

## A review on phytochemistry, pharmacological and nutritional uses of *Chlorophytum tuberosum* (Roxb.) Baker

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### ABSTRACT

*Chlorophytum tuberosum* (Roxb.) Baker (Asparagaceae) commonly known as Safed musli is widely distributed in India. This species possesses potential medicinal uses in traditional herbal medicine mainly in India for treating various ailments like diabetes, diarrhoea, leucorrhoea, kidney stones, sexual disorders, general debility etc. It has been evaluated for many pharmacological activities to validate its traditional claims and has been scientifically reported to possess antioxidant, antimicrobial, immunomodulatory activities, etc. Phytochemical investigations indicated the presence of varied contents of bioactive compounds from various parts of this plant such as saponins, tannins, glycosides, alkaloids, flavonoids, phenolics, triterpenes, triterpenoids, etc. This review emphasizes on its phytochemistry, ethnopharmacology, pharmacology, and nutritional aspects of *C. tuberosum*.

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### 1. Introduction

*Chlorophytum tuberosum* (Roxb.) Baker (Asparagaceae) is an important species used in Ayurveda, the traditional system of medicine. In India, it is found in high rainfall areas. The plant generally grows along the grass covered slopes, forest margins and rocky regions (Hara 1966). It is an erect plant growing up to a height of 1.5–2 ft with sheathing leaf base. The roots are tuberous (Cooke 1958). The tubers are medicinally important and are known commonly as *Safed musli* which is used as an aphrodisiac and galactagogue (Nadkarni 1927; Chopra et al. 1956; Marais & Reilly 1978), nutritive, immunobooster, antioxidant and for hepatoprotective activities (Kirtikar & Basu 1975; Dhuley 1997; Nergard et al. 2004; Govindrajana et al. 2005). The tubers are also used in fever and leucorrhoea. It is used as tonic. Roots and leaves are used for the treatment of diabetes. Dried bulbs and leaves are crushed and used as flour for making bread. Sugar, proteins, starch, ascorbic acid, saponins, phenolics, amino acids, viz: alanine, leucine, valine, proline and glutamic acid are its main chemical constituents (Narsimhan et al. 2006).

### 2. Vernacular names

*Chlorophytum tuberosum* has many common names depending upon the languages spoken in a particular

region. The names used in different languages are presented as under:

|             |   |
|-------------|---|
| English :   | Edible Chlorophytum   |
| Guajarati : | Ujlimusli, Sufed or Safeta musli, Dholi musali                |
| Hindi :     | Safed musli, Sufed or Safeta musli, Hazarmuli, Satmuli        |
| Kannada:    | Dravanti  |
| Malayalam : | Shedeveli   |
| Marathi :   | Safed musli, Sufed or Safeta Musli, Kuli                      |
| Sanskrit :  | Sveta musli, Durnamaari, Maharrusha, Vrushya Kanda            |
| Tamil :     | Tannirvittang, Tannirvittan-Kizhangu, Tiravanticam, Vipurutti |
| Telugu :    | Tsallogadda, Kuchhela, Sarala Pagada                          |
| Urdu :      | Shaqaqule-hindi   |

### 3. Morphological description:

*Chlorophytum tuberosum* is a herb up to 20–50 cm tall (Figure 1). Underground parts comprise a small rhizome, surrounded by fibres. Swollen roots with dark tubers of length up to 7 cm are present on rhizome at their tips. Leaves are linear-lanceolate, borne in a rosette and are, 10–50 cm long. Inflorescence is a simple raceme with two flowers usually at each node.

The flowers are large, white, showy and good scented. There is no differentiation between the sepals and petals (Tepals). *Chlorophytum tuberosum* is the only species within the genus *Chlorophytum* which has 10–14-veined tepals. Stamens are shorter than tepals. Style is about 10 mm in length. Flowering occurs in the month of august and early september (Biswas and Temburnikar 2003). Fruits (capsule) are oblong-obovoid in shape containing seeds of 2 mm diameter.

**Figure 1**

#### 4. Distribution

The plant is widely distributed from Nigeria to eastern tropical Africa. It is found in Kenya, Tanzania, Uganda, Chad, Ethiopia, Somalia, Sudan, Nigeria, Cameroon, Central African Republic, India, Nepal, Sri Lanka and Myanmar (Figure 2). In India it is distributed in the subtropical Himalayas from Kumaon eastwards, the Khasia hills, Bengal, Assam, West peninsula and Madras extending to Kanyakumari (Biswas and Temburnikar 2003). It normally grows up to altitude of 1,700 m (asl). It occurs in woody forests, bushy areas or grasslands. In India it is also found in mixed forests.

