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**INDO AMERICAN JOURNAL OF
PHARMACEUTICAL SCIENCES**<http://doi.org/10.5281/zenodo.1215000>Available online at: <http://www.iajps.com>**Review Article****A REVIEW ON PHARMACOLOGICAL ACTIVITIES OF
KOCHIA SCOPARIA- A REVIEW****Ali Esmail Al-Snafi**Department of Pharmacology, College of Medicine, University of Thi qar, Iraq.
Cell: +9647801397994. E mail: aboahmad61@yahoo.com**Abstract:**

Kochia scoparia contained triterpenoid glycosides, alkaloids, saponins, and many other compounds. The stem and leaves of the plant contained essential nutrients such as protein and fiber, carbohydrates, carotene, vitamin C, vitamin B1 and vitamin B2, nicotinic acid, and trace elements. The pharmacological studies revealed that *Kochia scoparia* possessed antibacterial, antiparasitic, anti-cancer, antidiabetic, antioxidant, dermatological, anti-allergic, anti-inflammatory, analgesic, obesity preventive effects and inhibition of renin activity. This review will highlight the chemical constituents and pharmacological effects of *Kochia scoparia*.

Keywords: *Kochia scoparia*, *Bassia scoparia*, chemical constituents, therapeutic, pharmacology, toxicology

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INTRODUCTION:

In the last few decades there has been an exponential growth in the field of herbal medicine. It is getting popularized in developing and developed countries owing to its natural origin and lesser side effects. Furthermore, plants are a valuable source of many secondary metabolites used as pharmaceuticals, agrochemicals, flavours, fragrances, colours, biopesticides and food additives[1-15]. *Kochia scoparia* contained triterpenoid glycosides, alkaloids, saponins, and many other compounds. The stem and leaves of the plant contained essential nutrients such as protein and fiber, carbohydrates, carotene, vitamin C, vitamin B1 and vitamin B2, nicotinic acid, and trace elements. The pharmacological studies revealed that *Kochia scoparia* possessed antibacterial, antiparasitic, anti-cancer, antidiabetic, antioxidant, dermatological, antiallergic, anti-inflammatory, analgesic, obesity preventive effects and inhibition of renin activity. The current review was designed to highlight the chemical constituents and pharmacological effects of *Kochia scoparia*.

Plant profile:**Synonyms:**

Bassia sieversiana [Pall.] W.A. Weber, *Kochia alata* Bates, *Kochia scoparia* [L.] Schrad., *Kochia scoparia* [L.] Schrad. var. *culta* Farw., *Kochia scoparia* [L.] Schrad. var. *pubescens* Fenzl, *Kochia scoparia* [L.] Schrad. var. *subvillosa* Moq., *Kochia scoparia* [L.] Schrad. var. *trichophila* [Stapf] L.H., Bailey, database artifact, *Kochia scoparia* [L.] Schrad. var. *trichophylla* [Stapf] L.H. Bailey, *Kochia sieversiana* [Pall.] C.A. Mey., *Kochia trichophila* Stapf, *Kochia trichophylla* Stapf[1].

Taxonomic classification:

Kingdom: **Plantae**, Subkingdom: **Tracheobionta**, Superdivision: **Spermatophyta**, Division: **Magnoliophyta**, Class: **Magnoliopsida**, Subclass: **Caryophyllidae**, Order: **Caryophyllales**, Family: **Chenopodiaceae**, Genus: *Bassia* [*Kochia*], Species: *Bassia scoparia* [*Kochia scoparia*][16].

Common names:

Arabic: haitham, Sha,r Banat; **Chinese:** di fu; **English:** belvedere, burningbush, kochia, Mexican firebrush, Mexican fireweed, mock cypress, summer-cypress; **French:** ansérine belvédère; **German:** Besenkraut, Besen-Radmelde; **Japanese:** hōkigi; **Korean:** daepssari; **Portuguese:** mirabela; **Spanish:** mirabel; **Swedish:** sommarcypress[17].

