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RESEARCH ARTICLE

A Comprehensive Review of *Corchorus Capsularis*: A Source of Nutrition, Essential Phytoconstituents and Biological Activities.

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ABSTRACT

The golden fiber and one of the main cash crops of Bangladesh is *Corchorus capsularis* L. (white jute). An in-depth literature survey on the nutrition, chemistry and pharmacological activities of this species has been carried out. The present study was conducted on the basis of previous nutritional, chemical and biological activities published in various national and international research articles and for this, published articles, dissertations, magazines, and book reports were collected. Aim of the work is to exploit the medicinal information among both the users and non-users, benefited by this species. Protein, lipid, calcium, iron, carotene, vitamins, folic acid and some enzymes have been reported from the leaves. A large number of phytoconstituents with their structures including flavonoids, saponins, tannins, steroids, glycosides, sugars and triterpenes and their applications have also been reported from the leaf, bark, root and seeds of the species. Many of these compounds have been found to possess significant biological responses like cardiac, antinociceptive and anti-inflammatory activities.

KEYWORDS: *Corchorus capsularis* L., Biological, Nutrition, Phytochemicals, Review.

INTRODUCTION:

Jute is known as golden fibre of Bangladesh. It is the main cash crop for the country, since Bangladesh supplies more than 95 percent of the world's requirement of this important fibre[1]. The word jute is probably coined from the word *jhuta* or *jota*, an Orrisan word. However, the use of *jutta potta* cloth was mentioned both in the Bible and Monushanghita-Mahabharat. Among the all species, white Jute (*C. capsularis*) is commercially important available and the present study was conducted on the subjected one. The centre of origin of this species is said to be Indo-Burma including South China[1,2].

Jute grows under wide variation of climatic conditions and stress of tropic and subtropics. It is grown in India, Myanmar, Nepal, China, Taiwan, Thailand, Vietnam, Cambodia, Brazil and some other countries[2].

It was observed in different literatures that the green, leafy vegetable of *C. capsularis* is rich in beta-carotene for good eyesight, iron for healthy RBCs, calcium for strong bone and teeth, and vitamin C for smooth, clear skin, strong immune cells and fast wound-healing. Vitamins A, C and E present in the jute leaf sponge up free radicals, scooping them up before they can commit cellular sabotage. Antioxidants from jute leaves have been associated with protection from chronic diseases such as heart diseases, neoplasm, diabetes and hypertension. Ayurvedics use the leaves for ascites, algesia, piles and tumors. Elsewhere the leaves are used for cystitis, dysuria,

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fever and gonorrhea. The cold infusion is said to restore the appetite and strength[2].

The present study was conducted on the basis of previous nutritional, chemical and biological; national and international research works. For this, published articles, dissertations, magazines, and book reports were collected, from the past up to 2012. Aim of the work was targeted to exploit the medicinal information among both the users and non-users, benefited by this species world-wide.

DESCRIPTION OF THE WHITE JUTE (*C. CAPSULARIS*):

Corchorus (Family: Tiliaceae) is a genus of annual herbs. Nearly 40 species are known to occur in nature and distributed in the tropics of both the hemispheres[3].

PRODUCTION SEASON AND SOIL:

Jute grows well where the annual rainfall is 1500 mm, with at least 250 mm during each of the months of March, April and May. The optimum range of temperature required is 18-33ºC. Jute is cultivated in the rainy season. In Bangladesh sowing usually starts at the end of February and continues up to the end of May, depending on the species. Cultivation largely depends upon pre-monsoon showers and moisture conditions. *C. capsularis* is more water tolerant and thus generally can be grown in low lands, and even under water logging conditions (Image 1). But it can be grown in a number of soil types, ranging from clay to sandy loam with optimum fertility, and pH ranging from 5.0-8.6[2].

