



## GOSSYPIUM HERBACEUM LINN: AN ETHNOPHARMACOLOGICAL REVIEW

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### ABSTRACT

*Gossypium herbaceum* Linn is known as cotton plant, belongs to the family Malvaceae, and occupies an imperative place in traditional systems of medicine especially in Unani and Ayurvedic medicines. The plant is widely distributed throughout western India, Africa, Middle East countries, central Asia and graded availability is found in Iran, Afghanistan, Russian and Turkistan. The qualitative phytochemical study of this plant extract indicates the presence of carbohydrates, saponins, steroids, glycosides, phenolic compounds such as tannins and flavonoids. The principle pigment of cotton seed is gossypol, a phenolic compound. The unsaponifiable fraction of Indian cottonseed oil contains sitosterol, ergosterol, lipids, gossypol, oleic, palmitic, and linoleic acids. The herb has been used traditionally from antiquity, in the treatment of inadequate lactation, bronchial asthma, dysmenorrhea, diarrhea, dysentery, otalgia, sexual debility, general weakness, diabetes, lung and skin diseases. It chiefly possesses antifertility, galactagogue, antispermatogenic, antidiabetic, antiviral and antibacterial activity. This work is an endeavor to explore and assemble the various pharmacological action and pharmacognostic aspects of the plant *G. herbaceum* reported till date.

**KEYWORDS:** *Gossypium herbaceum*, Phenolic compound, Phytochemical study, Pharmacological studies.

### INTRODUCTION

Malvaceae is a family of flowering plants containing 243 genera and at least 4,225 species of herbs, shrubs, and trees. Economically, the most important member of the family is *Gossypium* (cotton).<sup>1</sup> The genus *Gossypium* is a leading species, comprises around 50 species in the tribe *Gossypioideae* and few new species continue to be discovered.<sup>2</sup> The origin of this genus dates back to around 5-10 million years.<sup>3</sup> The name of the genus is derived from the Arabic word *goz*, which refers to a soft substance.<sup>4</sup> The word "cotton" originated from the Arabic term '*al qutn*', which became in Spanish '*algodón*' and cotton in English. Cotton was first domesticated in the Old World about 7,000 years ago.<sup>5</sup> It is native to India, having numerous varieties in this region.<sup>6</sup> A legend was perpetuated from a factual description of *G. herbaceum* plant by Greek historian Herodotus in the 5th century BC. It was first cultivated in China by about 600 AD.<sup>7</sup> The plant is mainly grown for its fibers, which are used to make clothing and similar products. *Gossypium* species are distributed in arid to semiarid regions of the tropics and subtropics. Generally shrubs or shrub-like plants, the species of this genus are extraordinarily diverse in morphology and adaptation, ranging from fire-adapted, herbaceous perennials in Australia to trees in Mexico.<sup>2</sup> Commercial species of cotton plant are *G. hirsutum* (>90% of world production), *G. barbadense*, (3-4%), *G. arboreum* and *G. herbaceum* (together, 2%).<sup>7</sup> However, *Gossypium herbaceum* has been widely used in the production of food and medicine as well. Cotton seeds are not only a valuable source of vitamins but an excellent pain reliever.

*Gossypium herbaceum* plant is mentioned in indigenous systems of medicine. It is an erect, shrubby, hairy plant, 2-8 feet high with thick woody stem and twigs and leaves sparsely hairy, rarely glabrous. The leaves are 5-7 lobed, lobes ovate, and rotundus only slightly constricted at base.<sup>8,9</sup> Bracteoles with 6-8 serrated teeth on the margin, broadly

triangular, usually broader than long. The flowers are large, yellow with purple center; calyx base is black with glandular dots and capsules ovate, pointed.<sup>8</sup>

Cotton seed is a by-product of the cotton ginning industry. Commercial cotton seed as obtained from the Gin contains besides the seed proper, remnants of unginning lint and a thick coating of short fibers constituting the fuzz. The fuzz is present in almost all types of cotton. The seeds after the removal of fuzz are dark brown or nearly black in color, pointed ovoid in shape and vary in size from 5.0 to 20 mm in Length.

