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REVIEW: BIOCHEMICAL COMPOSITION AND MEDICINAL USES OF CHROZOPHORA GENUS

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ABSTRACT

Plants have been used for thousands of years to flavor and conserve food, to treat health disorders and to prevent diseases including epidemics. Species of *Chrozophora genus* (Euphobiaceae family) are distributed in West African and Asia. These species are monoecious, shrubby herb and annual plants and their leaves, stems and fruits besides the whole plant have been used in food and traditional medicine for the treatment of infectious diseases. Many of these species showed high content of protein and oil with high percentages of fatty acids. The extracts from different parts of the Chrozophora plants showed the presence of diterpenoids, triterpenoids, flavonoids and chromone glucosides, Alkaloids, coumarins, chromones xanthones, diterpenoids and phenylpropanoid glycosides. However, there are many investigations showed this genus have antimicrobial, anticancer and antioxidant, antiplasmodial, antidiabetes, and anthelmintic property agents, and phytotoxic activity. Thus, in the present work, *Chrozophora genus* plants with emphasis on their chemical composition, food and feed, and medicinal uses are reviewed.

Key words: Euphorbiaceae, Chrozophora, Botanical description, Chemical composition, Antimicrobial, Antioxidant, Medicinal, Food Uses.

INTRODUCTION

Euphorbiaceae, the spurge family, is a large family of flowering plants with 300 genera and around 7,500 species. Most spurges are herbs, but some, especially in the tropics, are shrubs or trees [1]. This family occurs mainly in the tropics, with the majority of the species in the Indo-Malayan region and tropical America. A large variety occurs in tropical Africa, but they are not as abundant or varied as in these two other tropical regions. However, Euphorbia also has many species in non-tropical areas such as the Mediterranean Basin, the Middle East, South Africa, and Southern USA [2]. The leaves are alternate, seldom opposite, with stipules. They are mainly simple, but where compound, are always palmate, never pinnate. Stipules may be reduced to hairs, glands, or spines, or in succulent species are sometimes absent.

The fruit is usually a schizocarp, but sometimes a drupe. This family contains a large variety of phytotoxins (toxic substances produced by plants), mainly diterpene esters, alkaloids, glycosides, and ricin-type toxins [3]. Many plants of Euphorbiaceae family are grown as ornamental plants and some species proved to be effective against genital herpes (HSV-2) [4]. Euphorbiacea family includes succulent or nonsucculent plants range from herbs and shrubs to trees and cactus types. Many of them contain a milky juice which is more or less toxic, especially for cold-blooded animals. The fruits are usually three-celled capsules, each cell containing a single seed from which in some species, toxic, vesicating, and irritant seed oils may be obtained. The largest genera of the spurge family are those of Croton, with about 700 species, and of spurge or Euphorbia, with about 1600 species [5].

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CHROZOPHORA GENUS

Chrozophora genus is a plant of the family Euphorbiaceae and the sole genus comprised in the subtribe chrozophorinae. It comprises 8-7 species, which are mostly monoecious herbs under shrubs. This genus is distributed in Pakistan, India, West Africa and Mediterranean regions. Previous phytochemical investigation of the genus Chrozophora resulted in the isolation of several types of chemical constituents including essential oils, terpens, sterols, phenylpropanoid glycosides, xanthones, chromone and flavonoids. It was reported that the plant contained essential oils and flavonoids. A literature search revealed only flavonoid aglycones and an acylated glucoside of apigenin. In continuation of our studies on phenolic constituents from Egyptian plant, we report herein on the isolation and structure elucidation of a novel brocchlin carboxylic acid and its methyl ester from the aqueous ethanolic extract of Chrozophora brocchiana, together with eight known phenolic compounds, gallic acid, methylgallate, ethylgallate, ellagic acid, methoxyellagic acid, methylenedioxy ellagic acid, apigenin [6]. This review paper aims to review Chrozophora genus plants e. g. *Chrozophora brochiana, C. senegalnsis, C. plicata, C. rotteri, C. tinctoria* and *C. oblongifolia* with emphasis on their chemical composition, food, feed, and medicinal uses

