON CHEMICAL CONSTITUENTS AND BIOLOGICAL ACTIVITIES OF GENUS RUMEX

Abstract

Genus Rumex belongs to the family Polygonaceae that is distributed worldwide and used in the treatment of different illnesses. Different parts of this plant are employed in the treatment of a number of ailments such as diarrhea, jaundice, hypertension, dermatopathy and inflammation. It was reported that they possess anti-oxidative, antimicrobial, antiviral and anti-cancer activities due to the presence of several phenolic constituents, anthraquinones and flavonoids such as rutin, luteolin and apigenin. Flavonoids play an important role against cardiovascular diseases by reducing oxidation of low-density lipoproteins. This article covers most of constituents of plants of genus Rumex reported from 2001 up to 2022. Furthermore, the biological activities of plants of genus Rumex are presented.

Keywords

Rumex, Active Constituents; Anti-microbial, Anti-oxidant and Anti-inflammatory Activities

Authors

Rima Mohammad Kheir Boukhary, Zeina Omeiche, Mohamad Ali Hijazi, Priscilla Jawhari, Lyn Jawish, Hussein Ajjour, Maha Aboul Ela, and Abdalla El-Lakany

1. INTRODUCTION

Genus Rumex comprises about 200 species of annual, biennial, and perennial herbs in the buckwheat Family Polygonaceae and are distributed worldwide in European, Asian, African and American countries. *Rumex* is the second largest genus of Family Polygonaceae. (Andrea, 2015). It is also located in Punjab and Khyber Pakhtunkhwa (KPK) provinces of Pakistan (Badshah, 2011). The Family Polygonaceae has 59 genera with 5109 species; of these 1266 are accepted species names (The Plant List, 2013). Members of this genus are very common perennial herbs with a native almost worldwide distribution, and introduced species growing in the few places where the genus is not native. Many species of this genus are herbs but some are shrubs too and a few are rhizomes. Their Leaves are arranged in alternating manner, sometimes hastate or sagittate. These plants are edible and the leaves of most species contain oxalic acid, tannins, and many have astringent and slightly purgative effects (Khalil, 2022).

Some species with particularly high levels of oxalic acid are called sorrels (including sheep's sorrel *R. acetosella*, common sorrel *R. acetosa*, and French sorrel *R. scutatus*) (Tonny *et al*. 2017). Some of these species are grown, as leaf vegetables or garden herbs, for their acidic taste (Łuczaj, 2008). Moreover, many authors have examined the nutritional and dietary properties of the leaves, stem and oils of these plants, and concluded that these have the prospect of creating a niche in the food industry (Bae *et al*., 2012).

Researchers have reported that root and the whole plant is used as laxative, in rheumatism skin diseases and bleeding of lungs (Vasas *et al*., 2015). *Rumex* is traditionally used in the treatment of sexually transmitted diseases including AIDS (Vermani *et al*., 2001). Moreover, the Ethiopian traditional knowledge applies many medicinal plants including this plant to treat different viral infections (Shinwari, 2003). Reports of the chemical components of many of them confirm that they can be promising to fight COVID-19 (Sumaira, 2014).

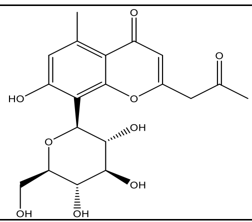
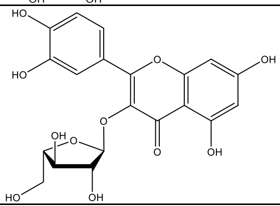
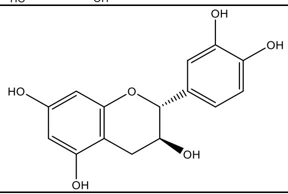
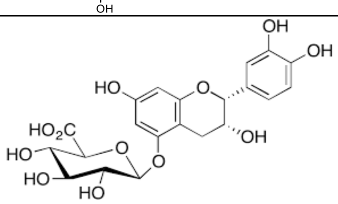
This article aims to provide an overview of medical uses, chemical constituents, pharmacological activities, toxicity, and safety of *Rumex* species indicating their significance in phytotherapy and the possible interest of including some species of the genus *Rumex* in the field of drug industry.

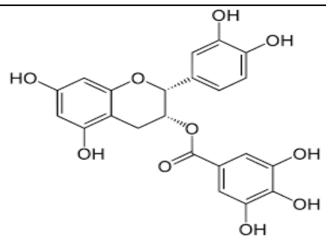
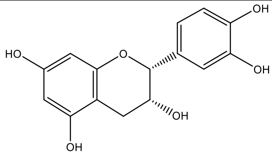
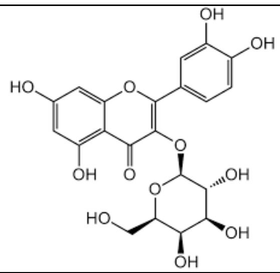
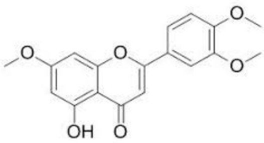
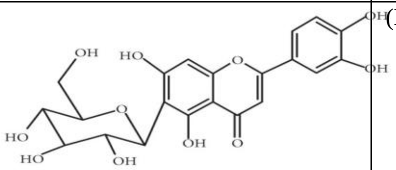
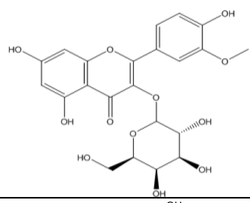
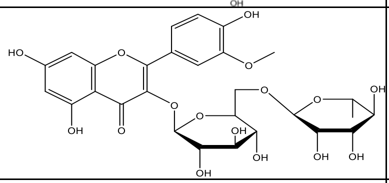
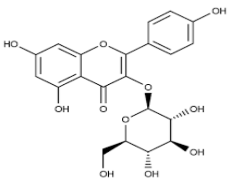
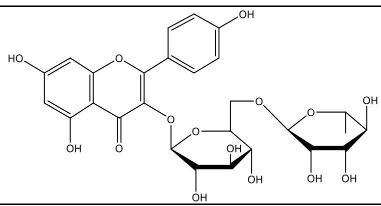
Table 1: Figures of the most common *Rumex* species

