



Jute-A biological elixir with multifaceted applications: An overview

Abdul sadat* and Kaushik chakraborty

University of Gour Banga, Mokdumpur, Malda, West Bengal, 732103, India

ABSTRACT

Jute (*Corchorus* spp.), the 'golden fibre' has innumerable applications from time immemorial. It is ecologically-safe and bio-degradable fibre crop next to cotton. Jute leaf has been used as food stuff and folk medicine in many cultures. In many countries jute leaf are consumed as, the leaf juice, fried leaf, cocked with vegetables and some time whole green leaf. It's nutritional value is well documented, as it contain as many as 17 active important raw materials like crude protein, fat, carbohydrate, crude fibres, ash and other minerals. It is rich in calcium, potassium, magnesium, copper, manganese, phosphorous, beta-carotene, and vitamin A, C and E. Recent studies suggests the presence of cardiac glycosides, triterpenoid, phenolic compounds, sterols, fatty acid and ionones in jute extract which have direct curative effect on human health such as anti-tumour, anti-inflammatory, antiseptic properties and help to cure other many chronic diseases. The review article gives a gross idea on the biochemistry and pharmacological activity of jute leaf, which broadly covers various scientific publications in different journals and contemporary works of the scientists.

Keywords: Anti-tumour; cardiac glycosides; human health; Jute leaf; phyto-chemistry.

INTRODUCTION

Jute, the 'golden fibre' has innumerable applications from time immemorial in daily life. Jute constitutes one of the most important degradable and renewable bio-resources (Duke 1979, Islam 2014). The use of jute is not only restricted to its fibre as structural and binding materials but with the advent of time has become an important component of the rural industries and biomedicines (http://www.worldjute.com/jute_news). Demand of jute for traditional garments and for medicinal value is ever increasing due to growing recognition of natural products being equally effective, safe, non-narcotic, and affordable and having no side effects. There is large scale international trade in the medicinal plants using jute leaf as major component (Islam 2012).

India has been traditionally rich in various types of medicinal plants. Since ancient times, people have been using herbal medicines to cure diseases (Anusriti *et al.*, 2015). About 20,000 species of plants are being used as medicinal plants world over. Out of the gross plant products which constitute about 25% of the prescribed medicines in world, jute shares a considerable portion (Calleja and Danny 2010 and Anwar 2011). This paper reviews history, chemical constituents, plant morphology and on the various biological activities of jute (*Cor-*

chorus spp.). The use of jute leaves is endless and because of this it is an indispensable resource for the rural people and now scientists all over the world trying to use this for treatment of several serious diseases.

HISTORICAL NARRATION

Jute grows under wide variation of climatic conditions and 'stress situation' of tropic and subtropics. Along with white jute, tossa jute has also been cultivated in the soil of Bengal. Currently, Bangladesh is the only global producer of white jute variety. However the Bengal region (West Bengal in India, and Bangladesh) is the largest global producer of the tossa jute varieties (Annon 2007 and Annon 2011).

The use of jute leaves as traditional medicine by the Egyptian and Indian dates back to some 2500 years. They used it to treat 'phlegm', cooling fever, laryngitis, diarrhoea and vomiting (Islam 2012). It is used as an herb in Middle Eastern and African countries, where the leaves are used as an ingredient in a mucilaginous potherb called 'molokhiya' (بذرة لوز مخ, of uncertain etymology). The Book of Job, in the King James translation of the Hebrew Bible mentions this vegetable potherb as "Jew's mallow. It is very popular in some Arabian countries such as Egypt, Jordan, and Syria as a soup-based dish, sometimes with meat over rice or lentils. Green jute leaves become so famous among peoples belonging to different religion and culture because of its high nutritional value. These leafy greens are cooked by different recipes in different cultures from time immemorial (Islam 2014).

* Corresponding Author

Email: abdulsadat8293257675@gmail.com

Contact: +91-9932341504

Received on: 09-11-2015

Revised on: 01-12-2015

Accepted on: 06-12-2015

VERNACULAR NAME AND NOMENCLATURE

In the province of Bengal jute is known as 'Paat' from the start of the 19th century. The name jute comes from the Odyssey term "jota". In West Bengal and Bangladesh jute known as *Pat*, *Paat*, *Naila* etc (Islam 2014).

TAXONOMY AND SYSTEMATICS

Represented in the table below

DISTRIBUTION AND CULTIVATION

Corchorus are flowering plants belongs the family-Tiliaceae and includes about 40 species (Islam 2014). All of the 40 species of jute are known to occur in nature and distributed in the tropics of both the hemisphere (CSIR 1950 and Islam 2014). Jute is grown (Fig.1) in India, Bangladesh, Myanmar, Nepal, China, Taiwan, Thailand, Vietnam, Cambodia, Brazil and some other countries.

West Bengal state of India used to enjoy almost a monopoly of this fibre commercially. Although jute is grown in almost all the districts of West Bengal, Murshidabad, Hooghly, Nadia, Howrah, 24 Pargana (North and South), Dinajpur (North and South) and Medinipur districts is the important producer district out of the total state territory. Among these both North and South Dinajpur district jointly covers 31,973 ha land for jute cultivation (Raja 2012).

PRODUCTION AND PRODUCTIVITY

Tossa and white jute varieties are thought to be native to Bangladesh and India, and are also the world's producer. It is grown for both fibre and culinary purposes. Total area under the crop cultivation of Bangladesh in the year 2010 was 708,000 ha and the total production was 8395,000 bales (BBS 2011). On the other hand in India during 2011 area under the crop cultivation was 768,000 ha and the total production was 1799,000 bales (FAO 2011).

PLANT PHENOLOGY, ARCHITECTURE AND PHYTO-CHEMISTRY

STEM: The plants are tall, usually annual herbs which reaches a height of 2-4mt. These plants are mostly unbranched or with only a few side branches (dicke 2000).

