International Journal of Pharmacy and Biological Sciences
ISSN: 2321-3272 (Print), ISSN: 2230-7605 (Online)
IJPBS | Volume 8 | Issue 3 | JUL-SEPT | 2018 | 01-09
Review Article | Pharmaceutical Sciences | Open Access | MCI Approved| ज्ञान-विज्ञान विमुक्तये
|UGC Approved Journal |

A REVIEW ON ETHNOMEDICINAL, PHARMACOLOGICAL AND PHYTOCHEMICAL ASPECTS OF *SONCHUS OLERACEUS LINN.* (ASTERACEAE)

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ABSTRACT

Sonchus oleraceus Linn. (S. oleraceus) is one of the therapeutically important herb, broadly distributed all through world. S. oleraceus species find their roots in various ancient medicinal systems including Chinese medicines. Traditionally various parts of S. oleraceus had been employed in the treatment of different diseases like Galactagogue, febrifuge, sedative, vermifuge. Liver disorder. It treats phthisis hepatitis, infections, inflammation, and rheumatism treatment of vitiligo. It is used as a cathartic, a sedative, in a cancer treatment and a vermicide etc. Nowadays S. oleraceus species are being explored as a potential antioxidant. Considering these facts, we endeavoured to present a comprehensive review enlightening the phytochemistry and pharmacological activities of plant S. oleraceus. We utilized logical writing and scientific literature from electronic search engine such as Springerlink, Science Direct, PubMed, Scopus and BioMed Central as well as relevant books, websites, scientific publications and dissertations as a source of information. Phytochemical profiling of this species has revealed the presence of some imperative phytochemicals sesquiterpene lactones of the eudesmanolides and guaianolide structures. It also contains flavonoids, flavonols, proanthocyanidins, total phenols, saponins and alkaloids. The pharmacological activities exhibited by S. oleraceus are attributed to the presence of valuable bioactive phytoconstituents. Literature revealed that plant S. oleraceus possess' antioxidant, antidiabetic, anti-inflammatory, antipyretic, antinociceptive, anxiolytic, cytotoxic and antibacterial activity. This review intends to investigate the published report regarding phytochemicals, ethnomedicinal and pharmacological viewpoints and put forth the therapeutic potential of S. oleraceus. Future research can be directed to extensive investigation about phytochemistry, clinical trials and pharmacokinetics acquiring safety data so as to add new dimensions to therapeutic utilization of S. oleraceus and other Sonchus species.

KEY WORDS

Sonchus, S. oleraceus, Asteraceae, Antioxidant

1. INTRODUCTION:

S. oleraceus L. (*S. oleraceus*) belongs to the family Asteraceae / Compositae which is largest family of flowering plants, in terms of number of species.(Sonchus oleraceus) is a plant of Asteraceae Family, found almost everywhere in the world, edible, rich in vitamins A, D and E.[1] 'Asteraceae' is derived from the type genus Aster, while 'Compositae', an older but still valid name, means composite and refers to the characteristic inflorescence, a special type of pseudanthium found in only a few other angiosperm families. The Asteraceae is a large and widespread family which contain many genera. The Asteraceae family comprises more than 1,600 genera and 23,000 species. It is broad-based most commonly occur in the temperate regions and tropical mountains. These are

most usually herbs, but some shrubs, trees and climbers do exist. They are generally easy to distinguish, mainly because of their characteristic inflorescence. Leaves are alternate, opposite, whorled, simple, deeply lobed, incised, often conduplicate or revolute, margins is entire or dentate. Flowers are either bisexual or monosexual and variously arranged. Calyx tube is entirely adherent to the ovary. Corolla is epigynous, gamopetalous, regular or sometimes irregular, tubular, and either ligulate or bilabiate. Stamens are 5-4, inserted on the corolla and alternate with its segments; filaments usually free above; anthers 2-celled, introse, cohering into a tube which sheaths the style, the cells often tailed at the base. Ovary is 1-celled; ovule solitary, erect, anatropous; style slender; arms linear, ½-terete, acute, obtuse, truncate or penicillate. Fruits are specialized type of achene, sometimes called cypsela. One seed per fruit is formed. It may sometimes be flat, winged or spiny and adheres to the persistent pappus. The seeds usually have little or lack endosperm. [2-4]