BOTANICAL DESCRIPTION

Chrozophora brocchiana (Vis.) Schweinf

A shrubby herb up to 60–150 cm tall; taproot stout and very long; stem ascending, knotty, much-branched from the base, white-velvety hairy with stellate hairs. Leaves alternate, simple; stipules small; petiole long; blade angular-ovate to triangular-ovate, 2.5–4 cm × 1.5–3 cm, base deeply chordate with 2 glands, apex rounded, margins undulate, upper surface sparsely hairy, lower surface velvety hairy, 3-veined at base. Inflorescence a condensed axillary raceme, with male flowers at the top and female flowers at the base, bracts small. Flowers unisexual, regular, 5-merous; calyx velvety hairy, petals deep red; male flowers with short pedicel, stamens up to 10, filaments fused into a column; female flowers with pedicel elongating in fruit to 6 mm long, petals smaller than in male flowers, ovary superior, 3-celled, styles 3, fused at base, 2-fid at apex. Fruit a 3-lobed capsule c. 1 cm long, densely covered with white or violet-tinged, shiny stalked scales, 3-seeded. Seeds ovoid, smooth, yellowish brown, covered by a thin, pale, shiny aril [7]. *Chrozophora brocchiana* occurs in the area of Cape Verde and Mauritania throughout the Sahel region east of Sudan, and is also found in Algeria, Ethiopia and Egypt commonly it is found in dried-up inundated flats or sandy river beds [8].

Chrozophora senegalensis A. Juss

Chrozophora senegalensis closely resembles *C.brorcchiana* but it has hairs, shorter petioles and non-elongating sepals in fruits. It is an herb with small green leaves, deep red flowers and violet tingled capsules, occurs on sandy soils. An under shrub, sometimes prostrate, in seasonally flooded flats and on riverbanks of the savanna region from Senegal to Northern Nigeria, and in Shari.

Chrozophora plicata (Vahl) A. Juss. ex Spreng

Prostrate or more or less erect, branched annual or perennial herb, up to 50 cm. Most parts densely covered in grayish stellate hairs. Leaves rhombic-ovate, up to 7 × 5 cm with a long petiole, plicate-undulate, especially when young, 3-5-veined from the base with 2 dark purple glands at the base; margin more or less entire or obscurely toothed. Flowers in leaf-opposed or pseudo-axillary inflorescences, covered in stellate hairs, unisexual. Male flowers, orange-yellow or pinkish; female flowers, crimson-red, Fruit up to 5 × 9 mm, 3-lobed, densely covered in stellate hairs, reddish or bluish-purple when ripe [9]. Flowers in leaf-opposed or pseudo-axillary inflorescences, covered in stellate hairs, unisexual. Male flowers, orange-yellow or pinkish; female flowers, crimson-red, fruit up to 5 × 9 mm, 3-lobed, densely covered in stellate hairs, reddish or bluish-purple when ripe. It occurs throughout tropical Africa to Northern South Africa, Egypt, Syria, Palestine, and North-Western India to the Mediterranean. It grows in warmer climate and temperate regions [10,11].

Chrozophora tinctoria A. Juss

It is an herb or undershrub, monoecious, indumentums consisting of very dense, sessile and peduncle stellate or lepidote hairs, next to simple hairs. Stipules narrowly triangular, scars very indistinct. Leaves spirally arranged and simple. Flowers actinomorphic, staminate flowers usually 2 per node, pistillate flowers usually single and fruits, slightly lobed capsules, triangular in transverse section, dehiscing usually septicidally and partly loculicidally into 3 bivalved parts, outside densely stellate, inside glabrous, thin-walled; column slender, with frayed remnants of the septa, apically triangular; septa single veined. Seeds 3 per fruit, obovate, angular; covered by a thin, incomplete sarcotesta; the latter carunculate apically, embryo flat; endosperm copious. It is an annual plant, native to a number of countries in Africa, temperate and tropical Asia and Europe, and commonly known as ‘dyer’s-croton [12]. Süleyman [13] reported that *C.tinctoria*, is an annual plant and is the only species of chrozophora found in Turkey, that used as a source of dyeing material in Carpet, Kilims and in other crafts in Western Anatolia and it should benefit the economy of Turkey.

Chrozophora rottleri (Geiseler) Juss

It is an annual herb, prostrate or ascending; monoecious, the flowers borne in sessile auxiliary racemes with staminate flowers in upper and pistillate flowers in the lower part of raceme, main stem up to 50 cm long, stellate-pubescent. Leaves alternate, 2-5 x 1-4 cm. It is an erect herb with silvery hairs; lower part of stem is naked, upper part hairy and has slender tap-root. The three-lobe leaves are alternative, thick and rugose. The plant occurs naturally in tropical African, Asia and India.