LEAF

Morphology: The leaves (Fig.2) are simple and arranged in alternate fashion (dicke 2000). Leaves are 6-10 cm. long and 3.5-5 cm broad. Its shape is elliptic-lanceolate and its apical part is acute or acuminate with glabrous and slightly serrate leaf margin. The lower serratures on each side of leaf prolonged into a filiform appendage over 6 mm. long and which is rounded at the base. The stipules are subulate, pubescent, glabrous or ciliated. Each leaf contains 3-5 nerves for wa-

ter and food transportation (Osawaru *et al.*, 2012 and Islam 2014).

When harvested, young, jute leaves are flavourful and tender; older leaves tend to be more woody and fibrous, making them less ideal for consumption. Young jute leaves are light green in colour and contain high level of nutrition's in the form of primary and low level of secondary metabolites (Chowdhary *et al.*, 2013). As jute leaf matures it become dark green in colour due to high level of chlorophyll and then turn into yellow followed by senescence (Roy 2014, Islam 2014).

Phytochemistry (Table 1): Rowe (1941) was probably the first person who took initiative for chemical analysis of jute leaf. The leaves are rich in betacarotene, iron, calcium, and Vitamin C. It has an antioxidant activity with a significant level of α -tocopherol equivalent to Vitamin E (<http://en.wikipedia.org/wiki/Jute>). Leaves are highly nutritive in quality and contain as many as 17 active important raw materials like crude protein, fat, carbohydrate, crude fibres, ash and other minerals. It is rich in calcium, potassium, magnesium, copper, beta-carotene, thiamine, riboflavin, niacin, ascorbic acid and manganese; moderate in phosphorous, while poor in, iron and sodium (Islam 2010, Calleja 2010 and Islam 2014).

Polysaccharides and other sugars (Fig 3): Mucilage extract of dried leaf of *C. olitorius* yielded an acid polysaccharide which is rich in uronic acid (65%) and consisted of rhamnose, glucose, galacturonic acid and glucuronic acid in a molar ratio of 1.0:0.2:0.2:0.9:1.7 in addition to acetyl group. Methylation analysis, Smith analysis and Degradation analysis reveals that the acid polysaccharide mainly consisted of O-4 substituted galacturonic acid and O-2 substituted rhamnose residues and most of the (1-4)-linked uronic acid residues are substituted at the O-3 position with glucuronic acid residue (Ohtani 1995). Fructose and galactose were also identified in leaves and bark of *C. capsularis*. Leaves contain two functional compounds; phytol (3,7,11,15-tetramethyl-2-hexadecen-1-ol) and monogalactosyldiacylglycerol (1,2-di-O- α -linolenoyl-3- β -D-galactopyranosyl-glycerol) (Calleja 2010 and Islam 2014).

Cardiac glycosides (Fig4): Several glycosides like capsularin, corchoritin, corchsularin and corchorin were identified from jute leaves without defining the definite structural configuration of these compounds (Saha 1922 and Moslemuddin 1955). Two digitalis glycosides, corchoriside A2 $\{[\alpha]_D^{20} = +11^\circ\}$ and corchoriside B15²⁰ $\{[\alpha]_D^{20} = +68^\circ\}$ were isolated respectively from *C. capsularis* and *C. olitorius* (Khan 2006 and Zainul *et al.*, 2007). A monoglucoside of corchoriside A from *C. olitorius*, and a diglucoside and a triglucoside of corchoriside A from *C. capsularis* were also identified (Khan 2006 and Zainul *et al.*, 2007). The monoglucoside of *C. olitorius* is named as olitoriside (Khan 2006 and Zainul *et al.*, 2007). Leaves of *C. capsularis* treated with KCl (4%) yielded glycosides, capsulason $\{[\alpha]_D^{30} =$

+42.8°(EtOH)), corchorol {C₂₂H₃₈O₉ [α]_D³⁰= -22.6°(EtOH)} and capsularol {C₄₁H₇₀O₁₁ [α]_D³⁰= -20.7°(EtOH)} and small amount of free sugars such as glucose, galactose and arabinose. Capsularol when treated with weak acid it hydrolysed to yield glucose and an aglycon- capsularogenin {C₃₅H₆₀O₆ [α]_D³⁰= +2.97°(EtOH)} (Kahda 1994 and Khan 2006). Another glycoside (capsugenin-30-O-β glucopyranoside) was also isolated from the leaves of *C. capsularis* L. The capsin was identified as the 3-glucoside of 20, 24-epoxy-3β, 12β, 25, 30-tetrahydroxydammarane (Furumoto *et al.*, 2002 and Zainul *et al.*, 2007).

Triterpenoids (Fig. 5): Kohda *et al* (1994) has first reported the isolation of a triterpenoid- oleanolic acid from *C. olitorius* of Egyptian origin. *C. capsularis* of Indian origin was reported with a new dammarane triterpenoid glycoside, capsin (3-glucoside of 20, 24-epoxy-3β, 12β, 25, 30-tetrahydroxydammarane). Triterpenic glycoside- capsugenin (30-O-glucopyranoside) was isolated from mature leaves of *C. capsularis* (Khan 2006 and Islam 2014).

Fatty acid (Fig. 6): Sen *et al.*, (1973) reported the presence of fatty acid in seed of *C. olitorius*. Subsequent examination reveals the presence of four higher fatty acids with a trienone system, corchorifatty acid A, B, C, D; an decanoic acid corchorifatty acid E and a trihydroxy fatty acid corchorifatty acid F (Khan 2006).