2. INTRODUCTION TO *S. OLERACEUS* L.

2.1. Taxonomical Classification. [5]

Kingdom: Plantae
Subkingdom: Tracheobionta
Division: Magnoliophyta
Class: Magnoliopsida
Subclass: Asteridae
Order: Asterales
Family: Compositae
Genus: *Sonchus*

2.2. Vernacular names. [6]

Hindi: Dodak
English: Hare's Lettuce, Sow Thistle
Kannada: Naayi Hakkarike
Marathi: Pathari
Telugu: Ratrinta
Tamil: Oosithagarai
Bihar: Titaliya

2.3. Characteristics of Plant *S. oleraceus* L.

S. oleraceus is an annual herb, upto 4 ft. in height. The stems are shady green in color with a reddish-purple touch. *S. oleraceus* has hollow stems that exude latex, if damaged. Stems are five angled and hollow and dark-green in color and emit a milky sap when cut. The root system consists of a stout taproot. *S. oleraceus* has short taproot and deeply lobed leaves. Leaves are lanceolate to oblong in shape, hairless and dark green in color with pale white to purple veins. Morphology of *S. oleraceus* is given in (Fig 1.) The leaves are rotund with a little notched margin with a scarce spine. Leaf have thin hairs on the upper leaf surface. Mature leaves are thin, soft and dark-green in color with irregularly-toothed margins ending in small, soft spines. The superior leaves are minor than the inferior leaves, stalkless and clasp the stems with claw like basal lobes. Leaves are thin and soft, measuring up to 36 cm long and 12 cm wide. Flowers are yellow in color, upto 7 mm in diameter. Flowering generally takes place in the spring and summer. The floral bracts at the base of the flower head are dull green, hairless and overlap each other in a vertical series. Cotyledons are ovule shaped to barely curved, bald, short stalked and upto 3–7 mm lengthy. Seeds containing vessels are capped through a cluster of hairs, or pappus, like most of this large family of Composite. Bracts are smooth, tinny and green. Flowers are abundant and yellow. [7]

3. GEOGRAPHIC DISTRIBUTION:

S. oleraceus originates from Europe found in Asia and northern Africa. *S. oleraceus* is indigenous to Asia and Europe, and it can be found growing in North America, South America, Australia and the Middle East. *S. oleraceus* also found in Australia, Brazil, Canada, Falkland Islands, French Southern Territories, Greenland, New Zealand, Puerto Rico, Saint Helena, Saint Pierre and Miquelon, United States band Virgin Islands. [8]

a) Plant of *S. oleraceus* **b) Leaves of *S. oleraceus*** **c)Flowers of *S. oleraceus S.*** **d) Fruit of *S. oleraceus***

Fig 1: Morphology of *S. oleraceus*

4. TRADITIONAL USE

S. oleraceus L. demonstrates a number of proven therapeutic applications and are being utilized by ancient medicinal systems including Chinese medicines. It is known by different vernacular names in different languages of India as well as around world. *S. oleraceus* used in folklore medicine for the treatment of gastrointestinal tract disorder in addition to its used as food in some parts of Asia and Africa. [9] Juice expressed and tanked-up for hemorrhage during childbirth. [10] Decoction with kopa, clover and salt is administered to expel placenta worms and with disphymaaustrale used locally for boils. [11,12] It is also used as Galactagogue, febrifuge, sedative , vermifuge, and in the treatment of liver disorder. An ointment made from decoction is applied for healing wounds and ulcers.[13] Orally it is taken as tonic and treats phthisis.[14] Infusion, decoction or sugarcane alcohol (aguardente) are administered orally to treat gastric spasm, hepatitis, infections, inflammation, headaches, general pain, rheumatism, and even as a general tonic.[15,16] Similarly it is recommended for the treatment of vitiligo.[17] Traditionally it is used as a cathartic, sedative, in cancer treatment and as a vermicide.[18]

5. BIOLOGICAL & PHARMACOLOGICAL ACTIVITIES OF *S. OLERACEUS*

S. oleraceus is an important plant in traditional system of medicine which demonstrates various pharmacological activities like antioxidant, antidiabetic, Anti-inflammatory, antipyretic, antinociceptive, anxiolytic, cytotoxic and antimicrobial activity. The medicinal traits and pharmacological activities reported of various parts of *S. oleraceus* are comprehensively given as follows.

