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Research Review

Pharmacological Potential of Volatile Oil and Extract of *Anethum sowa* L.: A Review

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A B S T R A C T

Anethum sowa L. a variant of *Anethum graveolens* called East Indian Dill or Sowa, found in India, cultivated for its foliage as a cold-weather crop has been investigated less and that could be a great loss in unleashing lead drug molecules with various potential in the field of Medicine. Intense analysis of literature on PubMed and Google Scholar databases regarding the different pharmacological potential of essential oil and extracts of *Anethum sowa* L. is never documented together and is first of its kind which would give the researchers much quicker understanding on the different pharmacological studies explored with this therapeutic multipurpose herb. There is always a need for a systematic and detailed review to identify this plant's current potential in various medicine systems. Herb extract of *Anethum sowa* L. is studied more than herb oil, seed extract, and seed oil. Among the different therapeutic applications investigated with *Anethum sowa* L. it is used mostly in the Ayurvedic system of medicine.

***Key words*:** *Anethum sowa* L, Anticancer, Antioxidant, Anti-inflammatory, Gynecological, Food preservation

Anethum sowa L. belongs to the family of Apiaceae, commonly referred to as Sowa. Anethum springs from the Greek word Anesoon which suggests strong-smelling [1]. It has a long history of herbal use, going back to 2000 years. The *Anethum sowa* L. herb rises to 76cm, with small fluffy leaves, and stands on casing foot stalks with linear and jagged leaflets. The stem is erect, branched, cylindrical, and striated, smooth, and pale green. *Anethum sowa* L. is found in India, primarily in Punjab, Gujarat, Maharashtra, Assam, West Bengal, Rajasthan, and South Karnataka [3]. For the last ten years, *Anethum graveolens* study is done extensively when compared to *Anethum sowa* L. In *Anethum sowa* L. the reviews were based on seed essential oil, seed extract, herb essential oil and herb extract and it is observed that, herb extract of *Anethm sowa* L. was quite popular in reference to pharmacological studies. In the pharmacological studies, the relevance to its application was in reference to antimicrobial, antioxidant, Unani, anticancer, anti-inflammatory, gynecological, cosmetic, food, antidiabetic, antihypercholesterol and ayurvedic studies and is extensively studied in Ayurveda.

Essential oil and fatty acid configuration of Anethum sowa L.

Essential oils are volatile mixtures of plant-derived secondary metabolites [4]. They are traditionally used all over the world. Dill oil has its usage mainly in the food industry. Aromatic oils are found in all the various parts of the plant and have been used for thousands of years as incense, perfumes, cosmetics and also for their medicinal and Culinary applications [5]. They are traditionally used all over the world. Dill oil has its usage mainly in the food industry.

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Seed oil

Agarwal in (2002) had investigated and reported that carvone optical isomers had potential antimicrobial property. R-(+)- isomer of limonene and carvone in *Anethum sowa* seed volatile oil were comparatively more active concerning its killing properties against bacteria and fungi [6]. In the year 2007, Saleh-E-In-a and team investigated the fatty acid composition of *Anethum sowa* L. seed and the oil extracted which was made free of essential oil and extracted by Soxhlet had fatty oil of around 9.36%. Six fatty acids were identified, and among them, Oleic acid was the maximum. *Anethum sowa* L. seed exhibited antibacterial potentials against *S. aureus MRSA* and *Enterococcus Sp.* as determined by agar well diffusion and TLC Bioautography [2]

Herb oil

The dill herb oil and stem oil had alpha phellandrene, about 60% which was the lead molecule contributing to the fresh herbal character of the leaf oil [7-8]. The essential oil composition of the root of *Anethum sowa* L, consisted of palmitic and linoleic acid (33.81 and 30.03%). Phenylpropanoids contributed to the main compounds of the basis of volatile oil [9]. *Anethum sowa* L flower parts had monounsaturated fatty acid, which was about 51.93%. The palmitic acid content in flower was similar to the root fatty oil content but was more when compared to the seed which had 4.27%. The root carboxylic acid might not be a functional

ingredient in nutrition but shows its potentiality as a valuable source in various pharmacological properties [10].