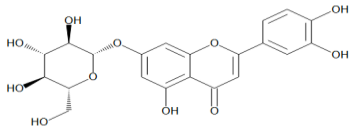
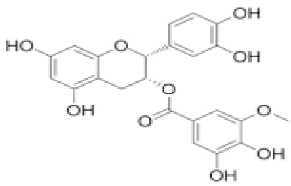
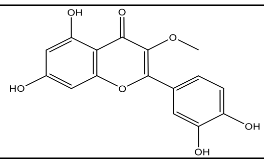
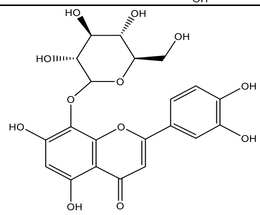
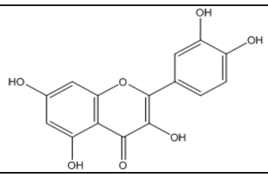
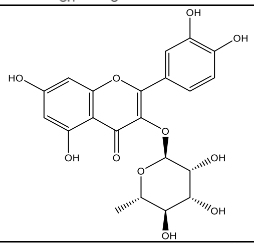
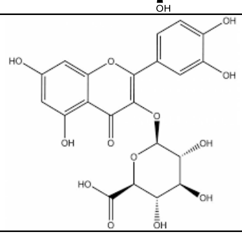
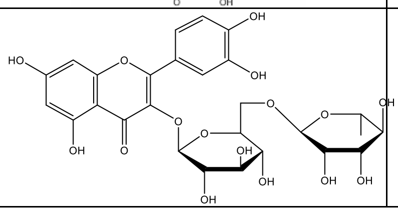
***Rumex* species**	**Illustration**	**Reference(s)**
R. crispus		**(Suzuki *et al*., 2006)**
R. patientia		**(Mei *et al*., 2009)**
R. dentatus		**(Usama *et al*., 2011)**

Rumex **species**	**Illustration**	**Reference(s)**
R. hastatus		**(Sumaira *et al*., 2014)**
R. nepalensis		**(Yilma *et al*., 2021)**
R. roseus		**(Saoudi *et al*., 2021)**

Table 2. Flavonoids isolated from the genus Rumex

Name	***Rumex*** **species (Part used)**	**Structure**	**Reference**
Aloesin	*R. acetosa* (Flowers)		(Bicker *et al*., 2009)
	R. nepalensis (Aerial parts)		(Yilma *et al*., 2021)
Avicularin	*R. acetosa* (Aerial parts)		(Bicker *et al*., 2009)
Catechin	*R.. acetosa* (Flowers)		(Bello *et al*., 2019)
	R. nepalensis (Aerial parts)		(Tonny *et al*., 2017)
Epicatechin7-O-ß-D glucuronate	*R.. acetosa* (Flowers)		(Bicker *et al*., 2009)

Name	*Rumex* species (Part used)	Structure	Reference
Epicatechin 3-O-gallate	*R. acetosa* (Flowers)		(Bello *et al.*, 2019)
	R. nepalensis (Aerial parts)		(Bahadur *et al.*, 2017)
Epicatechin	*R. acetosa* (Flowers)		(Bello *et al.*, 2019)
Hyproside	*R.. acetosa* (Aerial parts)		(Bello *et al.*, 2019)
5-hydroxy-3′-methoxyflavone	*R. crispus* (Aerial parts)		(Shafaghat *et al*. 2014)
Iso-orientin	*R. acetosa* (Aerial parts)		(Kemper *et al.*, 1999)
Isorhamnetin3-*O*-β-galactoside	*R. dentatus* (Aerial parts and roots)		(Usama *et al.*, 2011)
Isorhamnetin3-*O*-rutinoside	*R. dentatus* (Aerial parts and roots)		(Usama *et al.*, 2011)
kaempferol 3-*O*-β-glucoside	*R. dentatus* (Aerial parts and roots)		(Usama *et al.*, 2011)
Kaempferol 3-*O*-rutinoside	*R. dentatus* (Aerial parts and roots)		(Usama *et al.*, 2011)

Name	*Rumex* species (Part used)	Structure	Reference
luteolin7-*O*-glucoside	*R. hastatus* (Roots)		(Sumaira *et al*., 2014)
3-O-methyl epicatechin	*R. nepalensis* (Aerial parts)		(Yilma *et al*., 2021)
3-O-methyl Quercetin	*R. acetosa* flowers		(Bicker *et al*., 2009)
Orientin	*R. acetosa* (Aerial parts)		(Bicker *et al*., 2009)
Quercetin	*R.. acetosa* (Aerial parts)		(Bello *et al*., 2019)
	R. crispus. L (Aerial parts)		(Oladayo *et al*., 2017)
Quercetrin	*R. acetosa* (Aerial parts)		(Bello *et al*., 2019)
Quercetin3-O-ß-D glucuronate	*R. nepalensis* (Aerial parts)		(Atsushi *et al*., 2018)
Rutin	*R. hastatus* (Roots**)**		(Sumaira *et al*., 2014)