MORPHOLOGY AND DISTRIBUTION:

The plants are tall, usually annual herbs, reaching a height of 2-4 m, unbranched or with only a few side branches. The leaves are alternate, simple, lanceolate, 5-15 cm long, with an acuminate tip and a finely serrated or lobed margin. The flowers are small (2-3 cm diameter) and yellow, with five petals; the fruit is a many-seeded capsule. It thrives almost anywhere, and can be grown year-round[4]. Most genera are tropical, but the genus *Tilia*, commonly called linden, or lime tree, in Europe and Asia and basswood in North America, is found throughout the north temperate. Many species yield fiber, but the chief sources of commercial jute are two species; *C. capsularis* and *C. olitorius*, grown primarily in the Ganges and Brahmaputra valleys. Although jute adapts well to loamy soil in any hot and humid region, cultivation and harvesting require abundant cheap labor, and India remains the unrivaled world producer as well as the chief fiber processor. Kolkata (Calcutta) is the main center. Europe and the United States import large quantities of jute fiber and cloth; Dundee, Scotland, is also a major jute-textile manufacturer. The plant, cultivated in India from remote times, has been known to Western commerce only since about 1830. Jute is classified in the division Magnoliophyta, division of the plant kingdom consisting of those organisms commonly called the flowering plants, or angiosperms. The angiosperms have leaves, stems, and roots, and vascular, or conducting, tissue (xylem and phloem). Either of two herbaceous annuals *C. capsularis* has been grown and processed in the Bengal area of India and Bangladesh (Image 2) since ancient times[5].

Image 1: *C. capsularis* culture plant (Author)

METHODOLOGY

To do the present study we tried to gather information from the book reports, published different national and international articles, periodicals from the Bangladesh Jute Research Institute (BJRI), Dhaka, Bangladesh. The selection of the data was conducted on the basis of the nutritional, phytoconstituents and biological activities including tribal and other used information.

All the possible database information was made to congregate up to present (2012). In addition to the inclusion and exclusion criteria other strategy was set a manual search of dissertations of different institutions of Bangladesh.