Root essential oil of *Anethum sowa* L. exhibited marked antioxidant activity in a dose dependent manner. Apiol in the essential oil and its methoxy (-OCH_3) group has been a strong electron-donating group, which enhanced radical scavenging activity. The apiol present in the essential oil had contributed greatly to the antioxidant property [12]. The aqueous extract of the whole plant of *Anethum sowa* L showed an EC_{50} value of 90.24µg/ml whereas the standard gallic acid was 88.42µg/ml. Methanolic Extract of *Anethum sowa* L. herb (leaf and stem antioxidant activity was found to 47.62±1.095, and the standard ascorbic acid showed 39.85±0.025. The total phenol and flavonoid content was 306.34±34TFC mg QE/G and 329.023±0.050 TFC mgQE/G which was moderate when compared to other plants investigated in that study [15]. The Enzymatic antioxidants present on the fresh leaves of *Anethum sowa* L. which included superoxide dismutase (SOD), Catalase (CAT), Peroxidase (POD), glutathione reductase (GR), Catechol oxidase, (CO) and laccase (Lac) as 118.89±5.6, 0.11±0.01, 0.32±0.03, 0.31±0.04, 0.26±0.04, 0.23±0.02 respectively. Non enzymatic antioxidants namely ascorbate, glutathione, flavonoid, total phenol, tocopherol, carotenoids, lycopene and chlorophyll activities were determined as 160.20±0.51mg/ml, 215.82±2.12 (nmoles/g), 91.08±1.02, 132.33±6.13mg/g, 5.91±0.06mg/g, 732.67±5.44mg/g, 37.20±0.49mg/g, 0.48±0.01mg/g. The nonenzymatic antioxidants were important in protecting macromolecules against the action of free radicals. The high content of enzymatic and non-enzymatic antioxidants was found to be present in the fresh leaves of *Anethum sowa* L [16]. *Anethum sowa Roxb ex fleming* procured from Gujarat the hexane extract of the herb showed excellent antioxidant activity of 29.391±0.477 at 0.6 mg /ml concentration by DPPH radical scavenging assay [19-20]. *Anethum sowa* L. root methanol, ethyl acetate and chloroform extracts exhibited high antioxidant activity with an IC_{50}=13.08±0.03, 33.48±0.16 and 36.42±0.4µg/ml respectively [9].

Seed of *Anethum sowa* L. showed antioxidant activity, determined by DPPH method which was reported as 1.22±0.411mg/ml. 0.0018mg/ml concentration of Lupeol was obtained quantitatively by HPTLC method in the extract [21]. Another study done in Gujarat on the methanolic extract of *Anethum sowa* seed detected 1.98% of Eugenol and 3.67% of the total Tannis [22]. *Anethum sowa* L seed hexane extract of seed showed a good amount of antioxidant activity the percentage of total phenol, FRCA and DPPH activity was found to be 0.0675±0.0082%, 44.57±0.15%, 29.391±0.477 [23]. The dicholoromethane had exhibited an IC_{50} of 7.44±0.93µg/ml and possessed the highest phenolic content of 90.03±1.09 mg of gallic acid equivalent /gm of the dried seed extract [17].

Anticancer

Anethum sowa L. seed essential oil exhibited potential anticarcinogencity and showed LC_{50} 46.41 (µg/ml), root oil (LC_{50}0.81µg/ml) which was very much comparable with standard vincristine LC_{50} which was 0.48µg/ml. Apiol, a central component in the essential oils of *Anethum sowa* L., has been credited for its anticancer ability on cells (CoLo-205), human chronic myelogenons leukemia lung tumor, and breast adenocarcinoma cell line activity. This activity could be due to the allyl –(C_3H_5) and methoxy (-OCH_3) functional groups [11-13]. The phytochemical compounds such as physcione, B-sistosterol, stigmasterol, 2-oxo-3propyl-2H-Chromene-7-carboxylic acid, bergapten,3-ethyl-7-hydroxy-2H-chromen-2-one and graveolens were extracted from the root extracts of *Anethum sowa* L. and out of these compounds physcione and bergapten were predicted with drug like compounds targeted towards cancer therapy [14]. The cytotoxic activity of aqueous extract of the whole plant of *Anethum sowa* L. showed LC_{50} value 62.44µg/ml and the standard vincristine sulfate showed LC_{50} 0.52 µg/ml by brine shrimp lethality bioassay. Methanolic extract of the *Anethum sowa* herb (stem and leaf) showed an LC_{50} value greater than 1000µg/ml by brine shrimp lethality bioassay indicating the nontoxic effect, which was contradicting to the other results obtained by studies [15]. *Anethum sowa* L. root, methanol extract showed very prominent LC_{50} 5.03µg/ml, with 100% mortality [16]. The cytotoxic activity could have been contributed by steroids, flavanoids, saponins [9]. *Anethum sowa* L. seed methanolic extract showed an LC_{50} of 7.89±0.21µg/ml which demonstrated the quite potent cytotoxic effect by brine shrimp lethality bioassay [17]. The *Anethum sowa* L. seed induced to *salmonella typhimurium*, strains TA98 and TA100 mutagenicity. Carcinogenicity could not be observed in strain ACI rats which have been fed with *Anethum sowa* L. seed diets [18].