Phenolic compounds (Fig.7): Isolation and characterization of cyanidin and cyaniding glucosides from bark and leaf of *C. capsularis*, cyanidin glucosides from *C. capsularis* leaves, and astragalin and isoquercitrin from *C. olitorius* (Indian origin) leaves have been reported by Khan(2006). Leaves of *C. olitorius* (Egyptian origin) also contain four flavonoidal glycosides; astragalin (kaempferol-3-O-β-D-glucopyranoside), tolifolin (kaempferol-3-O-β-D-galactopyranoside), isoquercitrin (quercetin -3-O-β-D-glucopyranoside) and jugularin (kaempferol -3-O-β-L-glucopyranoside) (Ajuma 1999). Yuosikawa *et al.*, (1997) had first reported the presence of two coumarin glucpsides, cichoriine and scopolin from leaves of *C. olitorius* (Mukherjee 1998).

Sterols (Fig. 8): Isolation of β-sitosterol from *C. capsularis* seed, root and leaves; β-sitosterol D-glucoside from *C. capsularis* leaves and β-sitosterol 3-O- β-D-glucopyranoside from leaves of *C. olitorius* (Egyptian origin) have been reported by Kahda (1994) and Khan (2006) respectively.

Ionones (Fig. 9): Laves of *C. olitorius* contains ionone glucosides; corchoinoside A, B and C, an ionone galacosides (6S,9R)-roseoside and a monoterpenglucoside-betulabusive (Yoshikawa 1997).

Food and nutritional value: Jute leaves are consumed in various parts of the world. It is a popular vegetable in West Africa. The Yoruba of Nigeria call it "ewedu". The Hausa people of Nigeria and their Fulbe neighbours call it "rama." They use it to produce soup

("taushe") or boil the leaves and mix it with "Kuli-kuli" or groundnut cake and consume the mixture which they call "kwado" in Hausa. It is eaten with 'ugali', which is also a staple for most communities in Kenya. Jute leaves of certain jute plants [tosa jute and white jute], used as a food source in Asia, the Middle East, and parts of Africa. In addition to adding a distinct flavour to food, jute leaves also have nutritional value, and they act as thickeners in soups, stews, and sauces. Jute leaves may also be called saluyot or ewedu, depending on the region of the world in which one is cooking. It is possible to grow jute for its fresh leaves in some parts of the world, and some specialty stores also stock it in fresh, frozen, or dried form, depending on their location and size (Annon., 2011 and Calleja 2010). Like spinach, jute leaves can be cooked whole as a major component of a dish, or can be loosely chopped so that they blend better with other ingredients. Cooking with salt their jute leaves and rest them before cooking, to draw out some of the slime which can make them troubling to the palate. The longer jute leaves cook, the more slimy and dense they get, so it is important to pay attention to cooking times in recipes which call for jute leaves (Islam 2014). Ingredients comparison of jute leaf with leafy vegetable spinach is given below.

FLOWER (Fig 10): flowers are small yellow and 2-3cm diameter with five petals. Fruits encapsulate many seeds. It thrives almost anywhere and can be grown year-around (en.m.wikipedia.Corchorus. 2014 and Islam 2014)

JUTE LEAVES AND HUMAN HEALTH

Leaves of *Corchorus capsularis*, *C. olitorius* and *C. depressus* are demulcent, bitter, tonic, laxative, carminative, refrigerant, febrifuge, diuretic, and useful in chronic cystitis, gonorrhoea and disuria (Satyavati 1976). Following biological activities of jute leaf phytochemicals put lights on its medicinal values. Leaves of *C. depressus* are useful in increasing viscosity of seminal fluid (Wahhid 2000) and report on local survey shows that *Corchorus* species is used to increase sexual ability in males (Bhatt 2003).

Antinociceptive and Anti-inflammatory Activity

Acetic acid-induced abdominal constriction and hot plate tests: The chloroform extract of *C. capsularis* leaves was investigated for antinociceptive activity using acetic acid-induced abdominal constriction and hot plate tests in male Balb-C mice and the formalin tests in rats (Mosihuzzaman *et al.*, 1988). The extract was given 30 minutes prior to subjection to acetic acid-induced abdominal constriction and the hot plate tests. All concentrations used (10, 50 and 100% strength) showed significant reductions in the number of abdominal constrictions when compared to the control. The effective antinociceptive activity was seen at 100 mg/kg of the chloroform extract when compared to acetylsalicylic acid (100 mg/kg). The thermally induced

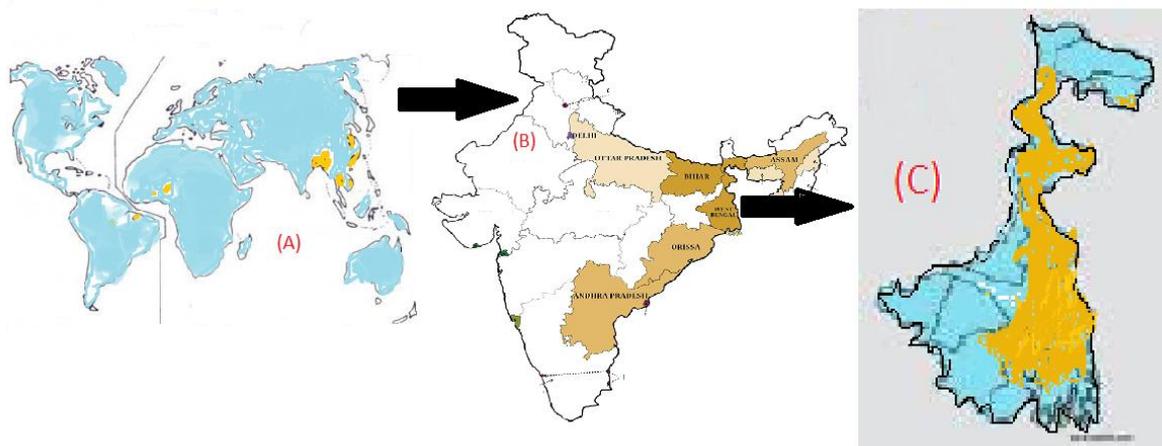


Figure 1: Jute Production In (A) World (B) India (C) West Bengal (After Abdul S, 2015)