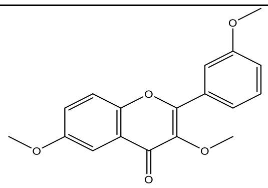
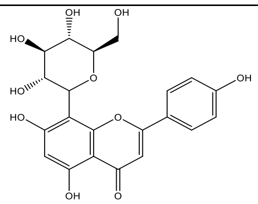
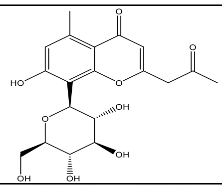
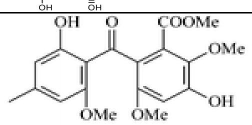
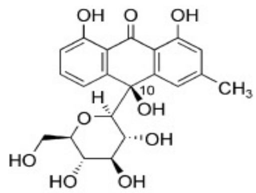
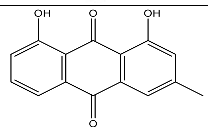
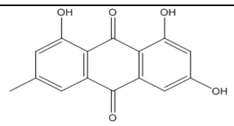
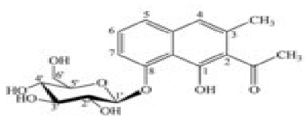
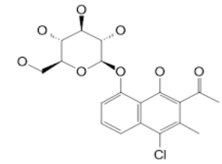
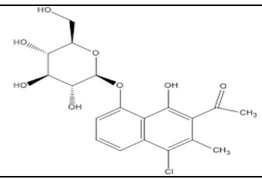
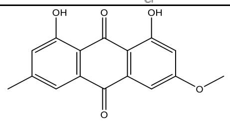
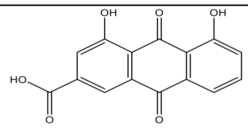
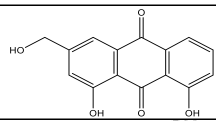
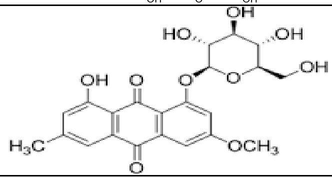
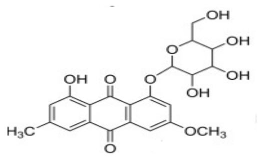
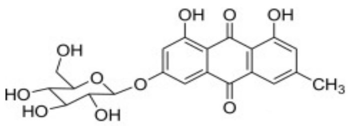
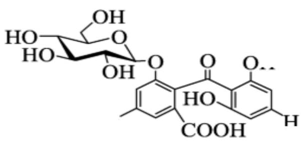
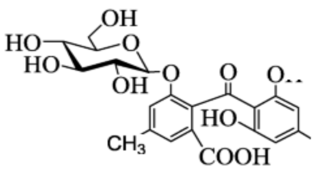
Name	*Rumex* species (Part used)	Structure	Reference
3,6,3′-Trimethoxyflavone	*R. roseus* (Aerial parts)		(Wang *et al*., 2012) (Saoudi *et al*., 2021)
Vitexin	*R. hastatus* (Roots)		(Sumaira *et al*., 2014)
	R. acetosa (Aerial parts)		(Bicker *et al*., 2009)

Table 3. Anthraquinones isolated from the genus Rumex

Name	*Rumex* species (Part used)	Structure	Reference
Aloesin	*R. nepalensis* (Roots)		(Yilma *et al*., 2021)
Asperfumin	*R. patientia* (Roots)		(Wang *et al*., 2014)
Cassialoin	*R. patientia* (Roots)		(Wang *et al*., 2014)
Chrysophanol	*R. nepalensis* (Roots)		(Yilma *et al*., 2021)
	R. patientia (Roots)		(Yang *et al*., 2013)
	R. japonicas (Roots)		(Lee *et al*., 2022)
Emodin	*R. nepalensis* (Roots)		(Yilma *et al*., 2021)
	R. patientia (Roots)		(Yang *et al*., 2013)
	R. japonicas (Roots)		(Lee *et al*., 2022)
Neopodin-*8O*-β-D glucoside	*R. nepalensis* (Roots)		(Yilma *et al*., 2021)

Name	***Rumex* species (Part used)**	**Structure**	**Reference**
Patientosides A	*R. patientia* (Roots)		(Yang *et al*., 2013)
Patientosides B			
Physcion	*R. patientia* (Roots**)**		(Yang *et al*., 2013)
Rhein	*R. patientia* (Roots**)**		(Yang et al., 2013)
	R. japonicus (Roots**)**		(Lee et al., 2022)
Aloe-emodin	*R. patientia* (Roots**)**		(Mei et al., 2009)
Chrysophanol-8-O-b-D-glucopyranoside	*R. patientia* (Roots**)**		(Mei et al., 2009)
	R. japonicus (Roots**)**		(Lee et al., 2022)
Physcion-1-O-β-D-glycopyranoside	*R. patientia* (Roots**)**		(Mei et al., 2009)
Emodin-6-*O*-β-D-glucopyranoside	*R. patientia* roots		(Mei et al., 2009)
Nepalenside A	*R. patientia* (Roots**)**		(Mei et al., 2009)
Nepalenside B	*R. patientia* (Roots**)**		(Mei et al., 2009)