Anti-inflammatory

Limonene which had been an important component in the *Anethum sowa* L. oil, could suppress cytooxygenase -1 & 2 pathways and reduce the release of inflammatory mediators [24]. Reactive oxygen species has a strong correlation with the inflammatory responses. *Anethum sowa* L. has excellent antioxidant potential which might be helpful in neutralizing the bad effects of the ROS. *Anethum sowa.* L herb oil constituent Myristicin exhibited the potential to inhibit lipopolysaccharide and D-galactosamine induced serum Tumour Necrosis factor-alpha concentration in mice [25]. The anti-inflammatory property of ethanolic extract *of Anethum sowa* L. plant have been studied in vivo by orally administrating it to albino rats and it significantly inhibited the effect of the carreggenan induced edema in rats in all the doses (100, 200, and 400mg/kg body weight) when compared to the normal saline control and std indomethaethacin. The activity resided more at higher doses of 400 mg/kg with 63% inhibition after 4 hours of extract administration [26-27]. A polyherbal formulation Arthritin consisted of extracts of *Anethum sowa* L. along with other plants which caused a decrease in serum lipid peroxidase and possessed a significant anti-inflammatory activity, with significant increase in SOD & GTx. Polyherbal formulation contained various phytochemicals, including phenols, flavonoids, terpenoids, alkaloids, and glycosides, which played a crucial role in scavenging the radicals [28]. *Anethum sowa* L. seed ethyl acetate had exhibited its potential in blocking RBC lysis which had played an essential role and had rendered anti-inflammatory potential to the plant [29]. *Anethum sowa Roxb* seeds 400 mg/kg chloroform extract, when orally administered before rats have been injected with 0.1% Carrageenan in normal saline showed 60.077% maximum inhibition of inflammatory activity [48].

Anti-hemolytic

Dichloromethane and ethyl acetate extracts of the Seed of *Anethum sowa* L. exhibited higher percentage inhibition of the haemolysis which was about 82.3±1.03% and 92.4±1.01 respectively as compared with that of the standard acetyl salicylic acid that inhibited the haemolysis at 77.91±0.29% [29].

Diuretic

The diuretic effects of ethanolic extract of *Anethum sowa* L. plant, increased the urine volume output 60% and increased sodium, potassium and chloride levels when compared to that of the control. 400 mg/kg dose showed 63% of urine output volume. The phytoconstituent steroid, flavonoid and saponins, might be responsible for diuretic activity [27].

Galactagogue

Anethum sowa L. flower head has been reported to possess various chemical constituents like limonene, estragole, Beta – sistosterol, carvone, Anethole, alpha phellandrene, flavonoids, coumarins, triterpenes, eugenol, phenolic acids, fenchone and Umbelliferones and was reported as *galactogogue* [30].