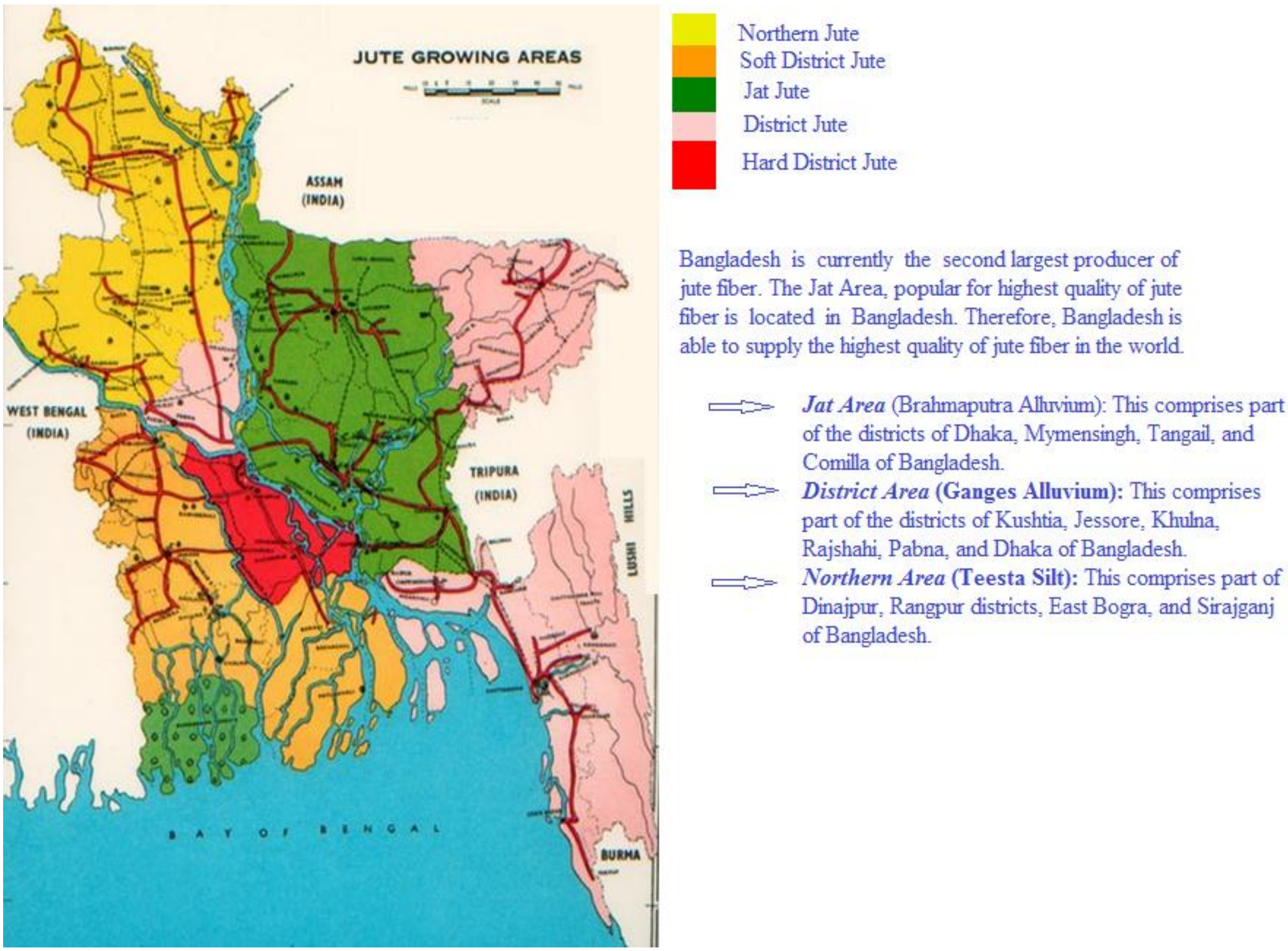


Image 2: Jute growing areas in Bangladesh (Image: Author)

RESULTS AND DISCUSSION:

WHITE JUTE LEAVES AS VEGETABLE:

Leaves of *C. capsularis* is a popular vegetable in Bangladesh and India, where it is called “pat shakh”. In Malays it is known as “kancing baju”[6]. The Yoruba of Nigeria call it “ewedu”. The Hausa people of Nigeria and their Fulbe neighbours call it “rama”. In Northern Sudan it’s called “khudra” meaning green in Sudanese Arabic. The Songhay of Mali calls it “fakohoy” whereas Tunisians call it “mulukhiyah”. In Egypt call it “mulukhiyya”, Cypriots call it “molocha”. The Philippines call it “saluyot”. Jute leaves are also consumed among the Luyhia people of Western Kenya, where it is commonly known as “mrenda or murere”. Japan has been importing dry jute leaf from Africa and they are using it as the substitute of coffee and tea. In Europe, jute leaves are being used as soup[2].

INGREDIENTS (CHEMISTRY OF WHITE JUTE LEAF):

Per 100 g, the leaves of *C. capsularis* are reported to contain 43-58 calories, 80.4-84.1 g water, 4.5-5.6 g protein, 0.3 g fat, 7.6-12.4 g total carbohydrate, 1.7-2.0 g fibre, 2.4 g ash, 266-366 mg Ca, 97-122 mg P, 7.2-7.7 mg Fe, 12 mg Na, 444 mg K, 6.41-7.85 mg beta-carotene equivalent, 0.13-0.15 mg thiamine, 0.26-0.53 mg riboflavin, 1.1-1.2 mg niacin, and 53-80 mg ascorbic acid. Leaves contain oxidase and chlorogenic acid. The folic acid content is substantially higher than other folacin-rich vegetables, ca 800 µg per 100 g (ca 75% moisture) or ca 3200 µg on a zero moisture basis[2].

One-half cup cooked saluyot leaves contains: 1.3 g protein, 0.3 g fat, 3.1 g carbohydrates, 0.4 g fibre, 87.3 mg Ca, 22.5 mg P, 1334 Aug AY-carotene or 222 Aug Retinol equivalent (vita A), 1.0 mg Fe, 0.02 mg thiamin, 0.04 mg ribiflavin, 0.3 mg niacin, and 10 mg ascorbic acid (vita C). Saluyot has antioxidant activity of 77% or Au-tocopherol equivalent (vita E) of 48.9[2].