DOI: 10.54729/2789-8288.1189

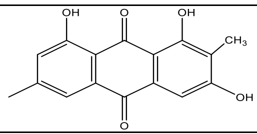
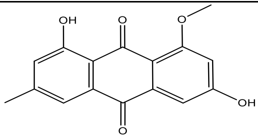
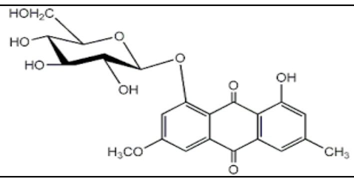
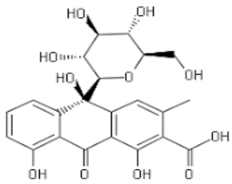
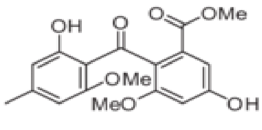
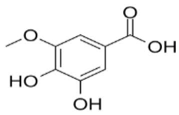
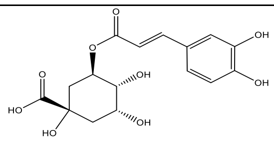
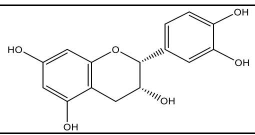
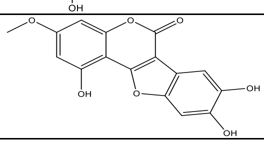
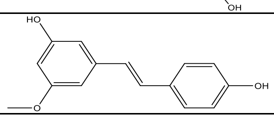
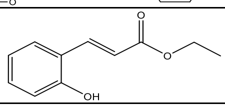
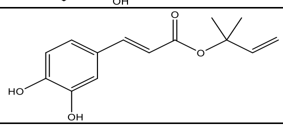
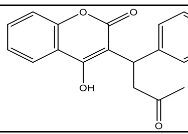
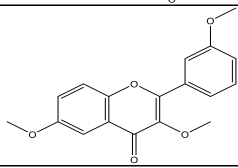
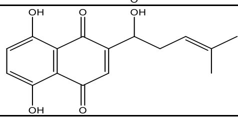
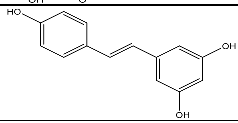
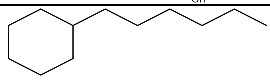
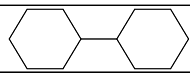
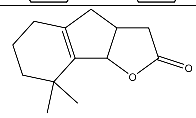
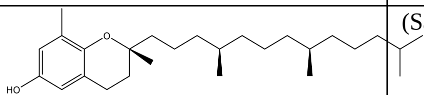
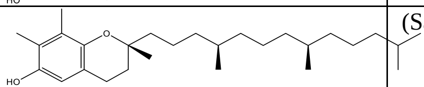
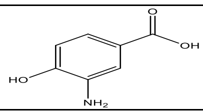
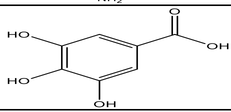
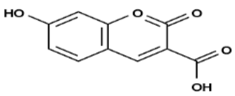
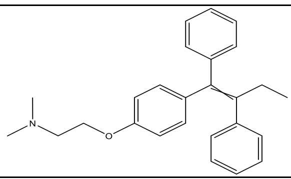
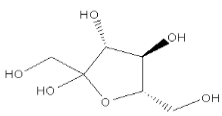
Name	*Rumex* species (Part used)	Structure	Reference
1-O-Methylemodin	*R. patientia* (Roots)		(Wang et al., 2014)
Questin	*R. patientia* Roots		(Wang et al., 2014)
Rumejaposide E	*R. patientia* (Roots)		(Wang et al., 2014)
Rumejaposide I			
1,2 Seco-trypacidin	*R. patientia* (Roots)		(Wang et al., 2014)

Table 4. Phenolic and other compounds isolated from the genus Rumex

Name	*Rumex* species /Part used	Structure	Reference
3,4-Dihydroxy-5methoxybenzoic acid	*R. roseus* (Aerial parts)		(Huyut *et al*., 2017)
Chlorogenic acid	*R. roseus* (Aerial parts)		(Savran *et al*., 2016)
Epicatechin	*R. roseus* (Aerial parts)		(Yahyaoui *et al*., 2018)
Wedelolactone	*R. roseus* (Aerial parts)		(Weitkamp *et al*., 2009)
Pinostilbene	*R. roseus* (Aerial parts)		(Yang *et al*., 2013)
Ethyl trans-2-hydroxycinnamate	*R. roseus* (Aerial parts)		(Shi *et al*., 2012)
Caffeic acid 1,1-dimethylallyl ester	*R. roseus* (Aerial parts)		(Garg *et al*., 2020)

Name	*Rumex* species /Part used	Structure	Reference
Warfarin	*R. roseus* (Aerial parts)		(Garg *et al*., 2020)
3,6,3′-Trimethoxyflavone	*R. roseus* (Aerial parts)		(Yang *et al*., 2013)
Shikonin	*R. roseus* (Stem)		(Wang *et al*., 2012)
Trans-3,5,4′-trihydroxystilbene	*R. roseus* (Stem)		(Wang *et al*., 2012)
Hexyl cyclohexane	*R.patientia* (Roots)		(Saoudi *et al*., 2021)
Bicyclohexyl	*R. patienia* (Roots)		(Saoudi *et al*., 2021)
8,8-Dimethyl -3a,4,5,6,7,8b-hexahydro-3H-indeno[1,2-b] furan-2-one	*R. patientia* (Roots)		(Saoudi *et al*., 2021)
δ-Tocopherol	*R. patientia* (Roots)		(Saoudi *et al*., 2021)
γ-Tocopherol	*R. patientia* (Roots)		(Saoudi *et al*., 2021)
3-amino-4-hydroxybenzoic	*R. crispus* (Aerial parts)		(Suzuki *et al*., 2006)
Gallic acid	*R. crispus* (Aerial parts)		(Huyut *et al*., 2017)
7-Hydroxycoumarin-3-carboxylic acid	*R. crispus* (Aerial parts)		(Wahdan *et al*., 2019)
4-Hydroxytamoxifen	*R. crispus* (Aerial parts)		(Shin *et al*., 2009)
(-) Fructofuranose	*R. crispus* (Aerial parts)		(Yu *et al*., 2015)

This literature review on the phytochemistry of genus *Rumex* revealed the presence of 27 flavonoids such as rutin, luteolin and apigenin playing an important role against cardiovascular diseases by reducing oxidation of low-density lipoproteins, 23 anthraquinones, and a variety of about 21 phenolic compounds in different parts of plants and extracts. These phytochemical constituents are responsible for the diversity in the pharmacological potential of *Rumex* used in the treatment of different illnesses.