Gynecology

Anethum sowa Roxb. ex. Flem had been used in amenorrhoea, memorrhagia, hypomenorrhoea, dysmenorrhoea, menopause, dryness of vagina, uterine fibroids and pain in vagina. The presence of phytoestrogens exerted their effect on the selective estrogen receptor modulation and was noted to inhibit the conversion of endogenougenous non-estrogen to estradiol and also possess oestrogen activity which had the potential in reducing the menopausal signs and symptoms. The dryness of the vagina issue could also be resolved with a rise in the estrogen levels which when supplemented with a tampon of Shatapushpa tail. The hypolipidemic and hypocholesterolaemia potential of satapusha helps maintain BMI and helps in the HPO axis and the rectification of the menstrual cycle [31]. Satapushpa could act as emenogue and relieves dysmenorrhoea which was due to the inhibition of prostaglandins production. Pelvic inflammatory disease, presence of haemorrhagic, discharges from the vagina could be corrected by the presence of tannin in the satapusha [32-34]. *Anethum sowa* L. had molecules like limonene which exhibited contractive capacity on the uterine myometrium, anethole also had been reported to play a crucial role in rendering the same effect. The seed extract of the plant was proved to be effective in decreasing postpartum haemorrhage [39]. The lipid content of shatapusha may also help in correcting problems responsible in infertility [35]. Shatapuspha fruit powder in a dose of 3g was reported to be used in disorders of female genital tract. Oral administration of the *Anethum sowa* L. diminished HCl-induced gastric lesions in mice [36].

Anti-amylase

Anethum sowa L. whole plant. aqueous extract had shown potent antiamylase activity with an IC_{50} value of 72.34µg/ml, when compared to acarbose IC_{50}value 82.72 µg/ml [15]. Methanol extract of *Anethum sowa* L. herb (leaf and stem) had outstanding alpha-amylase inhibition with IC_{50} Value 76.78±200µg/ml [16].

Antidiabetic

In vitro antidiabetic activity of *Anethum sowa* L. seed methanolic extract was investigated by starch iodine assay and 3,5-dinitrosalicylic acid method. IC_{50} was 252.9±0.5µg/ml and 0.236±0.04mg/ml respectively which showed the antidiabetic activity [21]. Ethanolic extract of the fruit of *Anethum sowa* L. contained phytochemicals with antidiabetic activity which included tannins, cardiac glycosides, and had been reported for its antidiabetic property. The fruit ethanolic extract has been used for the treatment of diabetes [37-38]. The animal study done on swiss albino mice models showed that the extracts, mainly dichloromethane and ethylacetate of the stem and the seed of *Anethum sowa* L., exhibited moderate blood-glucose-lowering effect [29].

Thrombolytic

The Thrombolytic activity screening could play a crucial role in the discovery of Cardioprotective drugs. The percentage of clot lysis of 100 µl of *Anethum sowa* L. stem and seed ethylacetate extract were found to be 45.3% and 43.77% respectively. The standard streptokinase exhibited 66.7% clot lysis [29].

Ayurvedic

Trayodashang Guggulu: An ayurvedic formulation which had *Anethum sowa Kurz* 1 part in the formulation showed good anti-inflammatory properties when tested for the extend of protein denaturation [39]. Studies done on human subjects with various PCOS symptoms supplemented with Polyherbal formulation containing *Anethum sowa* extract as one among the seven other plants had been found effective as 27.77% of patients showed complete improvement, reduction of pain, obesity, and menstrual irregularities [40]. *Anethum sowa* fruit 1 part was one of the ingredients in the aqueous extract of Maharasnadi Kwath polyherbal formulation, which showed an excellent antioxidant activity of 94% at a concentration of1000µg/ml with an IC_{50} value of 395µg/ml. The anti-inflammatory effect was evaluated against the BSA denaturation method. The IC_{50} value of Maharasnadi was 19,758µg/ml and aspirin as standard had IC_{50} 8877µg/ml and it also had contributed with antiarthritic activity [41]. A clinical trial was done on Oligomenorrhoea patients when administered with Satapuspa seed in the form of churn for three months in a dose of 5 g twice a day with cow grita showed positive effect with satapusa churna. 20% cases showed a maximum improvement, moderate improvement in 60% of the cases followed by 16.67% and 3.33% cases showed mild and unsatisfactory results [31]. Parts of Satapusha mixed with rock salt and ghee was used for local application to counteract bees poison (Bhela Samhita Vishal/216). Satapusha has been reported as the one drug mentioned in Madhuraskandha. The taste threshold was 3500 (Madhuratam). The amount of sugar estimated was 6.2g/100g. The presence of various phytochemicals in the methanolic extract of dried fruit of shatapushpa was alkaloids, carbohydrates, tannis, terpenoids, flavonoids, proteins [42].