PHOTOCHEMICAL FINDINGS:

A number of findings from the chemical investigations are as bellow:

Air dried powdered leaves of *C. capsularis* in chloroform in the ratio of 1:20 (w/v) demonstrated the presence of flavonoids, saponins, tannins, steroids and triterpenes[6]. The air-dried fibers of *C. capsularis* (supplied by CELESA, Tortosa; Spain) after milling and extraction with acetone (Soxhlet apparatus for 8 h) and water (3 h at 100ºC). Klason lignin content was estimated as the residue after sulphuric acid hydrolysis of the pre-extracted material according to Tappi rule T222 om-88 (*21*). The acid soluble lignin was determined, after the insoluble lignin was filtered off, by UV-spectroscopic determination at 205 nm wavelength. Ash content was estimated as the residue after 6 h of heating at 575ºC. The immediate analysis of jute fibers (as present of whole fibre) is as follows: ash. 1.0%; acetone extractives, 0.4%; water-soluble material, 1.0%; Klason lignin, 13.3%; acid-soluble lignin, 2.8% (Table)[7].

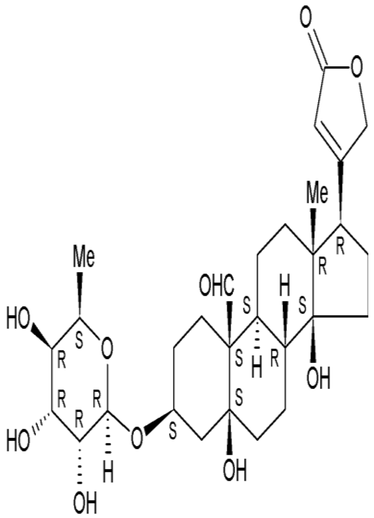
Table: Structural characteristics (relative abundance of the main inter-unit linkages, percentages of γ-acetylation and S/G ratio) from integration of ^{13}C-^{1}H correlation signals in the HSQC spectra of the milled-wood lignin (MWL) from *C. capsularis* fibers[7]

Linkage relative abundance	Percent of side chains involved
β-0-4/ linked units	72
Resinols	16
Phenylcoumarans	4
Spirodienones	4
p-hydroxycinnamyl alcohols	4
Erythro/threo ratio in β-0-4/ units	3.5
Percentage of γ-acetylation	4
S/G ratio	2.0

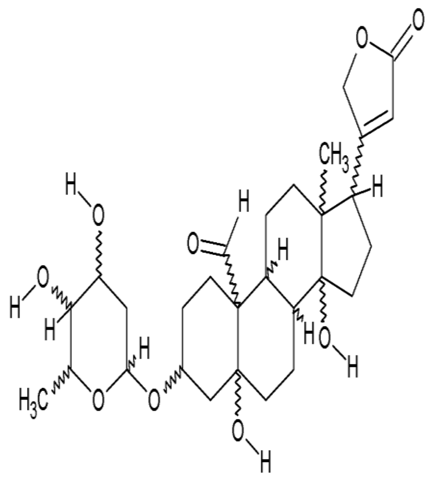
Dried and ground jute (*C. capsularis*) seed then exhausted with ether and petrol. The residue was next exhausted with 80% alcohol revealed the presence of raffinose (content about 2.25%). The substance had an extremely sweet taste, was very soluble in water and crystallized from alcohol in characteristic rosettes of white needles[8].

CARDIAC GLYCOSIDES, THEIR AGLYCONES AND A FEW UNCHARACTERIZED GLYCOSIDES/AGLYCONES:

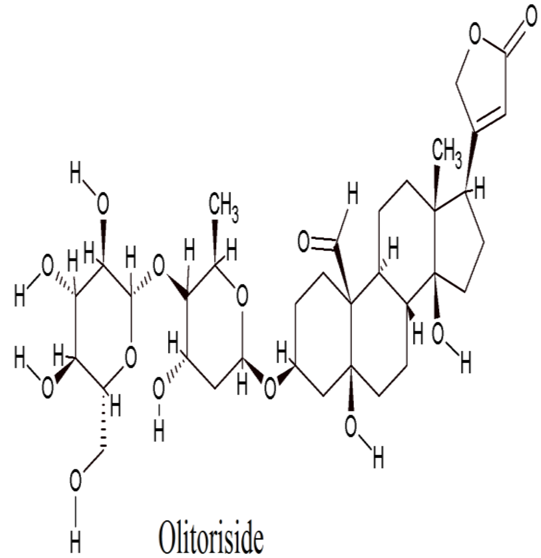
Several glycosidic compounds, referred to as corchorin, were isolated from different *Corchorus* species[9-12] but no define conclusions could be drawn regarding the structures of these compounds. Similar was the fate of capsularin[13], corchoritin[14] and corchsularin[15]. In the same manner, a number of aglycones namely corchsugenin[15] and corchortoxin[16] were isolated. A significant advancement was made when these aglycones were chemically identified as strophanthidin 1[17], the familiar aglycone of the cardiac glycoside strophanthin. This was followed by identification of 2-deoxy riboside and 2-deoxy-3-O-methyl riboside of strophanthidin[18,19], through the position of the sugar residue was not defined.