5.1 Anti- oxidant properties.

Schaffer *et.al.,* (2005) reported the antioxidant properties of Mediterranean food plant extracts. Where he collected *S. oleraceus* and tested it for *in-vitro* antioxidant potential. Results exhibited promising antioxidant activity of *S. oleraceus*. [19] Nehir SE *et.al.,* (2004) have evaluated *S. oleraceus* for antioxidative activity where radical scavenging effects, inhibition of hydrogen peroxide (H_2O_2), Fe_{2+} chelating and DPPH radical scavenging were selected as model for activity. His conclusions were greens plants having important antioxidative properties should provide an optimal supply of antioxidant substances in the diet. [20] Jimoh *et.al.,* (2005) investigated nutritional, phytochemical, antioxidant and antibacterial activities of acetone, methanol and water extracts of the leaves of *S. oleraceus*. His results showed that leaves of *S. oleraceus* are rich in minerals, flavonoids, flavonols, proanthocyanidins and total phenols. The extracts of *S. oleraceus* exhibited strong antioxidant properties. [21] Jie Yin *et.al*., (2011) Investigated *S. oleraceus* for *in-vitro* antioxidant activity by reducing power, hydroxyl radical-scavenging activity (HRSA) and 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assays. Study displayed concentration dependent activity and its Inhibitory concentration (IC_{50}) values ranged from (47.1 to 210.5) µg of 70% MeOH, boiling water and 70% EtOH extracts were (47.1, 52.7 and 56.5 µg/ml,). Results indicated S. *oleraceus* contains constituents showed that *S. oleraceus* extract might be used as a potential

source of antioxidants. [22] McDowell *et.al.,* (2011) reported *S. oleraceus* as a rich source of polyphenols that showed antioxidant activity as measured by the 2,2-diphenylpicrylhydrazyl (DPPH) assay. Whereas cellular antioxidant activity (CAA) assay was used to examine the antioxidant activity of leaf extracts. Using the CAA assay, it was revealed that extracts were effectively absorbed into HepG2 cells and employed antioxidant activity at comparable levels. Methylene blue staining of HepG2 cells indicated that extracts were not cytotoxic at concentrations below 100 mg DW/mL. Data showed the potential of *S. oleraceus* as a nutraceutical. [23] Lin K *et.al.,* (2014) evaluated the total phenolic and flavonoid contents in acid methanol extracts of *S. oleraceus* leaves. Antioxidant activity was determined by measuring the trolox equivalent antioxidant capacity (TEAC), oxygen radical absorption capacity (ORAC), and 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity. Polyphenol, flavonol, and flavonoid levels were high in *S. oleraceus* as compared to the rest of tested plants. Highest levels of the TEAC, ORAC, and DPPH radical scavenger were generated from extracts. Substantial and positive interactions among antioxidant activity and polyphenols and anthocyanins were observed. [24] Obeid *et.al.,* (2018) investigated ethyl acetate extract of the *S. oleraceus* for antioxidant activity. The ethyl acetate extract of the plant showed 89% radical scavenging activity (RSA). The extract was subjected to separation by column chromatography twelve fractions were tested with DPPH (1,1-Diphenyl-2-picrylhydrazyl). All twelve fractions exhibited high antioxidant activity. [25] Dao-Zong Xia *et.al.,* (2011) determined total phenolic, flavonoid content, antioxidant and antibacterial activities of six Sonchus wild vegetables (*S. oleraceus* L) in China were investigated. The results revealed that *S. oleraceus* extract contained the highest amount of phenolic and flavonoid, respectively. Among the methanol extracts of six species, Sonchus exhibited the highest radical scavenging activity. The results of antibacterial test indicated that the S. oleraceus extract showed higher activity than the other five Sonchus wild vegetables extracts, both in Gram-negative bacteria (Escherichia coli, Salmonella enterica and Vibrio parahaemolyticus) and in a Gram-positive bacterium (Staphylococcus aureus).[26] Ou Zong-Quan *et.al.,* (2015) Reported antioxidants protect against damage from free radicals and are believed to slow the ageing process. His Previous work described the high antioxidant activity of *S. oleraceus leaf extracts. From this it was hypothesised* that *S. oleraceus* extracts protect cells against H_2O_2-induced senescence by mediating oxidative stress. These conclusions indicated that extracts of *S. oleraceus* has a potential to be formulated as an anti-ageing agent. [27]

