

## PHYTOPHARMACOLOGICAL ASPECTS OF CHLOROPHYTUM BORIVILIANUM (SAFED MUSLI): A REVIEW

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### ABSTRACT

*Chlorophytum borivilianum* family Liliaceae is a traditional rare Indian medicinal herb widely used in the treatment of many clinical conditions in India. It is an important drug commonly known as 'Safed Musli'. It has many therapeutic applications in Ayurvedic, Unani, Homeopathic and Allopathic system of medicine. In the Ayurvedic literature, Safed Musli is celebrated as a Divya Aushad with unparalleled medicinal properties. It is a chief ingredient in the preparation of over a hundred Ayurvedic formulations. *Chlorophytum borivilianum* is widely cultivated throughout India. Major phytochemical components reported from the roots of *C. borivilianum* include mainly steroidal saponins, fructans and fructoligosaccharides (FOS), acetylated mannans, phenolic compounds and proteins. In this review paper, an attempt has been made to explore various dimensions of the drug including phytochemical and pharmacological studies carried out on this drug.

**Keywords:** Chlorophytum borivilianum, Safed musli, Phytochemical, Pharmacological study.

### INTRODUCTION

Safed musli (*Chlorophytum borivilianum*) is a herb, belongs to family Liliaceae. It was originally grown in thick forests of India. About 300 species are distributed throughout the tropical and subtropical parts of the world. Tropical and subtropical zones of Africa are the probable centres of origin of the genus. Seventeen species of *Chlorophytum* had been reported in India<sup>1</sup>. All differ in medicinal properties but due to lack of correct information, all of them are called safed musli. In India, it is considered as a valuable medicinal herb, whereas in other parts of the world it is being used as ornamental plant. The roots (tubers) are rich in alkaloids, vitamins, minerals, proteins, carbohydrates, saponins, polysaccharides and steroids. It has various therapeutic values as total rejuvenator, antioxidant and Immunomodulator. It is being used as an anti arthritic and anticancer drug. Because of its aphrodisial properties, it is mainly identified as 'Herbal viagra'. Safed musli is found in tropical moist and dry deciduous forests<sup>2</sup>. It is widely distributed in

India mainly in Southern Rajasthan, Western Madhya Pradesh, North Gujarat and few parts of Karnataka. But, continuous exploration has decreased its frequency, distribution and the quality.

The 'Safed Musli' complex is generally supposed to consist of *Chlorophytum borivilianum*, *C. arundinaceum*, *C. tuberosum* and *Asparagus adscendens*. Among all these varieties *C. borivilianum* is cultivated on large scale in many parts of the county because it produces the highest yield and highest saponin content and used as Safed Musli. Although Indian forests are rich in 'Safed Musli', its demand is increasing rapidly in the Indian and international drug markets. According to a report in 2005-06, the demand for dry Safed musli is in the order of 35,000 tonnes per annum, the supply stands at 5,000 tonnes per year<sup>3</sup>. Hence there is a strong need to understand the current scenario of its cultivation, description and its new medicinal properties.

**Vernicular Name**

Sanskrit	: Swetha musli.
Hindi	: Safed musli, Hazarmuli, Satmuli
Gujrati	: Ujlimusli, Dholi musali
Malyalam	: Shedeveli, Shedheveli.
Marathi	: Safed musli, Sufed Musli, Kuli.
Tamil	: Tannirvittang, Tannirvittan- Kizhangu, Vipurutti, Taniravi thang
Telgu	: Tsallogadda, Swetha musli.
Arabic	: Shaqaqule-hindi
Sinhalese	: Hirtha-wariya, Mushali
Garhwal	: Jhirna
U.P	: Khairuwa
Arabic	: Shaqaqule.
English	: India spider plant, Spider plant (India), White musale.
French	: Chlorophytum medicinal

**Ayurvedic Description**

**Botanical name:** *Chlorophytum borivilianum*

**Sanskrit name** : Swetha musli

**Synonyms** : Safed musli

**Properties** :

Rasa	: Sweet, Bitter
Guna	: Moist, Unctuous,
Heavy Virya	: Cold
Vipaka	: (post-digestive effect): Sweet <sup>4,5</sup> .