Analgesic, antidiarrheal and antidepressant activity

Dichloromethane stem and seed methanol extract of *Anethum Sowa* L. at 200 mg/kg exhibited analgesic effect on swiss Albino rats. *Anethum sowa* L. stem hexane and ethyl acetate extracts at the dose of 400 mg/kg had antidepression and antidiarrheal potential [29].

Antimicrobial

Anethum sowa L. root essential oil has antimicrobial activity against gram negative bacteria. *Ecoli 2799* showed the maximum inhibition zone followed by *Pseudomonas aeruginosa*, their effects were more in comparison with antibiotic tetracycline and lower than ciprofloxacin. MIC and MBC of the essential oil were within concentration ranges from 62.5- 250µg/ml and 125 to 500µg/ml respectively. The root essential oil 800µg/well showed promising antifungal activity against *Aspergillus niger* [12]. Ethyl acetate

extract of *Anethum sowa* L. root at 1200µg/ml and 2000µg/ml showed potential antimicrobial property against gram positive bacteria. Chloroform extract of the *Anethum sowa* L. root was potent enough to inhibit *Enterococcus faecalis, Ecoli 2799,* and *acetobacter aceti*, whereas, hexane extract had activity against *Bacillus*. The antimicrobial compounds in the ethyl acetate extract included flavonoids, alkaloids, Steroids, Glucosides, Cardiac glycosides, Anthraquinone glycosides, steroids, and Tannis. Chloroform and methanol extract was active against *Candida albincas* at MIC and MBC of 250 & 500 µg/ml [9]. Disc diffusion method reported that *Anethum sowa* L. stem hexane extract and seed dichloromethane methanol extract 400 µg/disc inhibited all the bacteria belonging to *Bacillus, Staphylococcus, sarcina species, Ecoli, Vibrio mimicus, Shigella dysenteriae, Pseudomonous aeruginosa, Salmonella typhi, Salmonella paratyphi* which were gram negative [17]. Ethanolic and butanol extracts of *Anethum sowa* L. different parts exhibited good antimicrobial activity *against Ecoli, Cogulase* (+ &-) *Satphylococci, Pseudomonas aeruginosa, Enterococci* and had antifungal activities against *Candida species* [1].

Food science application

Anethum sowa L. herb is used for flavouring salads, pickled vegetables. The food industry had preferred using essential oil when compared to fresh herbs and also it had been used as condiments and tea [3]. *Anethum sowa* L. herb essential oil had been reported to exhibit antimicrobial properties to bacteria like *Escherichia coli, Staphylococcus, Streptococcus* and *Pseudomonas* [30]. Soup Fortified with *Anethum sowa* L. leaf when extracted with aqueous and methanol showed increased level of phenolics with AESM-, AESM+, MESM- & MESM+ showed 1.40±0.02mg/g, 1.70±0.03mg/g, 0.46±0.01mg/g, and 1.06±0.01mg/g respectively. *Anethum sowa* L. Fortified soup had 2.5 times (aqueous) and 7 times (methanol) more reducing potential when compared with soup which was not fortified. IC_{50} values of the fortified soup were reduced from 16.5to 3.8µg/ml in aqueous and from 9.1 µg/ml to 3.9 µg/ml in methanolic extracts. The phenolics of *Anethum sowa* L. were more potent than tannic acid with respect to the IC_{50} value, which was 0.60µg/ml found to be far less than the standard tannic acid, which had an IC_{50} of 2.30 µg/ml. FRS activity expressed significant improvement which was evident in AESM+ and MESM+ compared to the soup mix without *Anethum sowa* L. [43]. *Anethum sowa* L. 20% extract showed preservative effect on tuna fillets treated with it, with a total plate count and TBA value of 8.13±0.03 logcfu/g, and 1.2 ±0.01mgMDA/100g respectively, whereas the control showed 8.67 log cfu/ and TBA value of 8.41±0.01mg MDA/100g. An outstanding sensory value of 6.51±0.10 was given for the tuna treated with *Anethum sowa* L. by the end of 13 days storage, proving that the microbial spoilage rate was delayed and the shelf life was extended [44].