It is native to the semi-arid regions of sub Saharan Africa and Arabia where it still grows in the wild as a perennial shrub. It was probably first cultivated in Ethiopia or southern Arabia and from there, cultivation spread to North Africa, Spain, Turkey, Ukraine, Turkestan, Persia, Afghanistan, and finally, to China.<sup>7</sup> The part of the plant used in medicine are seeds,<sup>8,9</sup> leaves,<sup>9</sup> root,<sup>8,9</sup> and root bark.<sup>9</sup> The taste of seeds is slightly bitter.

### Vernacular names:

Unani: *Pambadana*;<sup>9</sup> Arabic: *Habbul qutn*<sup>10, 11</sup> *qutn*;<sup>12</sup> English: Bona,<sup>10</sup> Kapasia,<sup>10</sup> Common cotton,<sup>10</sup> Indian cotton,<sup>10, 12, 13</sup> Levant cotton;<sup>9</sup> Urdu: *Pambadana*, *Habbul qutn*, *Rui*;<sup>12</sup> Hindi: *Kapasa*,<sup>10</sup> *Binaula*,<sup>10</sup> *Kapas*;<sup>10, 8, 12, 9</sup> Persian: *Pambadana*;<sup>11, 10</sup> Sanskrit: *Tundakesi*,<sup>10</sup> *Karpas*,<sup>10</sup> *Anagnika*<sup>12, 13</sup> *Chavya*;<sup>10, 12</sup> Kannada: *Hati*; *Arale*; *Ambara*; *Arali*; *Karpasa*<sup>10</sup>

**Pharmacological actions in traditional and ethno medicine:** The significance in the actions of both traditional and ethno medicine medicines shows the accuracy of the data. This comparison provides a concise summary that the traditional system of medicines itself has lot of experienced evidences not a mere of coincidence.

#### Action mentioned in Unani medicine

- *Muqawwie bah* (aphrodisiac)<sup>14, 15, 16</sup>
- *Moallide sheer* (galactagogue)<sup>15, 16</sup>
- *Musmmine badan*<sup>16, 17</sup>
- *Moallide mani* (spermatogenic)<sup>8, 10, 16, 17</sup>
- *Munaffise balgham* (expectorant)<sup>8, 10, 15, 16</sup>
- *Jali*<sup>8, 10, 16</sup>
- *Mulaiyan* (laxative)<sup>14, 16, 17</sup>

#### Actions mentioned in ethno medicine

- Demulcent<sup>13, 18</sup>
- Laxative<sup>13, 18</sup>
- Expectorant<sup>13, 18</sup>
- Galactagogue<sup>18</sup>
- Aphrodisiac<sup>13</sup>

#### Medicinal uses in Unani medicine

##### Seed:

- It is useful in *qillatul laban* (inadequate lactation), *sual* (cough),<sup>11, 14, 16,</sup> *zeequn nafas* (bronchial asthma),<sup>8, 15</sup> *zofe bah* (sexual debility),<sup>11, 8, 16, 17,</sup> *zofe aam* (general weakness),<sup>10</sup> *ziabatees*, (diabetes)<sup>15</sup> *ikhthenaqurrehm* (hysteria),<sup>15, 16</sup> *amraz riya* (lung diseases),<sup>15</sup> *amraz jild* (skin diseases) etc.<sup>14, 15, 16</sup>
- The flour of seed is five times more tonic (*muqawwi*) than wheat flour and two and half times more *muqawwi* than meat.<sup>15</sup>

##### Leaves:

- Water (juice) of leaves is useful in *ishal atfal* (childhood diarrhea).
- *Zimad* (paste) of leaves with *roghan gul* (rose oil) is useful in gout.
- *Zaroor* (powder) of leaves is useful to stop bleeding from the wound.<sup>11</sup>

**Dosage:** 3-7 g;<sup>16</sup> 6 – 20 g;<sup>16</sup> 25.5 g<sup>19</sup> (juice of leaves)

**Formulations in Unani medicine:** *Majoon arad khurma*,<sup>8, 10</sup> *majoon mumsik*<sup>8</sup> and *majoon pambadana*<sup>8, 10</sup>