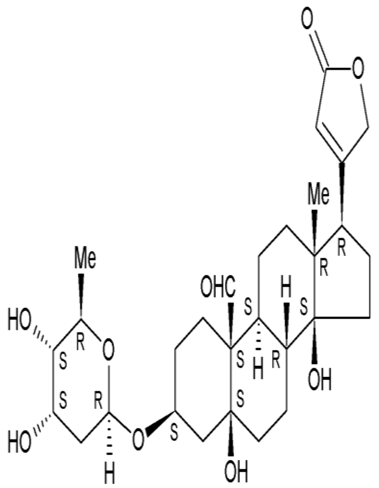
Strophanthidin



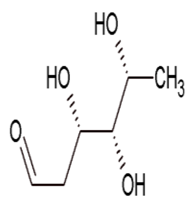
Corchoroside A



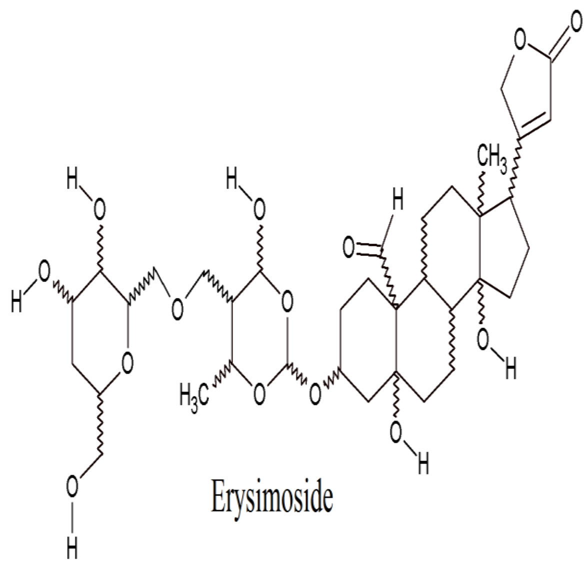
Olitoriside



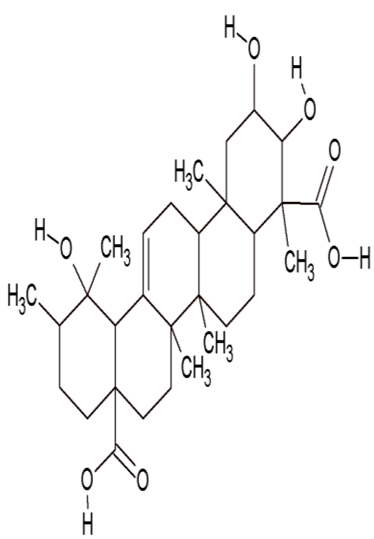
Helveticoside



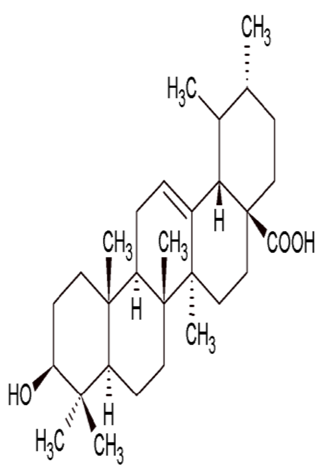
D-Boivinose



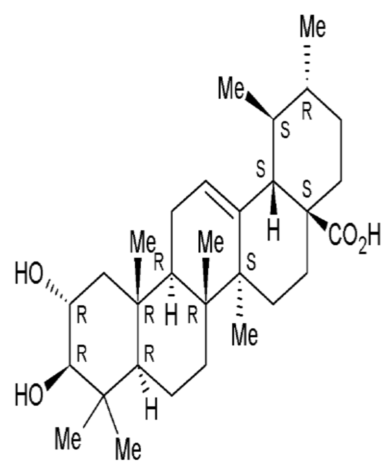
Erysimoside



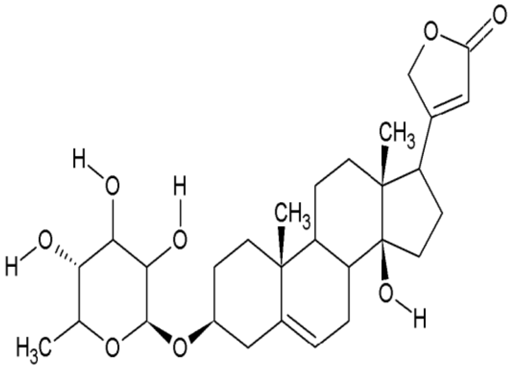
Corosin



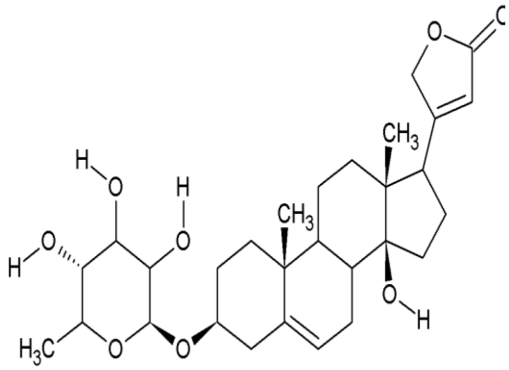
Ursolic acid



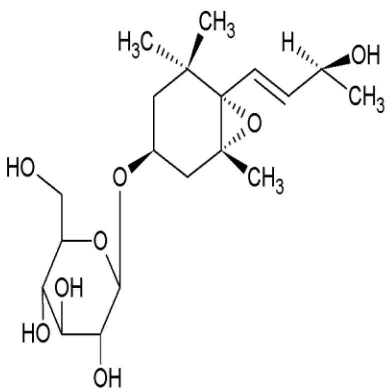
Corosolic acid



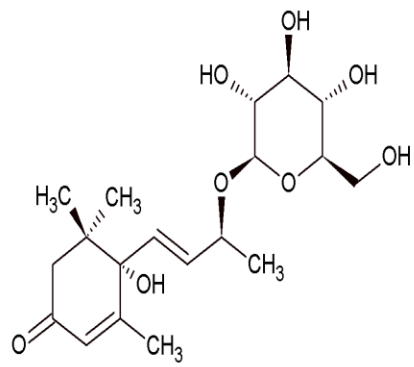
Corchoroside B



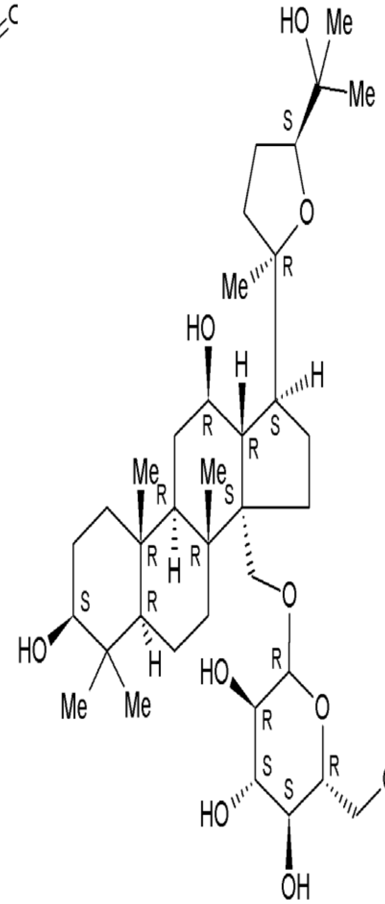
Corchoroside C



Corchoionoside A



Corchoionoside C



Capsugenin 30-O-glucopyranose

Two digitalis glycosides, corchoroside A 2 and corchoroside B 15[20], were isolated respectively from *C. capsularis*. An extract of the seeds of *C. capsularis*, after enzymatic hydrolysis, gave a fair yield of corchoroside A than the non-enzymatic treatment[21]. Seeds of this species gave a polar glycoside[22], O-D-glucopyranosyl-β-(1→3)-O-D-glucopyranosyl- β-(1→4)-D-boivinopyranosyl-β-(1→3)-O-D-strophanthidin. Energetic hydrolysis yielded glucose and no other hexose or pentose, whereas mild acid hydrolysis provided strophanthidin as an aglycone. Controlled enzymic hydrolysis with β-glucosidase gave olitoribose, glucose and boivinose, suggesting the sugar residue to be gluco-olitoribose. Complete enzymic hydrolysis of the product gave corchoroside A suggesting that glycoside is a higher homolague of corchoroside A. The periodate oxidation studies suggested that the nature of the linkage of glucose units is 1→3-β-linkage (laminaribiose residue). Laminaribiose residues were found for the first time as part of the cardiac glycosides[22].