Herbal feed additive

The male beetal kids fed with herbal feed supplemented with 2% *Anethum sowa* L. seed dry extract exhibited a higher fraction of nitrogen in the rumen. The ready to cook carcass expressed on a weight basis or as a percentage of live weight basis were significantly improved in the *Anethum sowa* L. fed group. The initial body weight was 15.9±0.53 and after 90 days, it was 19.45, whereas the control animals showed only 16.72. Supplementation of total mixed rations with *Anethum sowa* L. seed dry extract increased fermentation efficiency resulting in higher VFA production. The carcass yield was improved significantly with the dietary supplementation of *Anethum sowa* L [45].

Important molecules in Anethum Sowa

Sabinene, alpha - Pinene, alpha phellandrene, myrcene, limonene, para- cymene, alpha -thujene, carvone, had been reported to possess Galactopoietic effect [46]. The active polyphenols played an important role in contributing to the plant's various potentials like antioxidant, antimicrobial, antiallergic, hypolipidemic, anticancer, antimutagenic hepatoprotective, immune- modulators and cardioprotective [47]. Detoxifying enzyme gluthione S transferase induction was produced by limonene, carvone and anethofuran which had been reported in several mouse target tissue. Apiol was found to be effective to treat Mylasis [36].

CONCLUSION

Anethum sowa L. herb extracts are widely used when compared to the essential oil of this aromatic multipurpose herb with a wide range of its application in medical and food field and needs to be explored for its cosmetic potential and human skin fibroblasts cell line studies which would unleash its potential as plant containing antiaging molecules as they are rich in polyphenols and also has potent antioxidant potential in removing free radicals.

LITERATURE CITED

1. Mathur R. 2012. Antimicrobial potential and phytochemical analysis of plant extracts of *Anethum sowa*. *International Journal of. Current Research Review* 4: 55-59.
2. Saleh-E-In MM, Roy SK. 2007. Studies on fatty acid composition and proximate analyses of *Anethum sowa L*. (dill) seed. *Bangladesh Jr. Sci. Ind. Research* 42: 455-464.
3. Charles DJ, Simon JE, Widrlechner MP. 1995. Characterization of essential oil of Dill *Anethum graveolens* L. *Journal of Essential Oil Research* 7: 11- 20.
4. Sabulal B. 2012. Chemical composition and antimicrobial properties of essential oils from India. *In*: (Eds) L. Valgimigli, Essential oils as natural food additives. Composition, applications, antioxidant and antimicrobial properties. Nova Science Publishing, New York. pp 173-265.
5. Julia L. 2014. *The Encyclopaedia of Essential Oils*. Harper Collins Publishers.
6. Aggarwal KK, Khanuja SPS, Ahmad A, Kumar TRS, Gupta VK, Kumar S. 2002. Antimicrobial activity profiles of the two enantiomers of limonene and carvone isolated from the oils of *Mentha spicata* and *Anethum sowa*. *Flavour Fragr. Journal* 17: 59-63.
7. Raghavan B, Abraham KO, Shankaranarayan ML, Koller WD. 1994. Studies on flavour changes during drying of Dill (*Anethum sowa*. Roxb) Leaves. *Jr. Food Quality* 17: 457-466.
8. Blank I, Grosch W. 1991. Evaluation of potent odorants in dill seed and dill herb (*Anethum graveolens*) by aroma dilution method. *Jr. Food Science* 56: 63-67.
9. Saleh-E-In MM, Sultana N, Hossain MN, Hasan S, Islam Md. 2016. Pharmacological effects of the phytochemicals of *Anethum Sowa* L. root extracts. *BMC Complement Alternative Medicine* 16: 1-14.