**Traditional uses**

Traditionally, tubers are used in the treatment of rheumatism and the leaves as vegetable in various culinary preparations. It is traditionally used for its aphrodisial properties in lack of libido male impotency, oligospermia. It is also widely used as a general health promotive tonic and for delaying the ageing process. Dried root powder increases the lactation amongst the feeding mothers and lactating cows. It also removes the knee pains within a week if taken daily with milk<sup>6,7</sup>. Leaves are eaten by the tribal people of Western Ghats as an expectorant. In the traditional diet of nursing mothers (after confinement) its powder is added in the preparation of laddoos (sweet prepared in ball form) to be taken as a energizing food. Efforts are on in countries like the USA and England to make chips/flakes with the tubers to use it as a nutritious item in breakfast. *C. borivilianum* has been described in ancient Indian literature such as Bhavaprakash Nighantu, Rasendra Sarsangrah, Raja Ballabh Nighantu as 'Vajikaran' or aphrodisiac. The roots of *C. borivilianum* are a constituent of 'Chyawanprash' an outstanding rejuvenator<sup>8</sup>. It is known as the Indian Ginseng<sup>9</sup>, because of great therapeutic importance and its tubers are

the major constituents of more than 100 ayurvedic preparations<sup>10</sup>.

**Cultivation**

In India, it is cultivated in parts of Gujarat, Maharashtra, Rajasthan, Madhya Pradesh, Chhattisgarh, Uttar Pradesh, Haryana and Karnataka in tropical and sub tropical climates with altitudes up to 1500m. It is being grown on an area more than 400 hectares for its tuberous roots<sup>11</sup> and also grows naturally in most forest parts of central India where climatic conditions are suitable. This plant can grow well in a range of temperature and rainfall conditions. A sandy loamy soil with adequate drainage is ideal for its production. Normal pH range 6 to 7, higher dose of super phosphate, decomposed farmyard manure and good drainage system facilitates better tuber growth. It is usually found in soils rich in organic matter and requires bright sunlight<sup>5</sup>. Cultivation of Safed musli usually begins in the month of April/May. After the field is prepared, Safed musli is sown with the onset of the monsoon. Bavastin treated fingers are separated and planted at a distance of about 25 cm within the row. The planting density is about 80,000 fingers per hectare, weighing approximately 400-500 kg. Leaves turn yellow and fall off after 3.0 to 3.5 months, but they are left in the field for some more time and moisture content is maintained for ripening which increases their medicinal properties. The skin of the tubers turns dark brown by January-February when they are ready for harvest. Mature tubers should be dug out, long healthy fingers that detach naturally from the tubers are processed by peeling off the skin of the fingers with a stainless steel knife and sun drying for 3 - 4 days. They are then packaged in polythene bags and transported for marketing<sup>12</sup>.

**Morphology and Microscopy**

Safed musli is a tiny annual herb that grows well in tropical and sub-tropical climates with altitudes upto 1500m. It grows to a maximum height of 1.5 ft. Tubers can grow upto a depth of 10inches. Fig.1 Whole plant of *C. borivilianum*.

**Root**

Roots pale brown to white colour with characteristic odour and are tasteless in nature. Root tubers are fleshy, fascicled and directly originate from the stem disc devoid of any fibrous structure and distinguished it from other species of *Chlorophytum* genus. The shape of tubers were cylindrical, the thickness

being on the average 0.9 cm and the length 8cm. The number of tubers varies from plant to plant and on an average 5-30 tubers/ plant are observed and slightly tapering towards lower side look like pestle. Fig.2 Roots of *C. borivilianum*

#### Leafs

It has 6 -13 radical leaves spirally imbricate at the base, sessile in nature, lanceolate and linear or ovate with acute apex and slightly narrowed at the base and less than 30cm long. The leaves spread horizontally, with smooth surfaces, wavy margins and parallel venation.