Chloroform-butanol (1:3) fractions from the seeds[23] of *C. capsularis* byielded polar glycosides A and B. Chloroform-alcohol (2:1) extracted residue gave glycoside B and a new polar glycoside C. Comparison with an authentic sample showed glycoside A to be erysimoside, which had not previously been reported from the species, *C. capsularis* seeds. Glycoside C crystallized from isopropanol-methanol-ether, mp 200-10º/218-25ºC and was not identical with any compound isolated earlier from any *Corchorus* species.

Petroleum ether extracted seeds[24] of *C. capsularis* gave helveticoside. Its structure was confirmed by chemical and IR spectral data. Seeds[25] of the species on autofarmentation followed by extraction with methanol gave monosides corchoroside A 2 and helveticoside 4, biosides, olitoriside 3 and erysimoside 5, and a trioside, a glycoside of strophanthidin having boivinose and two glucose units as sugars.

Leaves of *C. capsularis* yielded glycosides, capsulasone, corchorol and capsularol besides KCl (4%) and small quantities of glucose, galactose and arabinose as free sugars. Capsularol, on acid hydrolysis, yielded glucose and an aglycone, capsularogenin[26].

POLYSACCHARIDES AND SOME OTHER SUGARS:

Free sugars, raffinose, sucrose, arabinose, fructose, glucose and galactose have been reported in the extract of seeds of *C. capsularis*, while raffinose, arabinose, fructose and glucose are reported in the root extract[27]. Oligosaccharide components of the seeds of the species were isolated and identified as sucrose, raffinose, stachynose and verbascose[28]. Fructose and galactose were identified in the bark of the species[29].

TRITERPENOIDS:

A triterpenoid corosin, isolated from root of *C. capsularis*, on refluxing with HCl, gave corosic acid ($C_{30}H_{44}O_6$), however, structures of both these compounds were not established[30]. Urosolic acid 25, corosoliv avid 26 and oxo-corosin were isolated from fresh, undried roots of the species[31].