#### Medicinal uses in ethno medicine

##### Seeds

- It is useful as a nervine tonic in headache and brain affections, and decoctions of the seed are given in dysentery and intermittent fever.<sup>13, 18</sup>
- The seeds in the form of emulsion are given in dysentery.
- Pounded and mixed with ginger and water they are applied to orchitis.
- The seeds in the form of poultice make a good application to burns and scalds.
- The cotton seed oil is useful in clearing the skin of spots and freckles.<sup>13</sup>

##### Leaves

- The juice of the leaves is useful in dysentery.
- The leaves externally in the form of poultice hasten the maturation of boils and with oil they are applied as a plaster to gouty joints.<sup>13</sup>
- Root bark of *Gossypium herbaceum* Linn. (*kapas*) and leaves of *Bambusa arundinacea*, (*bans*) are mixed together and given with water to induce abortion.<sup>20</sup>
- Leaves of *Gossypium herbaceum* (*kapas*) and *Bambusa arundinacea* (*Bans*) are given orally to augment labor.<sup>20</sup>
- Leaves of *Gossypium herbaceum* (*kapas*) are given orally in retention of placenta.<sup>20</sup>

#### Flowers

Flowers are useful in uterine discharge. Gossypol, phenolic compound is used in treating endometriosis and uterine bleeding.<sup>21</sup>

#### Root

- The root has emmenagogue property, useful in dysmenorrhoea and suppression of the menses produced by cold.<sup>13</sup>
- It is used to enhance the first stage of labor.<sup>13</sup>
- Decoction of root of *Gossypium herbaceum* are given orally in retention of placenta.<sup>20</sup>
- It is used for *sual* (cough), *zeequn nafas* (asthma) and *zofe bah* (sexual weakness).<sup>13</sup>

#### Pharmacognostical and phytochemical standardization of root

The microscopic studies of the transverse section of root of *Gossypium herbaceum* showed the parts from cork to xylem. The structure of cork, pericyclic fibers, phloem, lysigenous cavities, medullary rays and xylem are the distinguishing features of the root. Calcium oxalate crystals, starch grains, lignified fibers, pitted and annular vessels, tannin content, stone cells are found in powder microscopy.

The physicochemical parameters of the root were the loss on drying 6.47 % w/w., ash value 5.2 % w/w, the acid insoluble ash 0.02 % w/w, water soluble extractive 5.6 % w/w. and the alcohol soluble extractive 8.80 % w/w. Phenols, tannin, starch, saponin and carbohydrates were present in its root. All other components were found to be absent. TLC profile at 254 nm frequency, one spot, Rf value 0.04 & at 366 nm one spot, Rf values 0.50. After spray two spots, Rf values are 0.06, 0.51.<sup>22</sup>

#### Phyto-chemical constituents of seed

**Organic:** The cotton seeds contain glycosides, steroids, resins, saponins, carbohydrates, proteins and phenolic compounds tannins.<sup>8, 23</sup> It contains an adequate amount of other essential amino acids. The biological value and digestibility of the total proteins of cotton seeds are 91 and 78 respectively. The mineral constituents of the cotton seed are: phosphorus 1.03–1.33; calcium 0.24–0.04; iron 0.02–0.03;<sup>8, 18</sup> potassium 0.94–1.07; sodium 0.05–0.14; magnesium 0.44–0.56; manganese 0.03–0.04; aluminium 0.01– 0.06; silica 0.12–0.39; sulphur 0.17–0.28 and chlorine 0.92–0.04%. Traces of copper, boron, zinc, nickel, strontium and barium are also reported to be present. The oil free cotton seed meal contains iodine (23–1,400 ug/kg; dry basis) and fluorine (20–31 p.p.m). Cottonseed is rich in vitamins of the B-Complex (thiamine, 3.2; riboflavin, 2.3; nicotinic acid, 16; pantothenic acid, 11; pyridoxine, 0.91; biotin, 0.29; inositol 3,400 and folic acid, 3.8 ug/g on dry wt basis. Vitamins A, D, and E are also present. The enzymes reported to be present in the seed are lipase, catalase, peroxidase and phytase.<sup>18</sup>