Taxonomy And Systematics

Rank/place	Place with designation
Kingdom	Plantae – Plants
Subkingdom	Tracheobionta – Vascular plants
Superdivision	Spermatophyta – Seed plants
Division	Magnoliophyta – Flowering plants
Class	Magnoliopsida – Dicotyledons
Subclass	Dilleniidae
Order	Malvales
Family	Tiliaceae – Linden
Genus	<i>Corchorus L.</i>
Species	<i>Corchorus olitorius L.</i> – nalta jute <i>Corchorus capsularis L.</i> – white jute
English name	Jute
Bengali name	<i>Pat, Paat, Naila etc.</i>



Figure 2: Jute leaves

noniceptive peripheral stimulus in male Balb-C mice using the hot plate test at 50°C showed a significant concentration-independent antinociceptive activity in the chloroform extract of *C. capsularis* L. leaves. This activity was observed 30 min after the extract administration compared to morphine (5 mg/kg) which showed significant activity after 1 hour of its administration. These findings revealed the extract’s effectiveness in inhibiting chemically and thermally-induced nociception (Meara et al., 1952, Mosihuzzamana et al., 1982, Hasan et al., 1984, Quader et al., 1987, Mosihuzzaman et al., 1988, Furumoto et al., 2002, Zainul et al., 2007 and Ali 2013).

Formalin test: In the formalin test in rats, the chloroform extract of *C. capsularis* L. leaves was given 30 minutes prior to formalin injection. The extract exhibited significant antinociceptive activity at the early phase of nociception, indicating a neurogenic type of pain response, and also at the late phase of nociception, indicating an inflammatory type of pain response. (<http://www.globinmed.com/>). The anti-inflammatory profile of the chloroform extract of *C. capsularis* leaves was measured using carrageenan-induced paw edema test in rats. The extract at all concentrations (20, 50 and 100 mg/kg) caused a significant decrease in the thickness of edematous paw for the first 6 hours com

Table 1: Chemicals isolated from leaves of Corchorus species (C. capsularis and C. olitorius).

Chemicals	Corchorus Species	Compounds Isolated From Leaves	Reference
Cardiac Glycosides	<i>C. capsularis</i>	Capsulason, Corchorol, Capsularol	Zainul,2007
Cardiac Glycosides	<i>C. olitorius</i>	Corchoriside A,Olitoriside	Khan, 2006
Triterpenoid	<i>C. capsularis</i>	Capsin,Capsugenin,Capsularis	Khan 2006, Islam 2014
Triterpenoid	<i>C. olitorius</i>	Oleanolic acid	Kohda et al.,1994
Phenolic	<i>C. capsularis</i>	cyanidin glucosides	Khan, 2006
Phenolic	<i>C. olitorius</i>	Astragalin ,Tolifolin,Isoquercitrin, Coumarin glucpsides- Cichoriine and Scopolin	Mukherjee 1998, Ajuma 1999, Khan, 2006
Sterols	<i>C. capsularis</i>	β -sitosterol β -sitosterol D-glucoside	Kohda et al., 1994.Khan, 2006
Sterols	<i>C. olitorius</i>	β -sitosterol 3-O- β -D-glucopyranoside	Kohda et al.,1994. Khan, 2006
Fatty Acid	<i>C. olitorius</i>	corchorifatty acid A;B;C;D, Decanoic acid Corchorifatty acid E, Trihydroxy fatty acid Corchorifatty acid F	Khan, 2006
Ionones	<i>C. olitorius</i>	Ionone glucosides- Corchoinoside A, B and C, Ionone galacosides (6S,9R)-Roseoside,Monoterpenglucoside-Betulabuside	Yoshikawa 1997, Khan, 2006

Table 2: Nutritional values of jute leaves as saluyot (in boiled 100 grams edible portion), (Islam 2010, Islam 2012 and Islam 2014).

Nutrients	Range
Moisture (%)	80.4 – 84.1
Fat (g)	0.6-0.7
Food energy (cal.)	43 - 58
Protein (g)	4.5 –5.6
Fibre (g)	1.7 –2.0
Total Carbohydrates (g)	7.6 – 12.4
Ash (g)	2.4
Calcium (mg)	266 – 366
Phosphorus (mg)	97 - 122
Iron (mg)	11.6
Sodium (mg)	12
Potassium (mg)	444
Vitamin A (I.U.)	6,390
Thiamine (mg) (Vit.B1)	15
Riboflavin (mg) (Vit.B2)	28
Niacin (mg) (Vit.B3)	1.5
Ascorbic acid (mg)	95

pared to the control. The activity diminished in the last 2 hours of the experimental time compared to the control group (<http://www.globinmed.com/>). The positive reference compound used was acetylsalicylic acid (100 mg/kg) which produced significant anti-inflammatory activity. This test revealed the ability of the extract to block the inflammatory phase of the

formalin test, which confirmed the folkloric use of *C. capsularis* as a demulcent (<http://www.globinmed.com/>).