The leaves of *C. capsularis* gave a new dammarane triterpine glycoside, capsin[32,33]. Later on, one more new triterpine glucoside capsugenin 30-O-glucopyranoside 36 was isolated from the mature leaves of the species[34].

PHENOLICS:

Isolation and characterization of cyanidin 45 and cyanidin glucoside 46 from *C. capsularis* bark[35] and cyanidin glucoside from the species leaves[35] have been reported.

STEROLS:

Isolation of β-sitosterol 63 from *C. capsularis* seeds, roots[27, 30] and leaves[26], and β-sitosterol-D-glucoside 64 from laves of Egyptian origin have been reported.

BIOLOGICAL FINDINGS:

Corchortoxin (strophanthidin), a cardiac aglycone, isolated from the *C. capsularis* seeds showed a cardiac activity similiar to digitalis genins, which however, was not better than the activity of seed extract[16]. Corchorosides A and B isolated from the seeds of the species were also found to have a digitalis like action[20].

Air dried leaves of *C. capsularies* extracted with chloroform in the ratio of 1:20 (w/v) revealed the presence of antinociceptive activity: abdominal constructional test, hot plate test and formalin test and anti-inflammatory activity: the carragreenan-induced paw edema test[6].

CONCLUSION:

The results of the review provide us with the substantiation of nutritional, chemical and biological importance of white jute to the different communities world-wide. Mainly the cardiac glycosides are the new research face to the phytochemistry and pharmacology. Moreover, it (*Corchorus capsularis*) can be taken as alternative sources for other constituents applicable to the nutrition, medicine and cosmetics.

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