***Chrozophora oblongifolia* (Delile) A. Juss. Ex spreng**

This plant is distributed in Egypt, Saudi Arabia, Yemen, Oman, Sudan (Red Sea coast), Eritrea, Djibouti, Somalia, and Socotra. It is an erect shrub, subshrub or woody herb up to 1 m high, evenly stellate. Pubescent petioles 0.5-3.5 cm long. Leaf-blades triangular-ovate to triangular-lanceolate, 4-7 x 1.5-3 cm, acute or obtuse at the apex, cuneate, rounded or subtruncate at the base, subentire to repand-dentate, 3(-5)-nerved from the base, nerves impressed above and prominent beneath, evenly pubescent above and beneath. Stipules subulate, 2 mm long. Inflorescences up to 1.5 cm long, supra-axillary or leaf-opposed. Male flowers subsessile; sepals lanceolate to ovate-lanceolate, 3.5 mm long, stellate-pubescent; petals lanceolate to ovate-lanceolate, 4 mm long, lepidote without, yellowish; disc c. 1 mm diam.; stamens 4-7 (-12), variously connate, anthers sub-biseriate. Female flowers: pedicels 5 mm long, extending to 2 cm in fruit and becoming deflexed, 1-3 on a short peduncle; sepals and petals linear-lanceolate or lanceolate, otherwise as in the male sepals; ovary 2 mm diam., densely silvery-lepidote; styles stellate-pubescent and papillose, bipartite, 1-2 mm long. Fruit rounded-trilobate, 5-6 x 7-9 mm, somewhat muricate, lepidote, bluish-purple. Seeds triangular-ovoid, 4-5 x 3-4 mm, coarsely tuberculate, yellowish-gray [14].

A much-branched under a shrub, with stems stout and woody below, but sometimes herbaceous and dying after flowering in the first year; stems rather harshly white or tawny stellate-pubescent. Leaves distinctly petioled, ovate-rhomboid or oblong to lanceolate, obtuse, base cuneate, narrowly notched, 2-glandular, the margin usually more or less lobed or incised, rarely entire, 1–4 in. long, 1/3–2 in. wide, thinly and rather harshly stellate-pubescent above, more closely so beneath; petioles 1/4– 1/2 in. long, closely and coarsely stellate-pubescent; stipules linear, 1 lin. long, deciduous. Racemes short-peduncled, rather dense; lower female pedicels in fruit 1/2 in. long or rather longer. Male calyx globose in bud, closely and coarsely stellate-pubescent; lobes ovate-anceolate. Petals yellowish-white, lanceolate, shorter than the calyx-lobes. Stamens 5–10, 1–2-verticillate. Female sepals lanceolate. Petals linear, as long as the calyx-lobes. Capsule 3-coccous, blue-purple, about 1/2 in. wide, loosely clothed with floccose flat scales with fringed denticulate margins. Seeds rough [15].

Chemical Composition, Bioactive and Antioxidant Compounds

Chrozophora brorcchiana

The seed of *Chrozophora brorcchiana* had 37-40% oil and 26.2 % protein, and the fatty acid composition of the oil showed linoleic acid as the major component, followed by palmitic, oleic and stearic acids [16,17], while the triaclyglycerol composition of *C.brorcchiana* showed LLL 15.8%, OLL 14.9%, PLL 7.5%, OOL 7.7%, PLO 16.9%, OOO 2.8%, POO 11.7%, POP 3.9%, SOO 4% SOP 6% and SOS 2.3%. The ratio of mono-acidic: di-acidic: tri-acidic regardless the type of fatty acids and their position in the TAG was 1:2.65:1.17. and the chemical content of the aerial parts revealed an unusually high silica content72.2%. Hawas [18] reported that the aqueous methanol extract of the aerial parts of *C.brorcchiana* contains brocchiana carboxylic acid, an analogue of brevifolin carboxylic acid, as well as gallic acid, methyl gallate, ethyl gallate, ellagic acid, mono- and di-methoxy ellagic acid, apigenin and luteolin 7-O-glucoside .

Chrozophora senegalensis

The leaves of this species contain carbohydrates, saponins, tannins, steroids [19] glycoside and alkaloids [20]. Antonio et al., [21] reported that the DPPH (2,2-diphenyl-1-picrylhydrazyl) assay led to the isolation of three new flavonoid, glycosides namely quercetin 3-O-(6″-caffeoyl)-β-D-glucopyranoside-3′-O-β-D-glucopyranoside, quercetin 3-methylether-7-O-α-L-rhamnopyranosyl-(1→6)-(2′-p-coumaroyl)-β-D-glucopyranoside, acacetin 7-O-(6″-p-coumaroyl)-β- D -glucopyranoside and along with five known flavonoids, one phenolic derivative, and three megastigmane glycosides.