Based on all of these findings, the chloroform extract of *C. capsularis*, possessed antinociceptive and anti-inflammatory activities which confirmed the traditional claims of using *C. capsularis* to treat various ailments

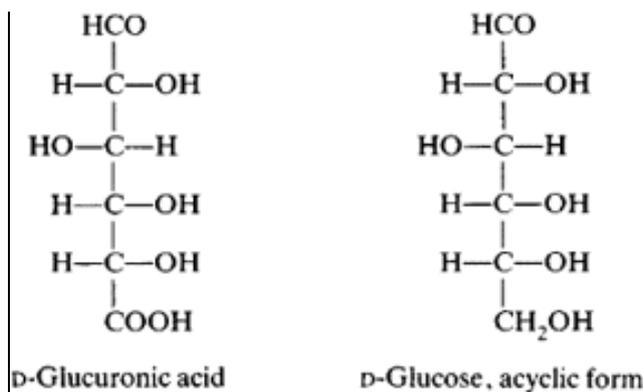


Figure 3: Polysaccharides

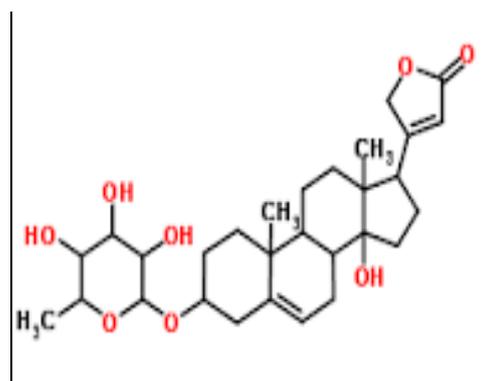


Figure 4: Corchoriside A; Cardiac Glycoside

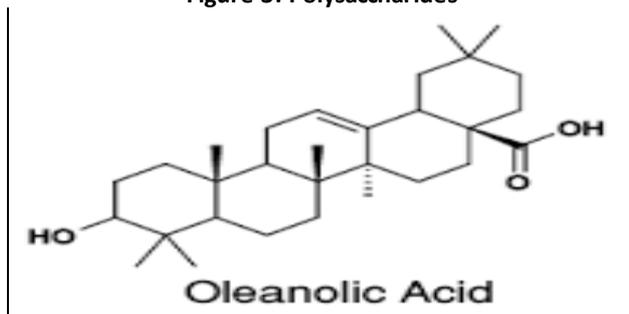


Figure 5: Triterpenoide

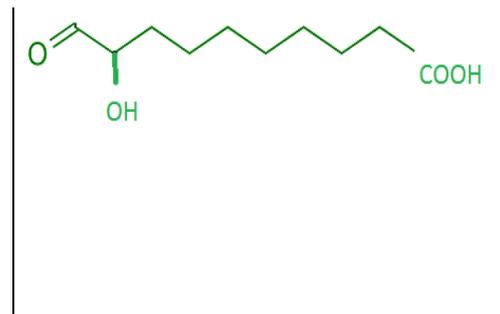


Figure 6: Corchorifaty acid E; Fatty acid

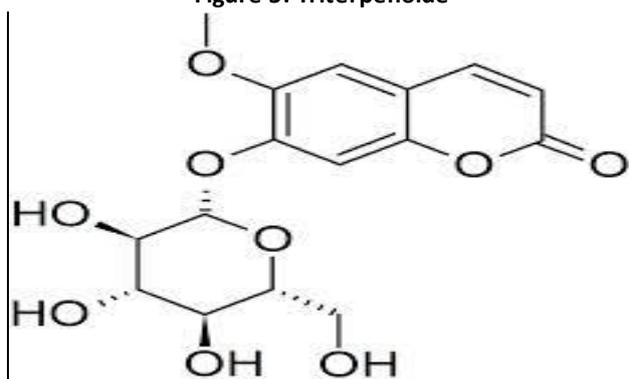


Figure 7: Scopolin; Phenolic compound

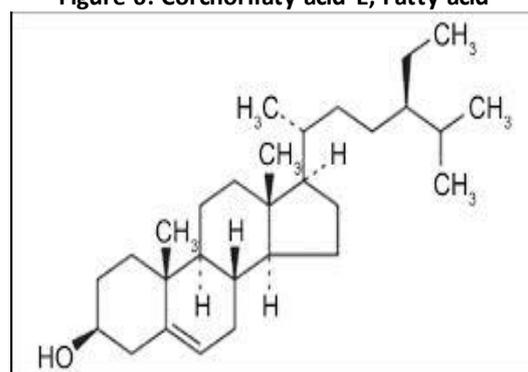


Figure 8: Sitosterol; Sterol compound

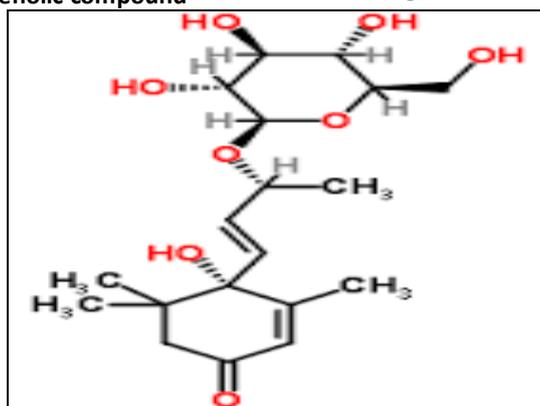


Figure 9: Corchinoside A; Ionone Compound

related to inflammation and pain (Meara et al., 1952, Mosihuzzamana et al., 1982, Hasan et al., 1984, Quad-er et al., 1987, Mosihuzzaman et al., 1988, Furumoto et al., 2002, Zainul et al., 2007, Ali 2013 and <http://indianjute.blogspot.nl/p/medicinal-use-herbal-use-of-jute-jute.html>).