Distribution:

It was distributed in Asia [Armenia, Azerbaijan, Russian Federation, China, Japan, Korea, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Nepal, Cyprus; Turkey, Iraq, Kuwait, Saudi Arabia, Afghanistan, Pakistan, Iran, Palestine], Europe [Russian Federation-European part, Belarus, Moldova, Ukraine, Austria, Czech Republic, Germany, Hungary, Poland, Slovakia, Switzerland, Albania, Bulgaria, Croatia, Greece, Italy; Macedonia, Romania, Serbia, Slovenia], Africa [Morocco]; Australasia [Zealand]; Northern America [Canada, United States]; Southern America [Argentina], and it was widely cultivated[16].

Description:

It is an erect, annual herbaceous plant that forms rounded bushes up to 7 ft [2.1 m] tall. The roots can grow at least 8 ft [2.4 m] deep and can have at least an 8 ft [2.4 m] horizontal radius. The alternate leaves are simple and linear to narrowly ovate with entire margins fringed with hairs. They can be up to 2.2 in [5.5 cm] long. They are sessile or have a very short petiole. They have 1-5 prominent veins. The flowers are held in a spike inflorescence. It is formed by clusters of inconspicuous, green, petal-less, stalkless flowers that grow in the axils of reduced leaves. Fruit: The fruit usually has knobby lobes or short horizontal wings. Seeds are egg shaped, flattened, and about 0.04-0.08 in [1-2 mm][18].

Traditional uses:

The dried fruit of *Kochia scoparia*, which is abundant in momordin Ic, has been orally and topically administered for more than 2000 years in China for the treatment of diseases of the skin, urinary tract, and eyes and also used in Japan as a foodstuff[19].

The fruit of *Kochia scoparia* was widely used as a medicinal ingredient for the treatment of dysuria, skin diseases and cancers in China, Japan and Korea. Especially, for breast masses and chest and flank pain[20].

It also used traditionally as a dietary supplement and herbal remedy to treat inflammatory diseases such as osteoarthritis, rheumatoid arthritis, and chronic pain[21].

K. scoparia has been used as a tonic, diuretic, analgesic, and antidote and for the treatment of cutaneous pruritus and thermal skin diseases in traditional Korean preparations[22-23].

Part used: fruit[19-20]

Chemical constituents:

Triterpenoid glycosides, alkaloids, saponins, and many other compounds were isolated from *K. scoparia*[24-26].

The stem and leaves of the plant contained essential nutrients such as coarse protein and coarse fiber, carbohydrates, carotene, vitamin C, vitamin B1 and vitamin B2, nicotinic acid, and essential elements[27-28].

Triterpenoid glycosides were isolated from the fruits of *Kochia scoparia*, included momordin Ic, the 6'-methyl ester of momordin Ic, its 2'-O-beta-D-glucopyranoside, momordin Iic, scoparianosides A, B, and C, 2'-O-beta-D-glucopyranosyl momordin Ic, 2'-O-beta-d-glucopyranosyl momordin Iic, momordin Ib, its 6'-O-methyl ester and oleanolic acid[24-25, 29-31].

Twelve compounds: tectorigenin, pratensein, 5,2'-dihydroxy-6,7-methylene dioxyisoflavone, iriflogenin, 5-hydroxy-6, 7-methylenedioxyflavone, fumalic acid, N-trans-feruloylmethoxytyramine, N-transferuloyltyramine, stigmaterol, oleanolic acid, beta-stigmaterol, daucosterol were isolated and identified from *Kochia scoparia*[32].

A series of flavone glycosides were isolated from *Fructus Kochiae*, including quercetin 3-O-β-d-apiofuranosyl-[1 → 2]-β-d-galactopyranosyl-7-O-β-d-glucopyranoside, quercetin 3-O-α-l-rhamnopyranosyl-[1 → 6]-β-d-galactopyranosyl-7-O-β-d-sophoroside, quercetin 7-O-β-d-glucopyranoside, quercetin 3-O-β-d-apiofuranosyl-[1 → 2]-β-d-galactopyranoside, quercetin 3-O-β-d-galactopyranosyl-7-O-β-d-glucopyranoside, and quercetin 7-O-β-d-sophoroside [33].