10. Saleh-E-In MM, Roy SK, Islam MR. 2009. Fatty acid composition of dill (*Anethum sowa* L.) flower. *Jahangirnagar University Journal of Science* 32: 1-8.
11. Bajracharya GB, Tuladhar SM. 2011. Brine shrimp bioassay for assessment of anticancer property of essential oils from spices. *Nepal Journal of Science and Technology* 12: 163-170.
12. Saleh-E-In MM, Sultana N, Rahim MM, Ahsan MA, Bhuiyan MNH, Hossain MN, Rahman MM, Roy SK, Islam MR. 2017. Chemical composition and pharmacological significance of *Anethum sowa* L. root. *BMC Complement Alternative Medicine* 17: 1-17.
13. Stefano VD, Pitonzo R, Schillaci D. 2011. Antimicrobial and antiproliferative activity of *Athamant asicula* L. (Apiaceae). *Pharmacogn. Mag*. 7: 31-34.
14. Saleh-E-In MM, Roy A, Al – Mansur MA, Hasan CM, Rahim MM, Sultana N, Ahmed S, Islam MR, Staden JV. 2019. Isolation and Insilico prediction of potential drug like compounds from *Anethum sowa* L. root extracts targeted towards cancer therapy. *Comput. Biol. Chem.* 78: 2259.
15. Kumar RV, Shashidara S, Anitha S. 2011. Invitro antioxidant, antiamylase, anti -Arthritic and cytotoxic activity of important commonly used green leafy vegetables. *Int. Jr. Pharmtech. Research* 3: 2096-2103.
16. Alam N, Sharma KR. 2020. Estimation of Phenol and flavonoid content, Antioxidant and alpha – Amylase inhibitory activity of some selected plants from Siraha district Nepal. *Asian Jr. Pharm. Clin. Res*. 13: 18-23.
17. Al-Mansur MA, Saha K, Sultana N, Siddiq MM. 2016. Comparative studies on cytotoxic antibacterial and antioxidant activity among different extracts of the seed and stem of *Anethum sowa* L. available in Bangladesh. *World Jr. Pharm. Med. Research* 5: 1-10.
18. Fukuoka M, Yoshihira K, Natori S, Sakamoto K, Iwahara S, Hosaka S, Hirono I. 1980.Characterization of mutagenic principles and carcinogenicity test of dill weed and seeds. *Jr. Pharm. Research* 3: 236-244.
19. Jagathambal M, Padma PR. 2016. Comparison of enzymatic and nonenzymatic antioxidant status in the leaves of five selected plants from Apiaceae family. *Int. Jr. Pharmtech. Research* 6: 1-3.
20. Riddhi MP, Yogesh TJ. 2012. Antioxidant activity of Medicinal spices and aromatic herbs. *Ann Phytomed*. 1: 75- 80.
21. Tripathi IP, Pathak V, Shukla PK, Dwived R. 2016. Antioxidant , Antidiabetic , potential and quantification of Lupeol in Methanolic extract of *Anethum sowa* Linn(seed). *Int. Jr. Curr. Res.* Chem. *Pharmacy* 3: 29-36.
22. Pathak V, Dwivedi R, Shukla. 2014. Pharmacognostical study of *Anethum sowa* Dill seed. *Int. Jr. Rec. Biotechnology* 2: 6-14.
23. Patel RM, Tasrai YT. 2015. Antioxidant activity screening of some common Indian Apiaceae family spice plants. *CIB Tech. Jr. Pharma. Science* 4: 43-50.
24. Leiro J, Alvarez E, Arranz JA, Laguna R, Uriarte E, Orallo F. 2004. Effects of cis-resveratrol on inflammatory murinemacrophages: antioxidant activity and down-regulation of inflammatory genes. *Jr. Leukoc. Biology* 75: 1156-1165.
25. Kaur C, Kapoor HC. 2001. Antioxidants in fruits and vegetables: The millennium's health. *International Journal of Food Science and Technology* 36: 703-725.
26. Wahab AE, Wassel SM, Ammar GM, Hanna NM. 1987. Flavonoid's constituents in different organs of selected Bauhinia species and their effect on blood glucose. *Herba Hungarica* 26(1): 27-39.
27. Singh P. 2019. Anti-inflammatory and diuretic property of *Anethum sowa* in swiss albino rats. *Jr. Emerg. Technol. Innov. Res.* 6: 909-916.
28. Chamundeeswari D, Vaijayanthi V, Umamaheswari S, Gandhimathi C. 2006. Antioxidant activity of Arthritin – a poly herbal formulation. *Indian Journal Exp. Biology* 44: 403-407.