Antitumor and anticancer promoting activity:

Two active components of *C. capsularis* were identified that showed activity against tumor promoter-induced Epstein-Barr virus (EBV) activation in *Raji cells*. They were isolated from the fresh leaves of *C. capsularis*. The active components were colorless oils and were identified as phytol (3,7,11,15-tetramethyl-2-hexadecen-1-ol) and monogalactosyl-diacylglycerol (1,2-di- α -

Table 3: Nutritional comparison between spinach and jute leaf (per 100 gm each), (Islam 2010, Annon., 2012 and Islam 2014)

parameters with unit	Leaf analyzed	
	Spinach	Jute
Calories (kl cal)	25	58
Protein (g)	3.3	5.6
Lipid (g)	0.2	0.6
Calcium (mg)	55	298
Iron (mg)	3.9	11
Carotene (mg)	5200	6400
Vitamin B-1 (mg)	0.13	15
Vitamin B-2 (mg)	0.23	28
Vitamin C (mg)	65	15

**Figure 10: Jute flower**

linolenoyl-3- β -D-galactopyranosylglycerol) (<http://www.globinmed.com/>). The antitumor-promoting activity was examined by an immunoblotting analysis using a mouse antiserum against EBV producer P3HR-1 cells. Phytol and monogalactosyldiacylglycerol completely inhibited the induction of EBV early antigen at concentrations of 15 $\mu\text{g/mL}$ (50.7 μM) and 30 $\mu\text{g/mL}$ (38.8 μM), respectively.

However insufficient inhibitory effects were shown by both compounds at concentrations of 10 $\mu\text{g/ml}$ and 25 $\mu\text{g/ml}$, respectively (; Meara *et al.*, 1952, Mosihuzzamana *et al.*, 1982, Hasan *et al.*, 1984, Quader *et al.*, 1987, Mosihuzzaman *et al.*, 1988, Furumoto *et al.*, 2002, Zainul *et al.*, 2007 and http://www.worldjute.com/jute_news/medijut.html). This study also revealed that both components increased gradually with an increasing in the period of treatment with hot water, indicating that the components were not easily decomposed by high temperature. These findings suggest that treatment of vegetables with hot water effectively increased the amount of active components with activity against tumor-promoting chemicals that may be consumed together with food (<http://www.globinmed.com/>). Alcoholic extract of whole plant showed anticancerous activity against human epidermal carcinoma of the nasopharynx in tissue culture (Khan 2006).

Cardiovascular Activity: Clinical effects of strophanthoid of jute (cardiac glycosides with strophanthin like action) were studied on 2000 human patients with cardiac decomposition. This drug shows rapidity of effect, effects on coronary vessel, degree of diastolic effect and diuretic action. Most active drugs used in cardiac problem are olitoriside and corchoriside which isolated from *C. olitorius* (Khan 2006). When cardiac glycosides are administered at different concentration levels (1.28, 12.8 and 128 mg/ml) to heart of Langendorff perfused rabbit; changes in left ventricular pressure, coronary flow and heart rate are observed as follows. At low drug concentration left ventricular pressure and coronary flow increased significantly. Further left ventricular pressure and coronary flow decreases and heart rate increased sharply and terminated with ventricular fibrillation at high drug concentration. This result suggests that leaf extract of *C. olitorius* have direct effects on cardiac myocardium (Khatib 1998 and Shamsuzzaman 2003).

Antihistaminic activity: Rat peritoneal exudate cell (induced by antigen-antibody reaction) treated with corchoinoside A, B and (6S, 9R)- roseoside isolated from *C. olitorius* leaves shows sharp reduction in histamine release (Yoshikawa 1997).

Table 4: Mechanisms of action of jute leaf and its components as medicine (after Islam MM, 2014)

Illness and disorders	Mode of accomplishment
Antinociceptive/ Anti-inflammatory	Study showed the extract of CC exhibited significant antinociceptive and anti-inflammatory activities confirming its traditional use for ailments associated with inflammation and pain. It is used traditionally to address concerns related to inflammation and pain. It is also been connected with curing the chronic inflammation of the urinary bladder.
Galactolipid / Anti-Tumor	Galactolipid 1 has been shown to be responsible for the anti-tumor promoting activity of jute (<i>Corchorus capsularis</i> L. and <i>Corchorus olitorius</i> L.).
Antipyretic/ Antinociceptive/ Anti-inflammatory	Study on the aqueous extract of jute plant leaves, <i>Corchorus capsularis</i> L., exhibited significant antinociceptive, anti-inflammatory and anti-pyretic activities in a dose-dependent manner and supports its claim of traditional use to treat various ailments.
Capsugenin	Study yielded a glycoside-capsugenin-30-o-B-glycopyranoside, from the leaves of <i>orchorus capsularis</i> L.
Headaches, Liver disorders	The powdered leaves, dried, 1 or 1 1/2 tbsps to a cup of water, steep for 3 to 5 minutes, and strain before drinking.
Dysentery, coughs and phthisis, and poulticing sores	Malays use a decoction of the leaves for dysentery, for coughs and phthisis, and as a tonic for children. Also, used for poulticing sores.
Antiseptic	Finely carded fiber sometimes used as base for antiseptic surgical dressings in traditional cure method.
Acute dysentery	Cold infusion of the leaves as a bitter tonic; used in patients recovering from acute dysentery.
Atonic dyspepsia, liver disorders, chronic cystitis, gonorrhoea, dysuria, worms in children, hepatic and intestinal colic, and gastric catarrh	Infusion of leaves used for atonic dyspepsia, liver disorders and as febrifuge. Also used for chronic cystitis, gonorrhoea, dysuria, worms in children, hepatic and intestinal colic, and for gastric catarrh.
Eyesight	Its vitamin content is good for eyesight, as the vegetable contains beta-carotene.
Swine flu	The Philippine Department of Health advises the public to increase their intake of jute leaf vegetable, to include malunggay and banana as well, in order to build resistance against the threat of swine flu.
Carminative, demulcent, laxative, stimulant and stomachic	The leaves are appetizer, carminative, demulcent, laxative, stimulant and stomachic. An infusion is used in the treatment of dysentery, fevers, dyspepsia and liver disorders.

Anticonvulsant activity: Methanolic extract of *C. olitorius* showed significant anticonvulsive activity by altering the level of catecholamine and brain amino acids (Gupta 2003a).

Antimalarial activity: Aqueous extract of *C. olitorius* showed strong growth inhibition (>96%) of the malaria parasite, *Plasmodium falciparum* (Sathiamoorthi 1999 and Khan 2006).