Pharmacological effects:**Antibacterial effect:**

The antibacterial activities of EtOH extract of *Kochia scoparia* and its *n*-hexane, EtOAc, *n*-BuOH and water fractions were evaluated against 15 strains of methicillin-resistant *S. aureus* [MRSA] and 1 standard methicillin-susceptible *S. aureus* [MSSA] strain. Antimicrobial activity of *n*-hexane fraction of *K. scoparia* was remarkable. Against the 16 strains, the zone of growth inhibition was in the range of 15-18 mm, the minimum inhibitory concentrations [MICs] were in the range of 7.8 to 31.25 μg/ml and FICI values [(MIC of drug A in combination/MIC of drug A alone) + (MIC of drug B in combination/MIC of drug B alone)] for *n*-hexane fraction of *Kochia scoparia*+ Ampicillin and *n*-hexane fraction of *K. scoparia*+Oxacillin were 0.31 to 0.75 μg/ml and 0.12

to 0.37 μg/ml showing the increase of synergistic effect[34].

Anti-inflammatory and analgesic effect:

The effects of methanol extracts of *K. scoparia* dried fruit [MEKS] was investigated on ear swelling, histopathological changes [such as epidermal acanthosis, spongiosis and immune cell infiltration] and cytokine production in 1 fluoro 2,4-dinitrofluoro benzene [DNFB] induced contact dermatitis mice. Topical application of MEKS inhibited DNFB induced ear thickness and weight increases as well as DNFB induced epidermal acanthosis, spongiosis and immune cell infiltration. In addition, treatment with MEKS significantly decreased the levels of tumor necrosis factor α, interferon γ and monocyte chemoattractant protein 1 in inflamed tissues[35].

The effects of the methanol extract of the fruits of *Kochia scoparia* was evaluated for antiinflammatory on lipopolysaccharide [LPS]-induced nitric oxide [NO], prostaglandin E2, and tumor necrosis factor [TNF-α] release by the macrophage cell line RAW 264.7. The results indicated that the extract was a potent inhibitor of NO production and it also significantly decreased PGE2 and TNF-α release. The protein and mRNA expression level of inducible NO synthase [iNOS] and cyclooxygenase-2 were inhibited by methanol extracts of *Kochia scoparia* in a dose-dependent manner. It also inhibited the LPS-induced DNA binding activity of nuclear factor-kappaB, which was associated with prevention of the inhibitor kappaB degradation[36].

The the anti-inflammatory effects of externally applied *Kochia scoparia* water extract [KSW] was investigated in 2,4-dinitrochlorobenzene [DNCB]-induced contact dermatitis mouse model. 100 μl of 1% DNCB in acetone/olive oil [4:1] had been applied for three days on shaved dorsal skin. 1% KSW was topically applied to mice to develop atopic dermatitis-like skin lesions. After KSW treatment, histological analysis showed that hyperplasia of the epidermis and dermis in the KSW treated group was markedly decreased as compared with the DNCB group. The expression levels of pro-inflammatory cytokine such as IL-1β, and TNF-α mRNA were significantly reduced by topical application of KSW, whereas these cytokines were increased in DNCB-induced dorsal skin. NF-κB expression was inhibited by KSW treatment in DNCB-induced mice. KSW treatment also significantly suppressed the expression of several MAP kinases, including ERK1/2, p38, and JNK compared to their expression in DNCB-induced mice[37].

The anti-inflammatory effect of methanol extracts of *K. scoparia* dried fruit [MEKS] was investigated on ear swelling, histopathological changes [such as epidermal acanthosis, spongiosis and immune cell infiltration] and cytokine production in 1-fluoro-2,4-dinitrofluorobenzene [DNFB]-induced contact dermatitis mice. Topical application of MEKS inhibited DNFB-induced ear thickness and weight increases, as well as DNFB-induced epidermal acanthosis, spongiosis and immune cell infiltration. Treatment with MEKS significantly decreased the levels of tumor necrosis factor- α , interferon- γ and monocyte chemoattractant protein-1 in inflamed tissues[38].

Methanol extract of *Kochia scoparia* fruits and both ethyl acetate and Butanol fractions were active in the rheumatoid rat induced Freund's complete adjuvant reagent whereas chloroform fraction was inactive. Oleanolic acid and momordin Ic showed significant activities in the same assay. These effects were also observed in carrageenan-induced edema of the rat and in the antinociceptive activity tests undertaken in hot plate- and writhing methods. The results suggested that momordin Ic and its aglycone, oleanolic acid, could be active principles for rheumatoid arthritis[29].