5.2. Antidiabetic Activity

Teugwa CM *et.al.,* (2013) evaluated whole plant extracts of *S. oleraceus* for antioxidant and antidiabetic potential. The antidiabetic activity was assessed in mice using streptozotocin induced diabetes. The hydroethanolic extract of whole plants (150 mg/Kg) exhibited significant antidiabetic activities with 39.40% and 38.48% glycaemia reduction, respectively. [28] Schaffer *et.al.,* (2011) *evaluated* effect of oral administration of infusions at the dose level of 100mg/kg b.wt. and esculetin at the dose level of 6mg/kg b. wt for 4 weeks on the impaired oral glucose tolerance, insulin secretory response, serum lipid profile and oxidative stress in streptozotocin-induced diabetic rats. The treatment of diabetic rats with *S. oleraceus* infusions and esculetin resulted in a marked amelioration of the impaired glucose tolerance at all examined periods after oral glucose loading and the lowered insulin and C-peptide levels. The impoverished liver glycogen content and elevated liver glucose-6-phosphatase and serum AST and ALT activities of fasting diabetic rats were profoundly corrected as result of treatment with plant infusion and esculetin. Also, these treatments lead to improvement in serum lipid profile indicated by that decrease in serum total lipid, total cholesterol, triglyceride, LDL-cholesterol and vLDL-cholesterol levels and increase in HDL-cholesterol level. In conclusion, the treatment of diabetic rats with *S. oleraceus* infusions and their active constituent, esculetin improved the diabetic state and antioxidant defense system. [29]

5.3. Anxiolytic Activity

Vilela *et.al.,* (2009) evaluated the effect of hydroethanolic and dichloromethane extracts of *S. oleraceus* in mice submitted to the elevated plus-maze and open-field tests. Here clonazepam was used as the standard drug. In the elevated plus-maze test, the *S. oleraceus* extracts increased the percentage of open arm entries and time spent in the open-arm portions of the maze ($P < 0.05$). The extracts induced an anti-thigmotactic effect, evidenced by increased locomotor

activity into the central part of the open field set-up ($P < 0.05$). The extracts administered at 30–300 mg/kg, p.o. had a similar anxiolytic effect to clonazepam (0.5 mg/kg, p.o.). These statistics concluded that *S. oleraceus* extract exerts an anxiolytic-like effect on mice. [30]

5.4. Anti- Inflammatory Activity

Qi Li *et.al.,* (2017) reported anti-inflammatory activity of aqueous extract of *S. oleraceus.* Extract was used to treat RAW 264.7 cells for 24 h. Pro-inflammatory cytokines and mediators produced in cells were measured. Additionally, in-*vivo* anti-inflammatory activity of the extract was measured using xylene-induced mouse ear oedema model. Extracts significantly inhibited the production of pro-inflammatory cytokines and mediators at gene and protein levels that concluded activity of *S. oleraceus in-vivo* as a significant anti-inflammatory agent. [31] Vilela FC *et.al.,* (2010) evaluated *S. oleraceus for in vivo anti-inflammatory activity.* Carrageenan-induced paw edema, peritonitis and febrile response induced by lipopolysaccharide tests, as well as fibrovascular tissue growth induced by S.C. cotton pellet implantation were used to investigate the anti-inflammatory activity of hydroethanolic extract (SoHE) in rats. The SoHE at test doses of 100–300 mg/kg p.o. clearly demonstrated anti-inflammatory effects by reduction in paw edema induced by carrageenan, inhibited leukocyte recruitment into the peritoneal cavity and reduced LPS-induced febrile response, and in the model of chronic inflammation using the cotton pellet-induced fibrovascular tissue growth in rats, the SoHE significantly inhibited the formation of granulomatous tissue. The extract administered at 300 mg/kg p.o. had a stronger anti-inflammatory effect than indomethacin (10 mg/kg) or dexamethasone (1 mg/kg). The hydroethanolic extract of *S. oleraceus* markedly demonstrated anti-inflammatory action in rats, which supports previous claims of its traditional use. [32]