2. PHARMACOLOGICAL ACTIVITIES

2.1. Antioxidant and Anti-Inflammatory Activities

The antioxidant activity was recorded in several reports proving the antioxidant potential of methanol and butanol extracts of roots of *R. hastatus* at different concentrations using DPPH˙, ABTS˙+, ˙OH, H_2O_2, superoxide free radical scavenging, iron chelating power, reducing power, β-carotene bleaching power and HPLC by which antioxidant capacity and total phenolics and flavonoids were evaluated. The results showed that these extracts contain the highest level of phenolic constituents like rutin, luteolin and vitexin playing an important role in treating several illnesses including coronary heart diseases and breast cancer (Peterson *et al*., 2003).

Further studies were carried out to determine anti-oxidant and cardiac depressant effect of *R. dentatus* by using Langendorff's isolated heart apparatus (Sumaira *et al*., 2014). The results showed a remarkable antioxidant effect due to the presence of phenolic compounds such as luteolin and rutin determined by spectrophotometry at 506 nm and HPLC and other methods. Moreover, it was proved that *R. roseus* aerial part extracts showed effective cytotoxic activities for both cancer cells HCT116 and MCF-7 (Saoudi *et al*., 2021).

In addition, another study carried out on *R. acetosa* and *R. acetosella* demonstrated that they are considered as the most selective inhibitors of the COX-1 enzyme due to anthraquinones, chrysofanol, emodin and epigallocatechine isolated from root extracts (Mimica-Dukić, 2016). Moreover, the extracts of *R. nepalensis* showed significant antioxidant activities as reported by a study carried out by Gonfa *et al*. (Gonfa *et al*., 2021).

These studies proved the antioxidant effect of *Rumex* plant in the treatment of rheumatoid and other inflammatory diseases.

2.2 Antiviral Activity

The antiviral activity of the acetone-water extract from the aerial parts *R. acetosa* was reported (Gescher *et al*., in 2011). The fraction was reportedly containing high amounts of oligomeric and polymeric proanthocyanidins and flavonoid. It displayed a significant antiviral activity against herpes simplex virus type-1 (HSV-1). The HSV-1 specific inhibitory concentration (IC50) and cytotoxic concentration (CC50) were determined using plaque test and MTT assay on Vero cells. The R2 exhibited an IC50 of 0.8 μg/mL and a selectivity index (SI) of approximately 100 when added to the virus inoculum for 1 h at 37 °C prior to infection. The authors concluded that this antiviral activity was due to the presence of flavan-3-ols and oligomeric proanthocyanidins in the extract (Gescher *et al*., 2011).

2.3 Antimicrobial Activity

Most antimicrobial bioactive compounds in plants are anthraquinones and flavonoids, which are active against several human pathogenic bacteria (Mostafa *et al*., 2011). The antimicrobial potential of *Rumex* was reported in a study carried out on different species that compared the *in vitro* antimicrobial effect of different extracts of the leaves and roots using technically graded solvents.

This study was done *in vitro* on n-hexane, chloroform parts of 14 *Rumex* species (*R. acetosella, R. acetosa, R. alpinus, R. aquaticus, R. conglomeratus, R. crispus, R. hydrolapathum, R. obtusifolius subsp. obtusifolius, R. obtusifolius subsp. subalpinus, R. patientia, R. pulcher, R. scutatus, R. stenophyllus and R. thyrsiflorus*) against *Staph. epidermidis, S. aureus, MRSA, Bacillus subtilis, Moraxella catarrhalis, Streptococcus pyogenes, S. pneumoniae, S. agalactiae, Pseudomonas aeruginosa, E. coli* and *Klebsiella pneumoniae* using the disc diffusion method. The extract of the aerial part and root of *R. aquaticus* showed the highest antibacterial activity against most bacterial strains while the chloroform and n-hexane extracts prepared from the roots of the rest displayed lesser antibacterial activity (Orbán-Gyapai *et al*., 2017).

Another study was conducted in order to determine the bactericidal properties of *R. crispus* using graded concentration of the plant extracts, to determine the minimal inhibitory concentration (MIC) against the following chosen bacterial strains (Gram-negative: *K. pneumoniae*, *P. aeruginosa*, *E. coli*, and *V. cholera*., Gram-positive: *B. subtilis*, *S. aureus*, *S. pyogenes*, and *B. cereus*). The acetone extract of the root revealed the highest antimicrobial potency with the lowest MIC value of <1.562 mg/mL, in all the strains of bacteria. In addition, the ethanol extract of the root and methanol extract of the root showed high inhibitory capacity of the bacteria (Oladayo *et al*., 2017).

Other species such as *Rumex nervosus* showed inhibitory effects against many pathogens such as *Staphylococcus aureus*, *Micrococcus luteus*, *Escherichia coli*, and *Pseudomonas aeruginosa* (Khurram *et al*., 2009).