The 70% ethanol extract [KS-ext] from *Kochia* Fructus at an oral administration of 500 mg/kg had an antinociceptive effect on writhing responses induced by acetic acid, but, it was ineffective in nociceptive response in the hot plate test. Oleanolic acid oligoglycoside, momordin Ic isolated from *Kochia* Fructus significantly decreased the frequency of licking behavior within a unit of time at the late phase without affecting that of the early phase in the formalin test. KS-ext also inhibited the rise of vascular permeability induced by acetic acid, the increase of paw edema induced by carrageenin, histamine, serotonin or bradykinin and ear swelling induced by arachidonic acid. Momordin Ic also possessed an inhibitory effect on carrageenin-induced edema[23].

Dermatological effect:

The antiaging effect of a mixture of extracts of *Kochia scoparia* and *Rosa multiflora* was studied in photoaging skin. Eighteen-week-old hairless mice were irradiated with UVA 14 J/cm² and UVB 40 mJ/cm² three times a week for 8 weeks. A mixture of extracts of *Kochia scoparia* and *Rosa multiflora* [KR] was topically applied on the dorsal skin of photoaging mice twice a day for 8 weeks. Tesaglitazar, a known PPAR α/γ agonist, and vehicle

[propylene glycol:ethanol = 7:3, v/v] were applied as positive and negative controls, respectively. Dermal effects [including dermal thickness, collagen density, dermal expression of procollagen 1 and collagenase 13] and epidermal effects [including skin barrier function, epidermal proliferation, epidermal differentiation, and epidermal cytokines] were measured and compared. In photoaging murine skin, KR resulted in a significant recovery of dermal thickness as well as dermal fibroblasts, although it did not change dermal collagen density. KR increased the expression of dermal transforming growth factor [TGF]- β . The dermal effects of KR could be attributed to an increase in procollagen 1 expression, induced by TGF- β , and a decrease in MMP-13 expression. KR did not affect basal transepidermal water loss or stratum corneum integrity, but did decrease stratum corneum hydration. It also did not affect epidermal proliferation or epidermal differentiation. KR also decreased the expression of epidermal interleukin [IL]-1 α [39].

Antiparasitic effect:

Petroleum ether, chloroform, and methanol extracts of *Kochia scoparia*, were bioassayed for acaricidal activities against *Tetranychus urticae* Koch, *Tetranychuscinnabarinus* [Boisduval], and *Tetranychus viennensis* Zacher [Acari: Tetranychidae]. Extracts had both contact and systemic toxicity to these mites. Extracts with chloroform resulted in the highest mite mortality [78.86%]. Mite mortalities from the concentrated extracts by methyl acetate or distilled water were significantly lower than those by chloroform. The mean lethal concentrations [LC₅₀] of the extracts by chloroform, methyl acetate, and distilled water to the mites were 0.71 \pm 0.06, 2.08 \pm 0.16 and 8.75 \pm 0.062 mg/ml, respectively[28].

The petroleum ether, chloroform, ethyl acetate, acetone, and methanol extracts of three medicinal plants [*Dryopteris crassirhizoma*, *Kochia scoparia*, and *Polygala tenuifolia*] were screened for antiparasitic properties against *Dactylogyrus intermedius* in goldfish using in vivo anthelmintic efficacy assay. The methanolic extracts of *K. scoparia* showed antiparasitic properties with EC₅₀ values of 31.28 mg/l[40].

The effect of extracts obtained from 17 plants used in traditional Chinese medicine were tested in vitro against epimastigote form of *Trypanosoma cruzi*, *Kochia scoparia*, *Sophora flavescens* and *Ligustrum lucidum* showed effects with inhibition values between 25% and 60%[41].

Antiallergy effect:

The 70% ethanol extract [KS-ext] from *Kochia Fructus* [dried fruits of *Kochia scoparia* L.] was screened for activity in experimental models of type I-IV allergy. In type I allergic models, KS-ext at doses of 200 and 500 mg/kg, po. exhibited an inhibitory effect on 48-h homologous passive cutaneous anaphylaxis [PCA] in rats, which was related to IgE, and 1.5-h heterologous PCA in mice, which was related to IgG. In a type III allergic model, KS-ext showed an inhibitory effect on direct passive arthus reaction [DPAR] in rats, while it had no inhibitory effect on reversed cutaneous anaphylaxis [RCA] in a type II allergic model. KS-ext had an inhibitory effect on the effector phase in picryl chloride-induced contact dermatitis [PC-CD] in a type IV allergic model. Also, its anti-pruritogenic component, momordin Ic [oleanane saponin] exhibited inhibitory effects on 48-h homologous PCA and PC-CD[22].