Hepatobiliary, renal and haematological activity: When methanolic extract of *C. olitorius* are administered weekly at increasing concentration levels (15, 20, 25 mg/kg) in mice but significant increase in clotting time was seen in moderate and high doses and significant increase in white blood cell count was observed only at high dose. Further, SGPT, SGOT, NPN and plasma cholesterol level significantly increased at moderate and high doses. Serum alkaline phosphate and total bilirubin level were also increased at moderate and high

doses. Low doses of the extract did not exhibit any significant change in creatinine and serum protein levels, but the high dose level significantly increased creatinine level (Majumdar 2003 and Shamsuzzaman 2003).

Antioestrogenic activity: Methanolic extract of *C. olitorius* caused remarkable delay in sexual maturation in female mice by arresting normal oestrus cycle. This delayed situation was evidenced by the age at vaginal opening and appearance of first oestrus (Gupta 2003b).

On administration of Methanolic extract of *C. olitorius* decreased weight of ovaries and uterus was observed in adult mice. Cholesterol and ascorbic acid content in ovaries showed significant increase in treated mice. After 17 days of treatment two key enzymes (Δ^5 -3- β -hydroxysteroid dehydrogenase and glucose-6-phosphate dehydrogenase) decreased significantly. The increased substrate and decreased enzyme concentration indi-

cates the inhibition of steroidogenesis, and it may be due to presence of flavonoides in leaf extracts of *C. olitorius* (Gupta 2003b).

Inhibitory Effects on nitric oxide production: Corchorifatty acid A, B and C showed an inhibitory effect on lipo-polysaccharide induced NO production in cultured mouse peritoneal macrophages (Khan 2006).

CONCLUSION

A number of jute varieties developed, released and used at farmers' level for commercial production of high quality fibre. Apart from fibre production leaves of those varieties have both nutritional and medicinal values. Jute leaf has long been used as a traditional cure in many cultures. Finding reveals that jute leaves also contain many phytochemicals including cardiac glycosides, triterpenoid, phenol, sterols, ionones etc. which can cures from many critical diseases. Out of the different medicinal herbs, jute leaf is granted with vast array of healing benefits. Jute leaf contains protein, calories, fibres and as well as antitumor promoters like Phytol and Monogalactosyl-diacylglycerol. It may reduce risk of cancer. Therefore jute leaf has a great importance in terms of human nutrition, health and beauty care. In future, controlled studies are required to prove the effectiveness of jute leaf under the various conditions.

Reference

- Ajuma, K., Nakayama, K., Koshioka, M. and Kohata, K., 1999. phenolic antioxidant from *Corchorus olitorius* L. J. Agri. Food Chem., 47: 3363-3366.
- Ali, M., 2013. Jute-A plant with many name and many uses. The Reflector, Reflecting the issues and development in societies and states. Vol. II. Publisher: Md. Eanyet Ullah, 366 South Paikpara, Mirpur, Dhaka-1216, Bangladesh, pp: 1-15.
- Anonymus., 2012. Indian Jute (Medicinal use / Herbal Use of Jute (Jute Leaves, etc.
- Anonymous., 2007. Plants for a future: Edible, medicinal, and useful plants for a healthier world (*Corchorus olitorius* L.) (<http://www.pfaf.org/database/plants>).
- Anonymous., 2011. Vegetable dishes: Molohiya. Turkish-Cypriot Cuisine.
- Anusriti, B., Sushil, K.M., Talambedu, U., Birendra, K.B. and Arvind, K.G. 2015. Bamboo, as Potential Sources of Food Security, Economic Prosperity and Ecological Security in North-East India: An Overview. Res. Plant Bio., 5(2): 17-23.
- Anwar, A., 2011. The Golden, Copper, and Silver Fibers. Golden Fibre Trade Centre Limited.
- BBS., 2011. Yearbook of Agricultural Statistics of Bangladesh. Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.
- Bhatt, D.C., Patel, A.M., Parekh, P.P. and Parmer, R.P., 2003. Plants Used for Sexual Debility in Central Gujarat, India. J. Econ. Taxon. Bot., 27: 943-946.
- Calleja, A. and Danny, O., 2010. "Saluyot now a popular vegetable worldwide". Inquirer.
- Choudhary, S.B., Sharma, H.K., Karmakar, P.B., Kumar, A.A. and Saha, A.R., 2013. Nutritional profile of cultivated and white Jute (*Corchorus*) species. Australian J. crop Sci., 7(13): 1973-1982.
- Dicke, M., 2000. Chemical ecology of host-plant selection by herbivorous arthropods: A multitrophic Perspective. Biochem. Systema. Ecol., 28: 601-617.
- Duke, J.A., 1979. Ecosystematic data on economic plants. Quart. J. Crude Drug Res., 17(3):91-110.
- en.m.wikipedia.*Corchorus*. 2014
- FAO., 2011. FAO Statistics, Food and Agriculture Organizations, United Nations.
- Furumoto, T., Wang, R., Okazaki, K., Feroj Hasan, A.F.M., Ali, M.I, Kondo, A. and Fukui, H., 2002. Antitumor Promoters in Leaves of Jute (*Corchorus capsularis*, *Corchorus olitorius*). Food Sci. Technol. Res., 8(3): 239-243.
- Gupta, M., Majumdar, U.K., Pal, D.K. and Bhattacharya, S., 2003b. Onset of puberty and ovarian steroidogenesis following of methnolic extract of *Corchorus olitius* L. in mice. J. Ethnopharmacol., 89: 55-59.
- Gupta, M., Majumdar, U.K., Pal, D.K., Bhattacharya, S. and Chacrabarty, S., 2003a. Studies on brain biogenic amines in methnolic extract of *Corchorus olitius* L. Seed treated mice. Acta. Pol. Pherma., 60: 207-210.
- Hasan, C.M., Islam, A., Ahmed, M., Ahmed, M. and Wattermans, P.G., 1984. Capsugenin, a dammarane triterpene from *Corchorus capsularis*. Phytochem., 23(11): 2283-2587.
- <http://en.wikipedia.org/wiki/Jute>.
- http://www.worldjute.com/jute_news/medijut.html
- Islam, M. M., (2010). In: Jute (In Bengali version), Pub. By Dynamic Publisher. Bangladesh.
- Islam, M.M. 2012. Jute (*Corchorus capsularis* L. and *C. olitorius* L.) leaf: Vegetable for nutrition and medicine for human health and beauty, http://www.purejute.com/images/stories/purejute/pure_jute/publicaties/jute_leaf.pdf
- Islam, M.M., 2014. Medicinal/Herbal use of jute. Bangladesh Jute Research Institute, Dhaka, Bangladesh.
- Kahda, H., Tanaka, S. and Yamaoka, Y., 1994. Constituents of *Corchorus olitorius* (L.). Nat. Med., 48: 213-214.
- Khan, M.Y.S., Bano, S., Jadav, K. and Asad, M.M., 2006. A comprehensive review on the chemistry and pharmacology of *Corchorus* species-A source of cardiac