2.4 Cytotoxic Activity

A study carried out by Rahmani *et al*. determined the cytotoxicity of different extracts of *Rumex. roseus* on two different human cell lines, MCF-7 and HCT-116. (Rahmani et al., 2019). The activity was assessed by a 3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide (MTT) colorimetric assay. The absorbance was measured at 605 nm. Tamoxifen was used as a positive reference. The cytotoxic effect of the extract was estimated based on the percentage of growth inhibition. The highest cytotoxic activity against HCT-116 and MCF-7 was recorded for the dichloromethane extract with 62.1 and 80.0% inhibition at 50 mg/L, respectively. Another assay demonstrated the cytotoxic effect of *R. crispus* against two cancer cell lines (HCT-116 and MCF-7) and its potential to inhibit their growth (Saoudi *et al*., 2021).

Although there are reports on antitumor activity of *Rumex hymenosepalus* and *R. dentatus* (Chen *et al*., 2003). Moreover, *R. rothschildianus* showed significant inhibition of both HeLa and MCF7 cell lines related to its high content of terpenes and steroids.

2.5 Antitrypanosomal

A study revealed the antiplasmodial activity *of R. crispus* extracts where the solvent extracts were subjected to an *in vitro* screening against malaria-causing parasite (*P. falciparum* strain concentration) and compared with the positive control (chloroquine). Methanol extract of the leaf (LF-MEE; IC50: 15 μg/mL) showed a strong inhibition of *P. falciparum* causing viability of the parasite to be less than 50% (Oladayo *et al*., 2017).

2.6 Neurological Activity

The neurological potential was also measured (Ahmad *et al*., 2015) using different extracts of *R. hastatus* (Hexane, chloroform, ethyl acetate, aqueous fraction, crude saponins and flavonoids). Acetylcholinesterase (AChE) and butyrylcholinesterase, at various concentrations (125, 250, 500, 1000 μg/mL), were investigated using Ellman's spectrophotometric analysis. The study revealed that all the fractions exhibited moderate to high AChE inhibition supporting the potential role of *R. hastatus* in the treatment of various nervous disorders.

2.7 Anti Obesity Activity

A study, carried out to evaluate the anti-obesity effect of *R. rothschildianus*, showed that the acetone fraction exerted the greatest inhibitory action on α-glucosidase with an IC_{50} of 54.9 ± 0.3 μg/ml, compared that of acarbose. Moreover, this study revealed that the anti-diabetic effect is mediated by inhibiting α-amylase (Jaradat *et al*., 2021). The significant anti-diabetic activity of *R. nervosus* was also observed by comparing different extracts of this plant with glibenclamide proving that the plant root juice can be used in the treatment of diabetes according to the traditional Indian medicinal systems (Muthukumran *et al*., 2011).

3. DISCUSSION

Plants are the source of phytochemicals and possess several biological activities. The functional property of a plant relies upon the different secondary metabolites it possesses (Murugan *et al*., 2014). They determine the antioxidant, anti-inflammatory and antimicrobial capacity correlated to their redox properties in adsorbing and scavenging of free radicals (Adebayo *et al*., 2008). Among the phytochemicals namely polyphenols, anthraquinones and flavonoids have been proven to be of great importance because they help the human body to fight diseases. Flavonoids act as potent antioxidants but depend on their molecular structures and the position of the hydroxyl group on the chemical structure. It is therefore important to carry out more than one type of antioxidant assay to cover the different mechanisms of antioxidant action.

Flavonoids also have biochemical effect inhibiting a number of enzymes such as aldose reductase, xanthine oxidase, phosphodiesterase, lipoxygenase, etc. They have been found to have anti-inflammatory activity in both proliferative and exudative phases of inflammation and exert a regulatory role on different hormones like estrogens, androgens and thyroid hormone (Hema *et al*., 2009).

The literature review of the phytochemistry and the pharmacology of genus *Rumex* revealed the anti inflammatory activity of different species mainly *R. hastatus* and *R. dentatus* due to their high phenolic contents including flavonoids such as rutin, luteolin and vitexin. These phenolic compounds play an important role in treating several illnesses including coronary heart diseases (Giampaoli *et al*., 1995) and breast cancer (Peterson et al., 2003).The plants-derived polyphenols exhibit typical inhibitory trend against *in vitro* and *in vivo* oxidative reactions (Bahramika *et al*., 2009) due to redox properties. Therefore, it can be stated that tested plants may have important role as free radicals scavengers to the substantial content of phenolics and flavonoids.

Moreover, the anti-oxidant and cardiac depressant effect of *Rumex dentatus* using Langendorff's isolated heart apparatus (Sumaira *et al*., 2014) revealed a remarkable effect due to the presence of phenolic compounds.

In the reported cytotoxicity of *R. crispus* against two cancer cell lines (HCT-116 and MCF-7) indicated its potential to inhibit their growth (Saoudi *et al*., 2021).

Literature survey showed the broad antimicrobial potential of *Rumex.* Some species were antibacterial, while others are potent antiviral (Atsushi, 2018). An *in vitro* study of 14 *Rumex* species roots revealed the highest antimicrobial potency with the lowest MIC value of <1.562 mg/mL for all the tested bacteria strains. In addition, the ethanol extract and methanol extract of the root of *R. aquaticus* showed a high inhibitory capacity of the bacteria (Oladayo *et al*., 2017).

R. nervosus exerted inhibitory effects against many pathogens such as *Staphylococcus aureus, Micrococcus luteus, E. coli*, and *Pseudomonas aeruginosa* (Khurram *et al*., 2009).

Hopefully, based on the promising results collected in this manuscript, we recommend further research to be conducted on the extracts of this plant in order to identify other molecules responsible for the biological activities found in previous papers as each of the above-discussed pharmacological activities is related to a special bioactive component.