The antipruritic effect of the 70% ethanol extract of *Kochia Fructus* and its active components were investigated on a compound 48/80-induced pruritogenic model in male mice. The extract [200, 500 mg/kg, po.] inhibited the scratching behavior as a pruritogenic indicator. Oleanolic acid oligoglycoside, momordin Ic, isolated from the extract also exhibited the inhibition[42].

The role of a *K. scoparia* fruit ethanolic extract [KSEE] in allergic airway inflammation was investigated in a mouse asthma model. Intragastric administration of KSEE significantly attenuated OVA-induced influx of total leukocytes, eosinophils, neutrophils, macrophages, and lymphocytes into lungs, as well as attenuating levels of interleukin IL-4 and IL-5 in a dose-dependent manner. KSEE also significantly reduced the serum levels of total and OVA-specific immunoglobulin IgE and OVA-specific IgG1 release into the airspace. Histological studies showed that KSEE inhibited OVA-induced lung tissue eosinophilia and airway mucus production. Immunoreactivity showed that KSEE markedly attenuated the OVA-induced increase in expression of ICAM-1, VCAM-1, and MMP-9[43].

Anti-cancer effect:

The anti-cancer effect of *K. scoparia*, methanol extract [MEKS] was investigated on the proliferation rate, cell cycle arrest, reactive oxygen species [ROS] generation and activation of apoptosis-associated proteins in MDA-MB-231, human breast cancer cells. The results demonstrated that MEKS decreased

the proliferation rates of MDA-MB-231 cells in a dose-dependent manner with an IC₅₀ value of 36.2 µg/ml. MEKS at 25 µg/ml significantly increased the sub-G1 DNA contents of MDA-MB-231 cells to 44.7%, versus untreated cells. MEKS also induced apoptosis by increasing the levels of apoptosis-associated proteins such as cleaved caspase 3, cleaved caspase 8, cleaved caspase 9 and cleaved Poly [ADP-ribose] polymerase [PARP][20].

The methanol extract *Kochia scoparia* [MEKS] was evaluated for anti-cancer activity in oral squamous cell carcinoma [OSCC]. OSCC cells treated with MEKS, showed that the numbers of sub-G1 accumulated cells and apoptotic bodies were increased, indicated that MEKS inhibited OSCC cell proliferation selectively through induction of apoptosis. Apoptosis of MEKS-treated OSCC cells was induced in a dose-dependent manner by caspase-3 and -9 activation. Pretreatment with p38 inhibitor SB203580 in combination with MEKS significantly prevented MEKS-induced apoptosis in OSCC cells and also decreased cleaved caspase 3, 9, and cleaved PARP activity in western blotting. Accordingly, MEKS treatment significantly increased the apoptosis of OSCC and inhibited tumour growth in our animal model[44].

Momordin Ic was demonstrated to induce HepG2 cell apoptosis in a ROS-mediated PI3K and MAPK pathway-dependent manner. The underlying mechanisms of PI3K and MAPK pathway-mediated PPAR γ , and PGC-1 α co-regulator activation, as well as the effects of downstream proteins, COX-2 and FoxO4, on cell apoptosis were investigated. The results demonstrated that momordin Ic activated PPAR γ and inhibited COX-2. PGC-1 α and FoxO4 expressions were increased by the PI3K or MAPK pathways. PPAR γ inhibition decreased p-p38 and FoxO4 expression, and restored COX-2 expression. ROS inhibition exerted little effect on PPAR γ , COX-2 and FoxO4 expression but affected PGC-1 α expression[45].