#### Flowers and fruit

Flowers of *C. borivilianum* are small, white, bracteate, pedicellate, zygomorphic usually arranged in alternate clusters, each cluster comprising of 3 flowers. The flower clusters are dense on the upper part of the scape; bracts are linear, papery and purplish, 1.0 - 10.5cms long; pedicle whitish and 6 -10 mm long. It bears green to yellow coloured fruit which is almost equal in length and breadth. The seed is very small, black and enclosed in the holes. In one hole, there are about 10- 12 seeds. Seeds are endospermic, onion like, black coloured and angular in shape<sup>12</sup>. Fig.3 Flowers of *C. borivilianum*.

#### Microscopy

Microscopic characters of fresh entire tuberous root sample of *C. borivilianum* is as follows- Epidermis is present without cuticle & stomata, many unicellular root hairs. Cortex shows round parenchymatous cells with intercellular spaces. Starch is absent. Endodermis (50µm thick) shows barrel shaped closely arranged parenchymatous cell lies below the cortex & forms a ring. Single layered pericyclic cells are present below the endodermis which are Uniseriate & composed of thin walled parenchymatous cells. Numerous Xylem composed of a single layered round metaxylem towards the pith, protoxylem towards the periphery. Phloem Composed of companion cells and phloem parenchyma<sup>13</sup>. Powdered microscopy shows raphides of calcium oxalate, isolated single stone cells with simple pits on their walls and isolated and combined reticulate vessels<sup>14</sup>.

#### Phytochemistry

Major biochemical constituents of *C. borivilianum* are carbohydrates 42%, protein 10%, fibres 20 - 30%, saponins 2 -17% and alkaloids 15 - 25%. Primarily saponins and alkaloids impart medicinal value. It is a rich source of over 25 alkaloids, vitamins, proteins,

carbohydrates, steroids, saponins, potassium, calcium, magnesium, phenol, resins, mucilage, and polysaccharides and also contains high quantity of simple sugars, mainly sucrose, glucose, fructose, galactose, mannose and xylose. Recently Stigmasterol and saponin named as furostanol and Chlorophytoside-I (3b, 5a, 22R, 25R)-26-(β-D-glucopyranosyloxy)-22-hydroxy-furostan-12-one-3yl O-β-D-galactopyranosyl (1-4) glucopyranoside has been isolated<sup>15</sup>.

#### Pharmacological activity of *Chlorophytum borivilianum*

##### > Aphrodisiac activity

The aqueous extract of dried roots of *C. borivilianum* is reported to have a potent aphrodisiac and spermatogenic potential. To evaluate this effect, male wistar albino rats were orally treated with the dose of 125 and 250mg/kg/day, their sexual behaviour was monitored 3 hr later using a receptive female. Their sexual behaviour was evaluated on days 1, 7, 14, 21 and 28 of treatment by pairing with a pro-oestrous female rat. For sperm count the treatment was continued further in all groups (control group-dist. water and treated group except group with sildenafil citrate 4mg/kg/day) for 60 days. At 125 mg/kg, *C. borivilianum* group had a marked aphrodisiac action, increased libido, sexual vigor and sexual arousal as compared with other groups. Similarly, at the higher dose (250 mg/kg) all the parameters of sexual behaviour were enhanced, but showed a saturation effect after day 14. On day 60 the sperm count increased significantly in both the *C. borivilianum* groups, 125 mg/kg and 250 mg/kg, in a dose dependent manner<sup>16</sup>.

In another study, the effects of *C. borivilianum* (Cb) on sexual dysfunction, loss of body weight, and lack of libido in hyperglycemic rats induced with streptozotocin or alloxan was investigated. It was found that Cb extract treatment ameliorated the diabetes-induced dysfunction at 200 mg/kg dose. There was very low weight loss (P<0.05) in Cb-treated animals as compared to the diabetic control. There was a very high latency time (P<0.05) in the diabetic animals, whereas the latency time was very low in Cb-treated animals. Mount, intromission, and ejaculation frequencies were very high (P<0.01) in Cb-treated animals, while streptozotocin and alloxan groups animals had a very significantly lower sexual behavior (P<0.05) compared to the normoglycemic control group animals. Polysaccharide and saponin-rich aqueous extract appears to have the most suitable

effects on diabetes and its associated effects on sexual functionality<sup>17</sup>.