4. CONCLUSION

This review of genus *Rumex* highlights diversity of the bioactive compounds presence mainly anthraquinones, flavonoids, phenols, and saponins, and the potential to target in drug manufacturing and development for the treatment of various diseases that provide scientific evidence for some popular uses in several fields. Based on the result we conclude that *Rumex* species could be considered as an important natural antioxidants and effective cytotoxic against cancer cells.

Based on the reported data present in this review it is recommended that further research should be carried out in order to identify new biologically active-principles and mode of action for pharmaceutical industry and incorporation to maintain overall good wellbeing. Many efforts needed to be done by the researchers to find out more bioactive compounds of plants of genus *Rumex*. Additional efforts are needed to explore possible incorporation of these compounds in pharmaceutical industry. The reason is that they play an important role in human health, both as part of a balanced diet and as pharmaceutical agents, due to their potential for the prevention and treatment of cardiovascular disease, cancer and other diseases.

Based on the antimicrobial results, it is possible to conclude that *Rumex* extracts exhibited a broad range of antimicrobial activity such as *R. crispus, R nervosus, R. hastatus R. dentatus* and other species and thus can be used as antimicrobial agents in new drugs for therapy of infectious diseases.

Moreover, it is necessary to carry out more detailed phytochemical investigations to identify the active principles and mode of action as there is a strong correlation between the occurrence of flavonoids and other phenolic constituents maintaining overall good wellbeing.

REFERENCES

- Adebayo, AA., Jimoh, FO., Koduru, S., Afolayan, AJ., & Masik, PJ.(2008). Antibacterial and antioxidant properties of the methanol extracts of the leaves and stems of *Calpurnia aurea*. *BMC Complement Alt Med*. 8(1): 53.
- Atsushi, M., Taro, O., Chengwei, L., & Hideaki, O. (2018). Cyclopentane-forming di/ sesterterpene synthases: widely distributed enzymes in bacteria, fungi, and plants. *Nat Prod Rep.*10:1–17. https://doi.org/10.1039/c8np00026c.
- Bae, J.Y, Rhee, Y. S, Han, S. Y, Jeong, E. J, & Lee, M. k. (2012). A comparison between water and ethanol extracts of *Rumex acetosa* for protective effects on gastric ulcers in mice. *Biomol. Ther.*, 20, 425–430.
- Badshah, L & Hussain, F. (2011). People preferences and use of local medicinal flora in District Tank, plants against free radical-mediated protein oxidation. *Food Chem*. 115:37–42.
- Bello, O.M., Fasinu, P.S., Bello, O.E., A.B. Ogbesejana, A.B. Adetunji, C.O., Dada, A.O., Ibitoye, O.S., Aloko, S., & Oguntoye, O.S. (2019). Wild vegetable *Rumex acetosa* Linn.: Its ethnobotany, pharmacology and phytochemistry – A review. *South African Journal of Botany*. 125, 149–160.
- Bicker, J., Petereit, F., & Hensel, A. (2009). Proanthocyanidins and a phloroglucinol derivative from *Rumex acetosa* L. *Fitoterapia*. 80, 483–495.
- Gonfa, Y.H., Fekade, B., & Tedesse, M. G. (2021). Phytochemical investigation and potential pharmacologically active compounds of *Rumex nepalensis*: an appraisal. *Journal of Basic and Applied Sciences.*10:18.
- Garg, S. S., Gupta, J., Sharma, S., & Sahu, D. (2020). An insight into the therapeutic applications of coumarin compounds and their mechanisms of action. *European Journal of Pharmaceutical Sciences*. 152, 105424.
- Hema, C., Dharmender, R., Vikas, K., & Kanchan, K. (2009). Mechanism of action of flavonoids as anti-inflammatory agents: a review. *Inflamm Allergy Drug Targets***.** 8(3): 229-35.
- Huyut, Z., Beydemir, S., & G¨ulçin, I. (2017). Antioxidant and antiradical properties of selected flavonoids and phenolic compounds. *Biochemistry Research International*. Article ID 7616791, 10 pages.
- Kim, H.Y., Bae, C.H., Kim, J., Lee, Y., & Kim, H. (2022). *Rumex japonicus* Houtt. Protects Dopaminergic Neurons by Regulating Mitochondrial Function and Gut–Brain Axis in *In Vitro* and *In Vivo* Models of Parkinson's Disease. Antioxidants. 11, 141.
- Khalil, A. A., Zeb, F., & al. (2022). An Overview on *Rumex dentatus* L.: Its Functions as a Source of Nutrient and Health-Promoting Plant. Evid. Based Complement. and Alternat. Med. DOI: 10.1155/2022/8649119.
- Liu, Y. Q., Bin Zhan, L., Liu, T., Cheng, M. C., Liu, X. Y., & Bin Xiao, H. (2014). Inhibitory effect of Ecliptae herba extract and its component wedelolactone on pre-osteoclastic proliferation and differentiation. *Journal of Ethnopharmacology*. 157, 206–211.
- Łuczaj, Ł. (2008). Archival data on wild food plants used in Poland in 1948. *Journal of Ethnobiology and Ethnomedicine*. **4** (1): 4.