Effect on gastric emptying:

The roles of capsaicin-sensitive sensory nerves and the central nervous system in the inhibitory effect of momordin Ic, a principal saponin constituent of the fruit of *Kochia scoparia*, on gastric emptying were investigated in nonnutrient meal- or nutrient meal-loaded mice. Momordin Ic [12.5-50 mg/kg] significantly inhibited gastric emptying in carboxymethyl cellulose sodium salt test meal-loaded mice by 8.4%-60.6%, glucose test meal-loaded mice

by 42.8%, milk test meal-loaded mice by 36.4%, and 60% ethanol test meal-loaded mice by 37.2%. The inhibitory effect on the gastric emptying in carboxymethyl cellulose sodium salt test meal-loaded mice was potentiated by glucose, but markedly attenuated by pretreatment with alloxan and streptozotocin, in which the activity of sympathetic nervous system was decreased, or by insulin. The effect of momordin Ic was also attenuated by pretreatment with capsaicin[19].

Antioxidant effect:

The antioxidant activities of aqueous and 50% ethanol *Fructus Kochiae* extracts were investigated. *Fructus Kochiae* extracts effectively scavenge different free radicals. The activity of ethanol extracts was more remarkable than aqueous ones especially for hydroxyl-induced oxidation. Momordin Ic was effective in inhibiting protein oxidation and carbonylation[46].

Antidiabetic effect:

The methanolic extract of *Kochia scoparia* was found to inhibit the increase in serum glucose-loaded rats. Through bioassay-guided separation, momordin Ic and its 2'-O-beta-D-glucopyranoside, with three new saponins named scoparinosides A, B, and C were isolated as the active principles. Momordin Ic and its 2'-O-beta-D-glucopyranoside, were found to potently inhibit glucose and ethanol absorption in rats[31].

Prevention of obesity:

The effect of ethanol extract of *K. scoparia* fruit was evaluated for prevention of obesity induced in mice by a high-fat diet for 9 weeks. The ethanol extract of *K. scoparia* fruit prevented the increases in body weight and parametrial adipose tissue weight induced by the high-fat diet. Consumption of a high-fat diet containing 1% or 3% *K. scoparia* extract significantly increased the fecal content and the fecal triacylglycerol level at day 3 compared with those in the high-fat diet group. The ethanol extract [250 mg/kg] and total saponins [100 mg/kg] of *K. scoparia* inhibited the elevation of the plasma triacylglycerol level 2 or 3 h after the oral administration of the lipid emulsion. Total saponins, momordin Ic, 2'-O-beta-d-glucopyranosyl momordin Ic and 2'-O-beta-d-glucopyranosyl momordin Ic isolated from *K. scoparia* fruit inhibited the pancreatic lipase activity [in vitro][30].

Effect on renin activity:

Kochia scoparia fruit saponins [momordins] were found to inhibit renin activity[47].

Toxicity:

The serum clinical profiles and metabolic hormone concentrations in steers and wethers fed kochia hay was compared to those of suitable controls that were pair-fed equal amounts of DM as alfalfa hay. Eight steers that were pair-fed kochia or alfalfa hay for 21 day had similar levels of serum insulin [INS] or somatotropin [GH], but kochia lowered prolactin [PRL] [6.0 vs 118 ng/ml; P = .14]. Kochia hay did not elevate serum bilirubin at day 21 in these steers; however, lactic dehydrogenase and aspartate aminotransferase activities were elevated 1.3-fold [P less than .05]. Ten fine-wool wethers [29 +/- kg BW] pair-fed kochia or alfalfa hay for 21 day had similar levels of PRL and INS at day 0, 5, 10, and 21; however, GH was lower in wethers fed kochia at day 5 [P less than .05] and somewhat lower at day 10 and 21. Kochia elevated serum unconjugated bilirubin 1.25-fold over pair-fed controls [P = .06] and increased [P less than .05] activities of aspartate and alanine aminotransferases[48].

Over a period of 3 years, a total of 116 steers were given kochia as their sole forage. Twenty control steers were allowed to graze native grass pasture, and 20 steers were allowed to graze both native grass and kochia pastures. Steers grazing only kochia lost weight or gained poorly compared with control steers grazing native grass. Steers that grazed both kochia and native grass had intermediate rates of gain. Signs of toxicosis were observed only in steers grazing kochia alone. Morbidity in the steers grazing only kochia varied from 0%-28%, and mortality varied from 0%-10%. The most common signs observed in clinically affected steers were depression, dehydration, weight loss, muscular weakness, photosensitization, ocular discharge, and crusty muzzle with significant elevations in serum glutamic oxaloacetic transaminase, serum gamma glutamyl transpeptidase, serum bilirubin, serum calcium, and serum protein in steers grazing kochia. Necropsies performed on 6 of 9 steers that died or were euthanized showed that the primary pathologic findings were severe chronic nephrosis and degenerative hepatopathy[49].