➤ **Immunomodulatory activity**

Polysaccharide fraction (CBP) of *C. borivilianum* has immunostimulating properties. CBP is derived from hot water extraction of *C. borivilianum* (Cb), comprising of ~31% inulin-type fructans and ~25% acetylated mannans (of hot water-soluble extract), was evaluated for its effect on natural killer (NK) cell activity (*in vitro*). Human peripheral blood mononuclear cells, isolated from whole blood were tested in the presence or absence of varying concentrations of each *C. borivilianum* fraction for modulation of NK cell cytotoxic activity toward K562 cells. Preliminary cytotoxicity evaluation against P388 cells was performed to establish non-cytotoxic concentrations of the different fractions. Testing showed the observed significant stimulation of NK cell activity to be due to the CBP of *C. borivilianum*. Furthermore, *in vivo* evaluation carried out on Wistar strain albino rats for humoral response to sheep red blood cells and immunoglobulin-level determination using enzyme-linked immunosorbent assay (ELISA), exhibited an effectiveness of *C. borivilianum* aqueous extract in improving immune function. Thus, results provide useful information for understanding the role of CBP in modulating immune function<sup>18</sup>.

➤ **Anthelmintic activity**

Saponin extract of *C. borivilianum* has Anthelmintic property when checked against *Pheretima posthuma* and *Ascaridia galli*. He used methanolic extract, crude saponin extract and purified saponin extract, Piperazine as standard drug and dist Water as control. Parameters used were time of paralysis and time of death of the worm. All extracts showed significant anthelmintic activity on selected worms. Purified saponin extract was found more active than other extracts<sup>19</sup>.

➤ **Antioxidant activity**

Antioxidant activity of aqueous extract of *C. borivilianum* (250 mg/kg for 7 days) was studied by 1, 1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging assay and lipid peroxidation assay. The aqueous extract of *C. borivilianum* (250 mg/kg for 7 days) inhibits significantly the levels of DPPH free radicals and thiobarbituric acid reactive substances, respectively in a dose-dependent manner<sup>16</sup>.

Antioxidant activity of *C. borivilianum* root extract was again proved using

chemicals/metals-mediated oxidation. Aqueous extract, when used in graded-dose (25 to 1000 µg/ml), exhibits a very good antioxidant potency as evidenced by powerful nitric oxide, superoxide, hydroxyl, DPPH and ABTS [2, 20-azinobis (3-ethylbenzothiazoline-6- sulfonic acid)] radicals scavenging activity along with reducing capacity (ferricyanide couple assays), metal chelating ability, as well as markedly suppressed the lipid peroxidation in mitochondrial fractions. Further, aqueous extract significantly decreased ( $P < 0.05$ ) copper-mediated human serum and kinetics of LDL oxidation<sup>20</sup>.

Significant increase ( $p < 0.05$  to  $p < 0.001$ ) in the activity of reduced glutathione, catalase and superoxide dismutase and a significant decrease in the hepatic malondialdehyde level has been observed at 100, 400, and 800 mg/kg body weight of *C. borivilianum* root extract when compared with the control value<sup>21</sup>.

➤ **Antiulcer activity**

Alcoholic extract of *C. borivilianum* show ulcer healing property. Here cold stress induced gastric ulceration model was selected to evaluate antiulcer activity. The effect of single oral dose of the alcoholic extracts at the dose of 200 mg/ kg reduces the ulcer index significantly ( $p < 0.001$ ) compared to that of control group<sup>22</sup>.

➤ **Antistress activity**

This activity was carried out using chronic cold restraint stress rat model. Chronic stress resulted in significant increase in plasma glucose level, plasma cholesterol, triglycerides level, serum corticosterone level and adrenal gland weight as compare to control. Pre-treatment with aqueous extract of *C. borivilianum* at both dose levels (125 and 250 mg/kg) reverted significantly the rise in plasma glucose levels indicating adaptogenic potential, plasma cholesterol level, triglyceride level, serum corticosterone level and also adrenal gland hypertrophy<sup>16</sup>.