- Mei, R. Q., Liang, H. X., Wang, J. F., Zeng, L., H., Lu, Q., Cheng, Y. X. (2009). *Planta Med*. 75, 1162.
- Mimica, N. (2016). Native plants in Serbia as a source of new anti-inflammatory agents–the case of Polygonaceae Family. XV Optima Meeting June 611, Montpellier. Moerman, D., 2003. Native American Ethnobotany.
- Mostafa, H. A. M., El bakry, A. A., & Eman, A. A. (2011). Evaluation of antibacterial and antioxidant activities of different plant parts of *Rumex vesicarius* L. (polygonaceae). *International Journal of Pharmacy and Pharmaceutical Sciences*. 3 (2): 109–118.
- Murugan, R., & Parimelazhagan, T. (2014). Comparative evaluation of different extraction methods for antioxidant and anti-inflammatory properties from Osbeckia parvifolia Arn. – An *in vitro* approach. *J King Saud Univ Sci*. 26 (4): 267-75.
- Muthukumran, P., Hazeena Begumand, V., Kalaiarasan, P. (2011). Anti-Diabetic activity of Dodonaeaviscosa (L) Leaf Extracts. *International Journal of PharmTech Research*. 3(1), 136-139.
- Oladayo, A. I., Olubunmi, A. W., & Anthony, J. A. (2017). Phytochemical and antioxidant activities of Rumex crispus L. in treatment of gastrointestinal helminths in Eastern Cape Province, South Africa. *Asian Pac J Trop Biomed* .7 (12): 1071–1078.
- Peterson, J., Lagiou, P., Samoli, E., Lagiou, A., Katsouyanni, K., & al. (2003). Flavonoid intake and breast cancer risk: a case–control study in Greece. *British Journal of Cancer*. 89, 1255–1259.
- Saoudi, M. M., Jalloul, B., & Alouani, K. (2021). Phenolic Compounds of *Rumex roseus* L. Extracts and Their Effect as Antioxidant and Cytotoxic Activities. Hindawi BioMed Research International. Article ID 2029507, 10 pages.
- Savran, A., Zengin, G., Aktumsek, A., & al. (2016). Phenolic compounds and biological effects of edible: *Rumex scutatus* and Pseudosempervivum sempervivum: potential sources of natural agents with health benefits. *Food & Function*. 7, 3252–3262.
- Shafaghat, A., Pirfarshi, F., & Shafaghatlonbar, M. (2014). Luteolin derivatives and antimicrobial activity of *Achillea tenuifolia* Lam. methanol extract. *Industrial Crops and Products*. 62, 533–536.
- Shi, H., Yang, H., Zhang, X., & Yu, L. (2012). Identification and quantification of phytochemical composition and antiinflammatory and radical scavenging properties of methanolic extracts of Chinese propolis. *Journal of Agricultural and Food Chemistry*. 60 (50), 12403–12410.
- Shinwari, Z. K, & Gilani, S.S. (2003). Sustainable harvest of medicinal plants at Bulashbar Nullah, Astore (Northern Pakistan). *J Ethnopharmacol*, 84:289–298.
- Sumaira, S, Muhammad, R. K, and Rahmat, A .K. (2014). Comprehensive assessment of phenolics and antiradical potential of *Rumex hastatus* D. Don. Roots *BMC Complementary and Alternative Medicine*.14:47.
- Suzuki, H., Ohnishi, Y. Furusho, Y., Sakuda, S., & Horinouchi, S. (2006). Novel benzene ring biosynthesis from C3 and C4 primary metabolites by two enzymes. *Journal of Biological Chemistry*, 281(48), 36944–36951.
- The Plant List. (2013). Version1. Published on Internet. http://www. The plant list.org.
- Tonny, S., Sultana, S., & Siddika, F. (2017). Study on medicinal uses of Persicaria and Rumex species of polygonaceae Family. *J Pharmacogn. Phytochem.*, 6: 587–589
- Usama, W.H., Eman, F.A., Amal, F.A., & H, A. A. (2011). Biological activity of flavonol glycosides from *Rumex dentatus* plant, an Egyptian Xerophyte. *Journal of Medicinal Plants Research*. 5 (17), 4239-4243.
- Vasas, A, Gyapai, O. O, & Hohmann, J. (2015). The Genus *Rumex*: Review of traditional uses, phytochemistry and pharmacology. *Journal of Ethnopharmacology*, 175. 198- 222.
- Vermani, K & Garg, S. (2001). Herbal medicines for sexually transmitted diseases and AIDS. *J Ethnopharmacol*, 80:49–66.

- Wang, X.L., Hu, M., Wang, S & Cheng, Y.X. (2014). Phenolic Compounds and Steroids from *Rumex patientia*. Chemistry of Natural Compounds, 50, 311–313.
- Wang, R., Yin, R., Zhou, W., Xu, D. & Li, S. (2012). Shikonin and its derivatives: a patent review. *Expert Opinion on Therapeutic Patents,* 22 (9), 977–997.
- Weitkamp, P., Vosmann, K., & Weber, N. (2006). Highly efficient preparation of lipophilic hydroxycinnamates by solvent-free lipase-catalyzed transesterification. *Journal of Agricultural and Food Chemistry*. 54 (19), 7062–7068.
- Yahyaoui, M., Bouajila, J., Cazaux, S., & Abderrabba, M. (2018). The impact of regional locality on chemical composition, antioxidant and biological activities of *Thymelaea hirsuta* L. extracts. *Phytomedicine*, 41, 13–23.
- Yang, Y., Yan, Y. M., Wei, W., Jie. L., Zhang. L.S., Zhou, X.J., Wang. P.C., Yan, Y.X., Cheng. & Y. X. (2013). Anthraquinone derivatives from *Rumex* plants, endophytic Aspergillus fumigatus, and their effects on diabetic nephropathy. *Bioorganic & Medicinal Chemistry Letters.* 23, 3905–3909.
- Yilma, H. G., Fekade, B., & al. (2021). Phytochemical investigation and potential pharmacologically active compounds of *Rumex nepalensis*: An appraisal. *Journal of Basic and Applied Science. 10:18*.