5.4. Anti-Microbial properties.

Karar MG *et.al.,* (2017) investigated the anti-bacterial, anti-trypanosomal, anti-plasmodial, and antioxidant activities of selected Sudanese medicinal plants using many *in-vitro* assays. Methanolic extracts of various parts of the plants were evaluated against six bacterial strains *(Bacillus subtilis, Bacillus aquimaris, Clavibactermichiganensis, Escherichia coli, Erwiniaamy lovora, and Pseudomonas syringae)* using minimal inhibitory concentration (MIC) methods. The anti-plasmodial activity was tested against a chloroquine sensitive strain of *Plasmodium falciparum*, whereas the anti-trypanosomal activity was evaluated against *Trypanosoma brucei rhodesiense*. Antioxidant activity of the plant extracts was measured by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging. Extracts showed antibacterial, antiparasitic and antioxidant activities. *S. oleraceus* was ones with antioxidative, antiplasmodial, anti-trypanosomal and antibacterial activities. [33] Li W *et.al.,* (2015) *evaluated* antibacterial and anti-oxidant characteristics of traditional aqueous extracts derived from traditional Chinese medicinal plant (*S. oleraceus*). Results indicated that *S. oleraceus* showed the highest antibacterial value, especially against *Staphylococcus aureus*. The Minimum Inhibitory concentration (MIC) of the *S. oleraceus* was 5.0 mg/mL that was in-correlation with the high total phenolic and flavonoid contents. [34] Sharma *et.al.,* (2006) reported the larvicidal potential of petroleum ether, carbon tetrachloride and methanol extracts of *S. oleraceus* against malaria parasite, *Anopheles stephensi* Liston. Significant larvicidal activity was observed in extracts of *Sonchus oleraceus*. [35]

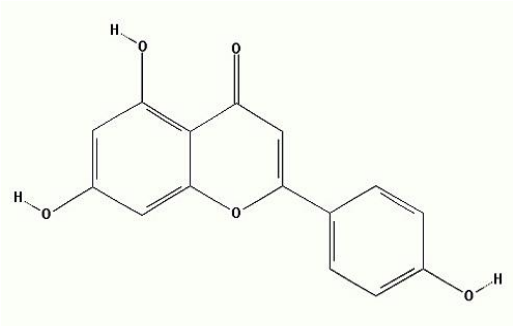
5.5. Antinociceptive activity.

Alves-da-Silva G *et.al.,* (2009) carried out a study to establish antinociceptive properties of hydroethanolic and dichloromethane extracts from aerial parts of *S. oleraceus* in mice using chemical and thermal models of nociception. To investigate antinociceptive activity in mice formalin, hot plate, tail immersion tests as well as acetic acid-induced writhing were used. Given orally, the extracts at test doses of 30–300 mg/kg, produced significant inhibitions on chemical nociception induced by intra-peritoneal acetic acid and sub plantar formalin since it decreases the number of writhing episodes and the time licking. Extracts treatment with the same doses produced a significant increase of the reaction time in tail immersion and in the hot plate test. The extracts administered at 300 mg/kg, p.o. had a stronger antinociceptive effect than indomethacin (5 mg/kg, p.o.) and morphine (10 mg/kg, p.o.). Results concluded that extracts of *S. oleraceus* markedly established antinociceptive action in mice. [36]

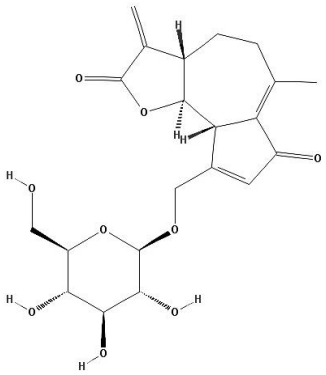
6. PHYTOCHEMICALS DETECTED IN *S. OLERACEUS*

S. oleraceus contains variety of phytochemical compounds such as sesquiterpene lactones of the eudesmanolides and guaianolide structures. It also contains flavonoids, flavonols, proanthocyanidins, total