➤ **Anti-tumour anti-mutagenic activity**

The roots of *C. borivilianum* contain cytotoxic steroidal glycoside saponinchloromaloside-A and spirostanolpentaglycosides embracing beta-Dapiofuranose which are responsible chemicals for anticancer property<sup>23,24</sup>. Anti-tumour and anti-mutagenic property of aqueous extract of roots of *C. borivilianum* were also established when he reported that skin papillomagenesis studies demonstrated a significant ( $p < 0.001$ ) decrease in cumulative numbers of papilloma, tumour

incidence, tumour burden, tumour size and tumour weight and significant ( $p < 0.01$ ) increase in average latent period when the animals received *C. borivilianum* root extract at a dose level of 800 mg/kg body weight/day orally in double distilled water at pre, peri and post initiation stages of carcinogenesis. A significant reduction in the frequency of chromosomal aberration and micronuclei was observed in the treated animals as compared to carcinogen controls. The present investigation suggests that *C. borivilianum* has anti-tumour, anti-mutagenic and chemomodulatory effects<sup>21</sup>.

In another study four new spirostane-type saponins named borivilianosides, isolated from an ethanol extract of the roots of *C. borivilianum*, shows cytotoxic effect on two human colon cancer cell lines (HT-29 and HCT 116)<sup>25</sup>.

#### ➤ Antidiabetic activity

A fructo-oligosaccharide, isolated from *C. borivilianum* extract were found to have significant antidiabetic activity with the blood sugar levels being 118.32 +/- 3.56 and 110.21 +/- 4.22, respectively, as compared to the control value of 231.25 +/- 3.03 along with moderate antioxidant activity in streptozotocin-induced diabetic animals<sup>26</sup>.

#### ➤ Antimicrobial activity

The antimicrobial potential of *C. borivilianum* was screened against eight bacteria and four pathogenic fungi, using microbroth dilution assay. Lowest concentration of the extract, which inhibits any visual microbial growth after treatment with p-iodo-nitrotetrazolium violet, was considered to be minimum inhibitory concentration. Water extracts of *Chlorophytum borivilianum* showed antimicrobial activity in a range of 75-1200 µg/ml<sup>27</sup>.

#### ➤ Larvicidal activity

The larvicidal properties of *C. borivilianum* saponin extracts (Methanolic extract, crude saponin extract, purified saponin extracts) was examined for the mosquito species *Anopheles stephensi*, *Culex quinquefasciatus* and *Aedes aegypti* on the basis of LC50 and EC50 values. All extracts found to be larvicidal activity and among them purified saponin fraction was found more effective<sup>28</sup>.

Recently some other activity reported includes-antiviral activity of *C. borivilianum* extract which shows a potent antiviral activity BHV-1 virus<sup>29</sup>. Antibacterial property of different extracts of *C. borivilianum* was carried out

against 4 bacteria, *Staphylococcus aureus*, *E. coli*, *Pseudomonas aeruginosa* and *Bacillus subtilis*, using cup diffusion method. Acetic acid extract shows antibacterial activity against all these 4 bacteria in the order of sensitivity as *Staphylococcus aureus* > *Pseudomonas aeruginosa* > *E. coli* > *Bacillus subtilis*<sup>30</sup>.

#### CONCLUSION

It would not be an exaggeration to call Safed Musli a unique gift of nature to mankind since the time immemorial. Under the Indian system of medicine, it has emerged out to be an extremely valuable gift of nature to mankind. Safed Musli is celebrated as a Divya Aushad with unparalleled medicinal properties as the preparation of *C. borivilianum* is a very popular herb in traditional Indian medicine, chief ingredient in over a hundred Ayurvedic formulations and used as a potent "Rasayana" drug in "Ayurveda" as a rejuvenator, a Vitalizer and health-giving tonic, a curative for pre-natal and post-natal problems, a restorative for immunity-improvement and as a remedy for diabetes and arthritis and as a potent aphrodisiac. As it has tremendous properties which can be utilised for health improvement of human beings, a special care should be taken in cultivation of *Chlorophytum borivilianum*, isolation of different phytoconstituents specially saponin, so true medicinal value of our indigenous medicinal plant can be explored.



Fig. 1: whole plant of *C. borivilianum*



Fig. 2: Roots of *C. borivilianum*



Fig. 3: Flowers of *C. borivilianum*

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