29. Al-Mansur MA, Alisiddiqi MM, Saha K. 2018. Analgesic Anti diarrheal and antidepressant activities of *Anethum sowa* Linn in swiss Albino rats. *Bangladesh Pharm. Journal* 21: 1-6.
30. Jana S, Shekhawat GS. 2010. *Anethum graveolens*- An Indian traditional medicinal herb and spice. *Pharmacogn*. 4: 179-184.
31. Mewara H, Mewara J, Chauchan PA. 2019. Review of Shatapushapa and its mode of action in gynaecological disorders. *Int. Jr. Res. Anal. Review* 6: 443-448.
32. Sharma PC, Yelne MB, Dennis TJ, Joshi A, Billore KV. 2001. Database on medicinal plants used in Ayurveda. Council for Research in Ayurveda and Siddha. New Delhi. pp 1-3.
33. Hosseinzadeh H, Reza K, Ameri M. 2002. Effects of *Anethum graveolens* L. seed extracts on experimental gastric irritation models in mice. *BMC Pharmacology* 2: 21.
34. Arora DS, Kaur JG. 2007. Antibacterial activity of some Indian Medicinal plants. *Jr. Nat. Medicine* 61: 313-317.
35. Nagamani J, Suresh J, Ahuja VR. 2012. Comparative phytochemical screening of Vatashunga, Shatavari and shatapusha claimed for Prajasthapana activity. *Ann. Biol. Research* 3: 1294-1304.
36. Jain A, Garg N. 2017. Therapeutic and medicinal uses of Shatapushapa A review. *World Jr. Pharm. Pharm. Science* 6: 336-342.
37. Lakshmi KR, Supraja M, Mounika M, Babu PS. 2016. A review on hypoglycemic activity of different extracts of various medicinal plants. *Int. Jr. Pharm. Sci. Research* 7: 3178-3184.
38. Kumar S, Saini M, Kumar V, Prakash O, Arya R, Rana M, Kumar D. 2012. Traditional medicinal plants curing diabetes: A promise for today and tomorrow. *Asian Jr. Traditional Medicine* 7: 178-188.
39. Sahiti M, Gurupadayya BM, DineshTK.2019. Evaluation of *In vitro* anti-inflammatory activity of *Trayodashang guggulu*: An Ayurvedic formulation in comparison with allopathic drugs. *Int. Jr. Res. Ayurveda Pharmacy* 10: 92-96.
40. Despande S, Moundekar K, Malekar S. 2013. Effect of polyherbal formulation in treatment of polycystic Ovarian Syndrome, IOSR. *International Journal of Pharm. Biology* 5: 63-66.
41. Vadore N, Vadore B, Rajgor N. 2020. Antioxidant and anti – sarthritic potential of Ayurvedic formulations Maharasnadi Quath extract and stifain tablet. *Indian Jr. Pharm. Pharmacology* 7: 43-47.
42. Asutkar R, Kadu A, Kharat R, Deogade M. 2017. Physico – chemical and phytochemical analysis of Satapushpa (*Anethum sowa* Linn). A Madhura prabhava drug delineated in Madhura Skandha of Charaka's materia medica. *Jo. in. Sys. Medicine* 5: 61-65.
43. Rekha MN, Yadav AR, Dharmesh S, Chauhan AS, Kamteka RS. 2008. Evaluation of antioxidant properties of dry soup mix extracts containing Dill (*Anethum sowa* L.) leaf. *Food Process Technology* 3: 441-449.
44. Kannaiyan SK, Kannuchamy N, Gudipati V. 2016. Preservative effect of solvent free natural spice extracts on tuna fillets in chilled storage at 4°C: Microbial Biochemical and sensory attributes. *Int. Jr. Fish. Aquat. Studies* 4(6): 20-24.
45. Hundal JS, Wadhwa M, Bakshi MPS. 2020. Effect of supplementing herbal feed additive *Anethum sowa* on nutrient utilization, productive performance and carcass characteristics of male beetal kids. *Anim. Nutr. Technology* 20: 25-38.
46. Bharati SK, Sharmal NK, Gupta AK, Murari K, Kumar. 2012. A pharmacological actions and potential uses of diverse galactogogues in cattle. *Int. Jr. Pharm. Therap*. 2: 24-28.
47. Gibbons S. 2003. An overview of plant extracts as potential therapeutics. *Expert Opin. Ther. Pat.* 13: 489-497.
48. Neelam G. 2018. Experimental evaluation of Anti-inflammatory activity of Satapushpa (*Anethum sowa* roxb) on Carrageenan induced paw Oedema. *International Ayurvedic Medical Journal* 6: 299-301.