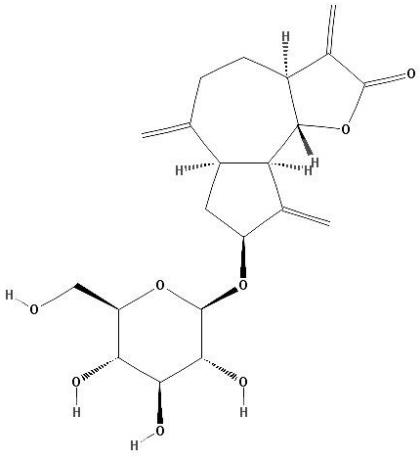
phenols, saponins, and alkaloids. High concentration of fatty acids, vitamin C, carotenoids, oxalic acid, and high mineral contents is found in this plant which gave high value in as nutritional supplements. [37] Literature reveals that various phytoconstituents have been isolated in the past are given in (Fig 2). Govindappa M *et.al.,* (2015) isolated and characterized coumarin from *S. oleraceus*. [38] Miyase T *et.al.,* (1987) reported isolation and established structures on the basis of chemical and spectral data of four new sesquiterpene glycosides, sonchusides A, B, C and D from *S. oleraceus.* Additionally, five known glycosides were also reported that are glucozaluzanin C, macrocliniside A, crepidiaside A and picrisides B. [39] Elkhayat ES (2009) described phytochemical investigation and biological evaluation of the isolated compounds. He isolated monoterpeneloliolide 1 for the first time from the genus Sonchus , in addition to 15-O- β -glucopyranosyl-11 β ,13-dihydrourospermal A , Ursolic acid , lupeol and β -sitosterol-3-O-glucopyranoside.[40] Xu Y *et.al.,* (2005) isolated and characterized ten compounds elucidated structure of luteolin (I), luteolin-7-O-β-D-glucoside (II), apigenin (III), apigenin-7-O-β-D-glucuronide methyl ester (IV), apigenin-7-O-β-D-glucuronide ethyl ester (V), apigenin-7-O-β-D-glucopyranuronide (VI), germanicyl acetate (VII), 3β-hydroxy-6β, 7α, 11β-H-eudesm-4-en-6, 12-olide (VIII), oleanolic acid (IX) and 1-cerotol (X) from *S. oleraceus*. [41] Bai YH *et.al.,* (2008) reported extraction and isolation of chemical constituents by column chromatography and preparative HPLC. Here six compounds were isolated and structure elucidated as lupeol(I), α-amyrin(II), β-amyrin (III), ursolic acid(IV), oleanolic acid(V), and betulinic acid(VI).[42] Ibrahim F *et.al.,* (2015) identified eighteen compounds from *S. oleraceus* such as Ethyl linoleate 43.05 %, (E)-9-Octadecenoic acid ethyl ester.[43] Mercadante AZ *et.al.,* (1990) studied the composition of carotenoids in *S oleraceus*.[44]