Chrozophora tinctoria

This plant is used for producing dye substances which due to their high solubility in water it produced dark blue dye [22] and flavonoids [23]. The natural dyes obtained from these plants include three main colors; red, yellow and blue. It is possible to obtain other colors from mixtures of these colors. Dye obtained from C. tinctoria, due to its high solubility in water, produced dark red color, but it did not show reaction with wool fiber, as such, dyeing of wool fibers was of low grade. Wool fibers are thus giving as light colored appearance. The lowest color intensity was 3.213 and the highest was 6.408 [24]. The HPLC analysis of the methanol extract of the aerial parts of *Chrozophora tinctoria* yielded five flavonoid glycosides, these were quercetin 3-o-rutinoside (1, rutin), acacetin 7-o-rutinoside (2), apigenin 7-o-b-d-[(6-p-coumaroyl)]-glucopyranoside (3), apigenin 7-o- b-d-glucopyranoside (4) and apigenin 7-o-b-d-[6-(3,4-dihydroxybenzoyl)] -glucopyranoside (named, chrozo phorin, 5), the last one was reported as a new natural product [25].

Chrozophora plicata

The fatty acid composition of *Chrozophora plicata* oil showed that the content of inolenic and oleic acids were varied from 60-75% and this oil resembles cottonseed oil in its proportions of linoleic, oleic and saturated acids. The plant has hydrocarbons, cholesterol, stigmasterol, β-sitosterol, β-amyrin, squalene, octacosanol, hexacosanol and tetracosanol [26]. The methanolic extract of the whole plant showed inhibitory activity against the yeast α-glucosidase and was considered as a target molecule for future anti-diabetic drugs [27-29]. The *Chrozophora plicata* leaves extracts had strong exhibited fungitoxicity against p-aphanidermatum and the fruit produced dyes, stains, inks, tattoos and mordants.

Chrozophora rottleri

The oil from the seed of Chrozophora rottleri was reported to be rich in linoleate, while the leaves and root

contain xanthone glycosides and chromone glycoside. The tannin was found in the whole plant [30]. Another study revealed the presence of alkaloids, carbohydrate, glycosides, tannins, steroids, flavonoids and saponins in the chloroform extract of C. rottleri [31]. Maharaj and Prabhakaran [32] reported that the weed *C.rottleri* had adverse allelopathic effects on the germination and growth of rice seedlings.

Chrozophora oblongifolia

The methanol hot aqueous extract of *Chrozophora oblongifolia* contains some bioactive compounds e.g. flavonoids, tannins, terpenoids. The extract exhibited antimicrobial activity with MIC values ≤ 125 μg/mL against Gram-positive bacteria and antioxidant activity, antiseptic for wounds and for hemorrhoids [33]. Fourteen novel dolabellane diterpenoids have been isolated from the aerial part of Chrozophora oblique (the old name) all of them are naturally acylated at the C-16 hydroxyl group with 3-hydroxy-3-methylglutaric acid [34].

FOOD AND FEED USES

Chrozophora brorcchiana

The plant is locally known as Argassi in Sudan, where in eastern states the boiled seeds of *Chrozophora brorcchiana* are used for food. In central Sudan sweet, non-drying oil is pressed from the seed extraction of the oil by using traditional mills, Argessi oil has a potential of a new type of vegetable oil. *Chrozophora tinctoria* is used in coloring foods, textiles, cosmetics and pharmaceutical preparations. The *Chrozophora brorcchiana* plant is not grazed by stock in Senegal and is said to cause vomiting and diarrhea for animals, nor is it grazed in Sudan, but camels and Grant's gazelle are recorded eating it in Kenya. In Niger though, it is sought after by goats and at certain times of the year also by cattle. It is known to be acrid and poisonous in India. The fresh shoots of *Chrozophora plicata* force-fed to Nubian goats and desert sheep caused poisoning (diarrhea, dyspnoea, dullness and loss of appetite) and die of all animals [35].