The principle pigment of cotton seed is gossypol (C<sub>30</sub>H<sub>30</sub>O<sub>8</sub>), a polyphenolic compound, present to the extent of 0.4–2.0% in the kernels.<sup>18</sup> The presence of six phenolic hydroxyl groups and two aldehydic groups makes gossypol chemically reactive. Gossypol can undergo Schiff base formation, ozonolysis, oxidation, and methylation to form gossypol derivatives.<sup>24</sup>

Other pigments present in the seed are gossypupurin, gossyfulvin, gossycaerulin, carotenoids and flavones, yellow

pigment. The unsaponifiable fraction of Indian cottonseed oil contains sitosterol and ergosterol. Other substances present in cotton seeds are saponins, lactic acid, choline, betaine and sulphhydryl compounds. Cottonseed is rich in total phosphorus, phytins and phosphatides. Phytins accounts for 72% of the total phosphorus present.<sup>18</sup>

#### Modern pharmacology

Gossypol and its derivatives has been the target of much research due to their multifaceted biological activities including anticancer, antifertility, antioxidant, antitrypanosomal, antimalarial, antimicrobial, and antiviral activities. Because of restricted rotation of the internaphthyl bond, gossypol is a chiral compound, which has two atropisomers (i.e., (+)- and (-)-gossypol) that exhibit different levels of biological activities.<sup>24</sup>

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##### Anti-bacterial activity

Agarwal et al mentioned that the extract of *Gossypium herbaceum* has antimicrobial property.<sup>25</sup>

Chaturvedi et al in their study found that free and bound flavonoid fraction of seed extracts of *G. herbaceum* as well as the free flavonoids of the callus extracts was active against *T. viride*. *G. herbaceum* and *G. hirsutum* showed activity against *B. cerus* and *S. typhimurium*. Free flavonoid fraction of seeds of *G. herbaceum* and *G. hirsutum* showed activity against *B. cerus*, *S. epidermidis*, *T. viride* and *Salmonella typhimurium*, *E. coli*, *T. viride* respectively. Free and bound flavonoids fraction (seeds and callus) of all the three *Gossypium* species did not show any activity against *C. albicans*.<sup>26</sup>

**Anti-cancer activity:** Mi et al investigated the in vitro and in vivo activities and related mechanism of apogossypolone (ApoG2) alone or in combination with adriamycin (ADM) against human hepato-cellular carcinoma (HCC). They concluded that ApoG2 is a potential non-toxic target agent that induces apoptosis by up regulating Noxa, while inhibiting anti-apoptotic proteins and promoting the effect of chemotherapy agent ADM in HCC.<sup>27</sup>

**Anticonvulsant activity:** Rasilingam and coworkers in their study concluded that, the gossypin a bioflavonoid exhibits anticonvulsant activity and the probable mode of action may be due to GABA-aminergic mediation, glycine inhibitory mechanism and inhibition of the electrical kindling effect.<sup>28</sup>

**Anti-depressant activity:** One of the study showed that aqueous extract of *Gossypium herbaceum* showed significant antidepressant-like effect due to activation of adenylyl cyclase-cAMP pathway in signal transduction system and hence protecting the neurons from the lesion.<sup>29</sup>

##### Anti-fertility activity:

Gossypol, a phenolic compound isolated from cotton seed oil was proposed as a male contraceptive. Hadley et al found that gossypol treatment reduced the level of serum testosterone and luteinizing hormone levels in dose and duration dependent manner. Gossypol acts directly on testes and induces azoospermia or oligospermia. Zavos and Zavos demonstrated that gossypol blocked cAMP formation in sperm, which resulted into inhibition of sperm motility. Nair and Bhiwgade have studied the effect of gossypol on pituitary gonadal axis and found the decreased secretory activity of accessory sex glands. Bai and Shi also investigated the inhibition of T type Ca currents in mouse spermatogenic cells

by gossypol. Antifertility activities were also found in hamsters and in rats.<sup>30</sup>