Twelve steers were given ad libitum access to Kochia hay for 38 day. Six steers were dosed orally with 15 mg of metoclopramide/kg of BW three times each week in gelatin capsules, and six steers

received empty gelatin capsules. Steers were housed in individual outside pens for the first 28 day, then inside in metabolism stalls for the last 10 day. Kochia intake averaged $1.2 \pm .04$ and $1.1 \pm .05\%$ of BW throughout 38 day for kochia-fed control and kochia plus metoclopramide-dosed steers, respectively. During the last 10 day, metoclopramide reduced N retention [P less than .01; 20 vs 8 g/d]. Kochia hay decreased serum prolactin and insulin concentrations [P less than .01] from 12.4 to 1.5 ng/ml and from .53 to .23 ng/ml, respectively. Metoclopramide had no effect [P greater than .50] on prolactin or insulin in steers fed kochia hay. Serum growth hormone was not affected by kochia but was suppressed by metoclopramide in steers fed kochia hay [P less than .07]. Serum bilirubin [total and unconjugated] was elevated [P less than .05], indicating early, mild hepatotoxicosis characteristic of kochia toxicosis. Kochia also increased serum concentrations of iron, total protein, albumin, globulin, and creatinine and decreased urea N [P less than .05][50].

12 wether lambs fed prebloom kochia showed decreased serum insulin and prolactin [P less than .05] below initial values [.48 to .11 and 102 to 28 ng/ml, respectively]. Serum somatotropin increased [P less than .05] from 4.5 to 6.8 ng/ml at 4 wk. Serum total bilirubin increased threefold at 3 wk [P less than .05] and declined slightly thereafter through 10 wk. Early changes in serum enzymes reflected mild hepatotoxicosis without cholestasis, whereas histopathology [at 80 day] showed diffuse hepatocyte swelling and nephrosis[51].

Sixteen ewes were divided into 2 groups and were allowed to graze a greater than 95% pure stand of *Kochia scoparia* for 72 or 55 day to determine the effects of plant maturity on liver function and weight gains. Four additional sheep [controls] were placed on weedy Bermuda grass pasture with the same water supply as the kochia-fed sheep. Liver biopsies were performed pre-, mid- and post-study to assess morphologic changes. An almost exclusive diet [$> 95\%$] of *Kochia scoparia* resulted in minimal elevations in serum GGT, suggesting mild hepatocellular injury, but was not associated with overt hepatic lesions or clinical disease. Other serum chemistry measurements were within normal ranges. Unlike for other domestic animal species, *Kochia scoparia* offering little risk of toxicosis for sheep [52].

The diet with 50% kochia fed to sheep for 5 wk, caused slight elevation of blood glucose, total bilirubin was increased about 1.5-fold [P less than .05], alanine aminotransferase was elevated slightly [P less than .05], and inorganic phosphorus and urea

[blood urea N] were diminished [P less than .05], and serum calcium was unchanged from initial levels [P greater than .10][53].

Cattle consuming only *Kochia scoparia* became ill with signs of lacrimation, depression, anorexia, nystagmus, head pressing, and recumbency. Some cattle died acutely, with the only clinical signs being recumbency, nystagmus, and occasionally opisthotonos. Pathologic findings revealed pulmonary edema and congestion, hepatic necrosis and fibrosis, necrosis of proximal convoluted tubular epithelium in the kidneys, epidermal necrosis of lightly pigmented areas, and laminar cerebrocortical necrosis[54].

Cattle consuming only high-sulfate water [2.3 g/l] and *Kochia scoparia* showed abnormally higher serum glutamic oxaloacetic transaminase, serum sorbitol dehydrogenase, and serum bilirubin over extended periods, suggesting chronic toxicosis. Clinical disease was manifested primarily as photosensitization. Polioencephalomalacia and thiamin-destructive principle, but the toxicosis seemed accentuated after substantial rains, when plant growth was accelerated, and flowering, pollination, and early seed development were occurring[55].

CONCLUSION:

The current review discussed the chemical constituent, pharmacological and therapeutic effects of *Kochia scoparia* as promising herbal drug because of its safety and effectiveness.

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