MEDICINAL USES

Chrozophora genus has several interesting medicinal uses, the plant ash of *Chrozophora brocchiana*, is applied to sore and the crushed leaves were rubbed on the affected sites to treat stitch in the side. The aerial parts are taken in decoction to strengthen lactating mothers and their children, and to treat fever and dysentery. While powdered dried leaves in water are taken to treat diarrhea. Root sap in water is used as ear drops to treat otitis. [36]. Analysis of the chemical content shows no particular reason for a beneficial action as a wound-dressing; however, there is an unusually high silica content. While *Chrozophora senegalensis* plant has been reported is an astringent for treatment diarrhea mainly caused by Salmonella specie, and in Senegal a root decoction is given to suckling babies to treat diarrhea [37]. It is boiled with cereal foods and the pregnant women used a decoction of it as a body wash, also used as a remedy for syphilis; and treatment of intestinal pain, typhoid and boils [38,39]. The fruit juice is used as eye drops to treat more severe cases, a maceration of leaves and roots is drunk to treat loss of hair and diabetes, and a water extract of aerial parts caused an in-vivo hypoglycemic response in rats [40] Tignokpa et al reported that leaves and stems extracts of *Chrozophora senegalensis* showed a high anti-plasmodial activity against two chloroquine-resistant Plasmodium falciparum strains, without toxicity in vitro and no toxicity in vivo by oral way in mice. While the leaf extracts alone showed antimicrobial activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*; with highly active on Salmonella typhi. In Sudan, *C. oblongifolia* stem and leaf extracts are used to treat gonorrhea and the chloroform and methanol extracts showed considerable antidiabetic activities.

Ugulu et al reported that *Chrozophora tinctoria*, has a high solubility in water, and produced dark red color, but it did not show reaction with wool fiber. The plant is used traditionally to treat warts, also has been used as an emetic, cathartic, and for the treatment of fever elsewhere [41].

Chrozophora plicata has an emetic, drastic and corrosive property. Its seeds are used as cathartic [42]. The leaf extracts exhibited strong fungi toxicity against P. aphanidermatum, the plant poisoning causes salivation, dyspnea, bloat, dullness, diarrhea, paresis of the hind limbs, recumbence and lateral deviation of the head and neck. While *Chrozophora rottleri* is traditionally used for the treatment of various diseases. In Sudan people use stems or whole plant as powdered and applied it to wounds to improve healing. The plant also used in Saudi Arabia and India to treat Jaundice and purifying blood. An infusion of seeds and leaves is taken as a laxative in Ethiopia and in Senegal, the plant is not browsed by most stock, except occasionally by sheep and goats, as it causes vomiting and diarrhea, whereas in Kenya, camels graze it. The fruits yield a purplish blue dye, which is used to dye mats in East Africa. The fruit juice is given in cases of cough and cold in Nepal [43]. The leaves of *Chrozophora rottleri* are used as a depurative agent and they are very much beneficial in treatment of skin diseases [44]. The seeds are used as cathartic like Ghodtapde and credited with purgative properties. Priyanka et al [45] reported that, the aqueous extract of the leaves of this plant has a significant anti-helmintic property against Pheritima posthuma (Indian Earth worm). The aqueous extract of *Chrozophora rottleri* possessed phytotoxic activity on rice, wheat and mustard. In an experimental study by Suparna and Tapaswi [46], they reported that, the leaf extracts of *Chrozophora rottleri* exhibited higher inhibition of shoot, root and radial elongation than the stem and root.

TOXICITY

Several toxic dolabellane diterpene glucosides, dolabellane diterpenoids and phenylpropanoid glucosides have been isolated from *Chrozophora obliqua*. Although rats fed 10% leaves in their diet had a low growth rate, bouts of soft feces, lesions of internal organs and

alterations in blood and urea, no death occurred among the rats. The fresh shoots of *Chrozophora plicata* force-fed to Nubian goats and desert sheep caused all animals to die, and the main signs of poisoning were salivation, dyspnoea, bloat, loss of appetite, dullness, diarrhea, paralysis of the hind limbs and lateral deviation of the head and neck.

CONCLUSION

Traditional uses of Chrozophora plants are to cure skin disorders, skin burns, diarrhea, jaundice, mouth ulcer, fever, joint pain and swelling, abdominal pain, migraine, menstrual problems, wounds, and to expel intestinal worms. And the screening and investigation for phytochemical and pharmacological studies of this these plants used in food, feed, personal body care and medicine provided scientific evidence for their rational use in food and prevention and treatment of infectious and oxidative stress related diseases.

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