Bender et al examined the tissues of female rats treated with gossypol acetic acid for morphologic evidence of an underlying mechanism of infertility. The number of estrous cycles, and body and adrenal weights were also compared. The number of estrous cycles decreased in rats treated with 60 mg/kg gossypol acetic acid for 30 days. Body weights were also reduced in rats treated with 40 mg or 60 mg/kg per day for 30 days when compared to controls. However, no significant differences were found in any group when comparing adrenal weights, adrenal weight/body weight ratios or adrenal histology. The body weight loss was related, at least in part, to diarrhea and dehydration in eight of the treated animals. It is interesting that though the gossypol-treated rats had reduced numbers of estrous cycles, no histopathologic changes were found in their ovaries, uterus or vagina.<sup>31</sup>

Another study was carried out to examine the role of Sertoli cells in the anti-spermatogenic action of two non steroidal male contraceptive compounds (CDRI-84/35 and gossypol) by evaluating their effect on some key parameters of Sertoli cell function in vitro. The authors concluded that the anti-spermatogenic action of CDRI-84/35 and gossypol is routed through Sertoli cells by disruption of important cell functions that support spermatogenesis in-vivo. However, the two compounds appear to have different course of action in Sertoli cells, ultimately leading to spermatogenic failure.<sup>32</sup>

**Anti-oxidant activity:** Kumar et al in their study reported that Hydro alcoholic extract of *G. herbaceum* provided a comprehensive profile of the antioxidant activity; with respect to its phenolic content. *G. herbaceum* reduces the free radical to corresponding hydrazine when it reacts with hydrogen donors in antioxidant principle.<sup>23</sup>

*Gossypium herbaceum* seeds are reported to have antioxidant activity, anti-diarrhoeic, wound healing, anti-migraine, and diuretic activity.<sup>33</sup>

**Antiulcer activity:** The aqueous and ethanolic extracts of flowers of *Gossypium herbaceum* L. increases healing of gastric ulcer and possess potential antiulcer activity.<sup>34</sup>

**Diuretic activity:** Narasimha et al investigated the diuretic activity of ethyl acetate and alcohol extract of *G. herbaceum* leaves in male wistar albino rats. The extract showed dose dependent increase in natriuretic and chloruretic activity and kaliuresis. The alcoholic extract showed significant activity than the ethyl acetate extract as a diuretic. The researchers found that the ethanol extract of *G. herbaceum* leaves was an effective hypernatraemic, hyperchloremic and hyperkalemic diuretic, which provides the pharmacological evidence of *G. herbaceum* leaves as an effective diuretic.<sup>33</sup>

**Galactagogue activity:** The studies conducted in buffaloes, showed that cottonseed feeding enhances the milk production significantly ( $P<0.01$ ) in comparison to commercial concentrate mixture fed control group animals.<sup>35, 36, 37</sup>

**Hepatoprotective effect:** A hepatoprotective effect of *G. hirsutum* and *G. herbaceum* extracts is reported by Batur et al.<sup>38</sup>

**Wound healing activity:** Velmurugan et al in their study confirmed that methanolic extract of leaves of *Gossypium herbaceum* have promising wound healing activity that may be attributed to presence of different phyto-constituents like flavonoids, tannins etc.<sup>39</sup>

*G. herbaceum* milk is useful for skin moisturizing, hair repairing and conditioning.<sup>40</sup>

**Toxicological study:** A phyto-therapeutic preparation containing *Gossypium herbaceum* was tested by Mello et al for preclinical toxicity, and the results revealed the absence of systemic toxicity at a therapeutic dose.<sup>38</sup>

## CONCLUSION

*Gossypium herbaceum* is an old age herb especially used in Unani and Ayurvedic medicines in the treatment of inadequate lactation, bronchial asthma, dysmenorrhea, sexual debility, general weakness, diabetes, lung and skin diseases. The pharmacological activities of this herb have been proven on the scientific parameter, which are attributed to its phyto chemical constituents such as saponins, steroids, glycosides, phenolic compounds such as tannins and flavonoids. It chiefly possesses galactagogue, antifertility, antispermatogetic, antidiabetic, antiviral and antibacterial activity.

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