- glycosides, triterpenoides, steroids and other compounds. J. Sci. Ind. Res., 65: 283-298.
- Khatib, S., Alkofahi, A., Hasan, N., Najib, M. and El-Oqlah, A., 1998. Effect of *Corchorus olitorius* leaf extract on left ventricular pressure, coronary flow and heart rate of isolated rabbit heart. Bio. Med. Let., 57: 147-152.
- Majumdar, U.K., Gupta, M., Pal, D.K. and Bhattacharya, S., 2003. Chemical and toxicological evaluation of methanolic extract of *Corchorus olitius* L. Seed on haematological parameters and hepatorenal functions in mice, Acta. Pol. Pherma., 60: 317-323.
- Mosihuzzaman, M., Fazlul Hoque, M. and Chowdhury, T.A., 1988. Phenolic Acids in Fresh and Retted Jute Plants (*Corchorus capsularis* and *Corchorus olitorius*). J. Sci. Food Agric. 42:141-147.
- Mosihuzzaman, M., Theander, O. and Amanb, P., 1982. Analysis of Carbohydrates in the Jute Plant (*Corchorus Capsularis* L.). J. Sci. Food Agric. 33: 1207-1212.
- Moslemuddin, M. and Ahmed, M., 1955. Cochorin. I, J. Indian Chem. Soc., 32: 577-580.
- Mukherjee, K.K., Mitra, S.K. and Ganguly, S.N., 1998. A new coumarin from *Corchorus olitorius* L. Nad. Prod. Sci., 4: 51-52.
- Ohtani, K., Okai, K. and Yamasita, U., 1995. Characterization of an acid polysaccharide isolated from *Corchorus olitorius* (Moroheiya). Biosci. Biotech. Biochem., 59: 378-381.
- Osawaru, M.E., Ogwu, M.C., Chime, A.O. and Amorighoye, A.R., 2012. Morphological evaluation and protein profiling of three accession of Nigerian *Corchorus* L. Species. Bayero J. Pure and Applied Sci., 5(1): 26-32.
- Quader, M.A., Ahmed, M., Hasan, C.M. and Waterman, P.G., 1987. Capsugenin-30-O-p -glucopyranoside: A new glycoside from the leaves of *Corchorus capsularis*. J. Natural Products., 50(3): 479-481.
- Raja, K., 2012. Complete information on area and production of jute in India. www. Preserve articles. Com/2012020322586.
- Roy, N., 2014. Role of *Chorchorus capsularis* phytochemicals on the feeding dynamics of *Diacrisia casignetum* Kollar (Arctiidac : Lepidoptera). J. Ento. Zoo. Stud., 2(4): 227-236.
- Saha, H. and Chaudhury, K.N., 1922. Capsularin, A new glycoside from jute leaf. J. Chem. Soc., 121: 1044-1046.
- Sathiamoorthi, P., Pollack, Y. and Golan, J., 1999. Screening for cytotoxic and anti-malarial activities in desert plant of Negev and Bedouin market plant product. Pharmaceutical Biol., 37: 188-195.
- Satyavati, G.V., Raina, M.K. and Sharma, M., 1976. Medicinal Plants of India. vol. I, ICMR, New Delhi, pp 278-281.
- Sen, G.A. and Majumder, U.K., 1973. The triglyceride composition of *Corchorus olitorius* seed oil. J. Sci. Food and Agri., 24: 1391-1395.
- Shamsuzzaman, K.M., 2003. Bangladeshi jute (*Corchorus capsularis*, *Corchorus olitorius*) leaf as medicine, Bangladesh Institute of Nuclear Agriculture, Bangladesh.
- The Wealth of India, Raw Materials. Vol II. National Institute of Science Communication and Information Resources, CSIR, New Delhi, 1950, 326-346.
- Wahhid, A. and Siddiqui, H.H., 2000. A survey of Drugs, 2nd ed, zafar Book Depo, Delhi. pp139.
- Yoshikawa, M. and Saka, M., 1997. Absolute stereostructure of corchoinoside A, B and C from leaves of Vietnamese *Corchorus olitorius* L. Chem. Pherma. Bull., 45: 464-469.
- Zainul, A.Z., Sulaiman, M.R., Gopalan, H.K., Abdul Ghani, Z.D.F., Raden Mohd Nor, R.N.S., Mat Jais, A.M. and Abdullah, F.C. 2007. Antinociceptive and Anti-inflammatory Properties of *Corchorus capsularis* Leaves hloroform Extract in Experimental Animal Models. Yakugaku Zasshi. 127(2): 359-365.