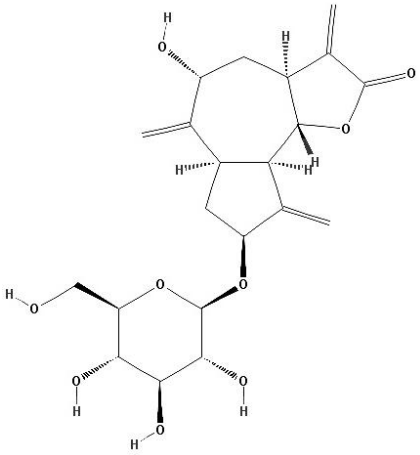
a) Apigenin



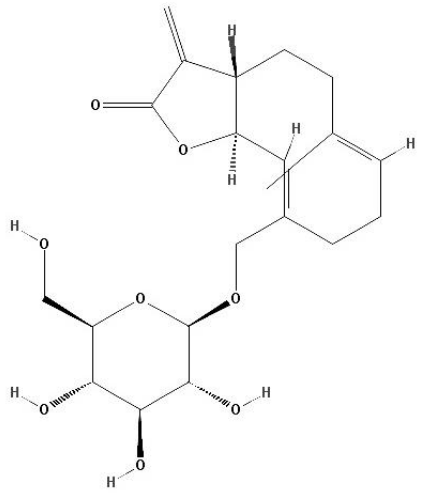
b) Crepidiaside A



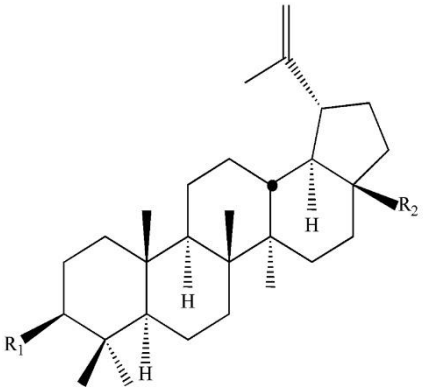
c) Glucozaluzanin C



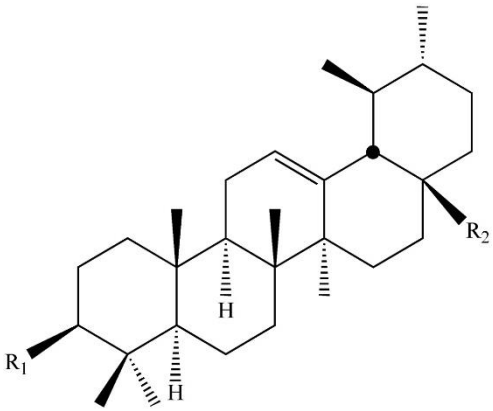
d) Macrocliniside A



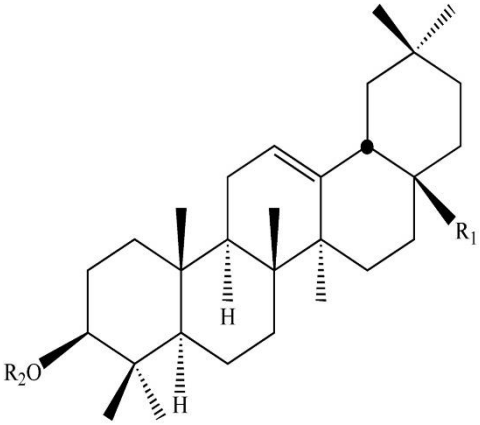
e) Picrisides B



Lupeol(R1:B-OH ;R2:CH3),
Betulinic acid(R1:B-OH ;R2:COOH)
f) Lupeol and Betulinic acid



Ursolic acid ; (R1:β-OH ;R2:COOH)
α-Amyrin (R1:β-OH ;R2:CH3)
g) Ursolic acid and α amyrin



Oleanolic acid (R1: COOH;R2: H)
β-Amyrin (R1:CH3 ;R2: H)
h) Olenolic acid and Beta Amyrin

Fig 2. Phytoconstituents of *S oleraceus.*

7. DECLARATION OF INTEREST

The authors declare that they have no conflict of interest.

8. CONCLUSION

The objective of the review was to show current advances in the phytochemical and pharmacological investigation of *S. oleraceus* as a prognostic therapeutic agent. According to the literature review, it is uncovered that the species possesses pharmacological activities such as antioxidant, antidiabetic, anti-inflammatory, antipyretic, antinociceptive, anxiolytic, cytotoxic and antibacterial activity. It could be advised that sesquiterpene lactones, guaianolide, flavonoids, flavonols, proanthocyanidins, total phenols, saponins and alkaloids might be valuable as a lead in the development of new drugs to treat various diseases. A number of pharmacological and ethnomedicinal properties found in various investigates might be useful in development of novel medications. Therefore, extensive pharmacological and phytochemical analysis, experimentations, together with pharmacokinetic, toxicological studies will be a focus for forthcoming investigation. This review article emphasizes on the potential of *S. oleraceus* that can be employed in new therapeutic drugs and will offer the base for future research on the application of herbal medicines.

9. ACKNOWLEDGEMENT

The authors express profound gratitude to Mr. Albert W. D'Souza, Chairman Adel Education Trust and Dr. Savita J. Tauro, Deputy Campus Director and Principal, St. John Institute of Pharmacy and Research, Palghar for generous support, motivation, encouragement and providing necessary facilities to carry out the present review paper.

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Received:02.05.18, Accepted: 05.06.18, Published:01.07.2018

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