**Figure 2**

#### 5. Phytochemistry

Qualitative phytochemical analysis shows that *Chlorophytum tuberosum* contain a wide range of bioactive compounds. The vital phytochemicals of this plant are saponins like sitosterol, stigmasterol etc. (Figure 3a, 3b) which have been reported in its tubers (Khanuja & Rao 2005). Studies indicate that it contained steroids, proteins, phenolics, sugars, triterpenoids, gallotannins. Hexane extract gave positive results for the presence of sterols while as, chloroform extract gave confirmation for the presence of triterpenes, triterpenoids and saponins. Sugars, saponins, fructans and phenolics have been found present in aqueous alcohol extract. Various amino acids namely aniline, valine, proline, leucine, arginine and glutamic acid were found present. The percentage of individual amino acids have also been worked out and arginine was found to be in maximum concentration (Narsimhan et al. 2006). Phytochemical analysis of tubers for phenolic estimation showed  $4.69 \pm 0.1$  (mg/g) total phenolic content (Bajpai et al. 2005). Preliminary analysis of its root revealed the presence of proteins, reducing and non-reducing sugars, fats, saponins, tannins, alkaloids and glycosides (Patil & Deokule 2010; Ghorpade & Thakare 2014; Deore et al. 2015). The protein quantity observed was higher than carbohydrates and saponins. HPTLC studies indicate that the saponins from the root samples gave yellow bands in visible light and blue bands after derivatization (in fluorescence light) while as stigmasteroids gave white bands in visible light (Patil & Deokule 2010).

The tubers have been reported to contain 35–42% carbohydrates, 8–8.5% proteins and 4–7% saponins (Khanuja & Rao 2005). Comprehensive investigation of total phenol, flavonoid and saponin content of *Chlorophytum tuberosum* tubers showed 93.5 TPC (mg GAE/g extract), 104.3 TFC (mg Quercetin/g extract) and 4.76% total saponin content (Shinde et al. 2016). A new Bis-isoflavonoid glycoside characterized as Bis (8-methyl-4'-methoxy-7-O- $\alpha$ -L-rhamnopyranoside) I-5, II-5 Bis isoflavone have been isolated from the roots of this plant (Figure 3c). The structure of this newly isolated compound has been determined by using spectroscopic techniques like IR, UV,  $^1\text{H}$  NMR,  $^{13}\text{C}$  NMR and FABMS (Yadav & Gupta 2014).

**Figure 3**

#### 6. Pharmacology

Roots and tubers of *Chlorophytum tuberosum* are useful owing to its medicinal and pharmaceutical properties. The plant has been reported to have aphrodisiac, antioxidant, anticancer, adaptogenic, antidiabetic, antimicrobial, hepatoprotective and immunomodulatory potential. Numerous phytoconstituents are present in the *C. tuberosum* which are responsible for its use for the treatment of various ailments.

##### 6.1. Antioxidant activity

Oxidative reactions are very important for the body but they can also damage the fundamental cells. Vitamin A, vitamin C and vitamin E and various enzymes such as glutathione, catalase, superoxide dismutase, peroxidase etc., are few of the examples of natural antioxidants which help us to fight against oxidative damage. Higher consumption of antioxidant-rich foods has been shown to be allied with reduction in risk of diseases and decreases morbidity and mortality (Tribble 2015). Antioxidant property of the roots of *Chlorophytum tuberosum* had been carried out. In the reducing capacity assay as well as DPPH radical scavenging activity ethanolic extract of the dried roots showed much promising effects than all other test samples (Chittam et al. 2015). Inulin type fructans (Polysaccharide) were found to possess immunomodulatory activity with  $\text{IC}_{50}$  values being 225.31, 888.44, 809.22 and 422.97  $\mu\text{g/ml}$  for scavenging of DPPH, nitric oxide, lipid peroxidation and ferry bi-pyridyl complex, respectively, along with a integral antioxidant activity of 2.986 nmol ascorbic acid/g equivalents in photochemiluminescence assay (Thakur et al. 2012). Antioxidant potential of this plant has been screened for its potential to scavenge DPPH, nitric oxide radical along with their capacity to reduce lipid peroxidation in rat liver homogenate radical scavenging potential. The studies showed that

the plant extract scavenged the DPPH radical in a dose dependent mode ( $IC_{50}$  value = 225.31 g/ml) with moderate lipid peroxidation scavenging property ( $IC_{50}$  = 809.22 g/ml) in rat liver homogenate. The total antioxidant potential of the extract was observed to be 187.91 nmol ascorbic acid which confirms the antioxidant potential of the extract (Narsimhan et al. 2006). Bajpai et al. (2005) calculated the total phenolic content (TPC) and antioxidant activity (AOA) of tubers of this plant species and found that the antioxidant activity as 52.0 %.

### 6.2. Antimicrobial activity

Ethyl acetate and alcoholic extracts of *Asparagus racemosus*, *Chlorophytum tuberosum*, *Hemidesmus indicus*, *Withania somnifera* showed significant antimicrobial activity as compared to the standard antibiotics (Sangvikar, 2012). The new isolated bisisoflavanoid [Bis (8-methyl-4'-methoxy-7-O- $\alpha$ -L-rhamnopyranoside) I-5, II-5 Bis isoflavone] of *C. tuberosum* was found to possess considerable antimicrobial activity (Table 1 and 2). The isolated bioflavonoid compound was screened for its antimicrobial activity (Filter paper disc method), which was expressed in terms of Inhibition Zone Diameter (Yadav & Gupta 2014).

**Table 1**

**Table 2**

Aqueous extract of leaves of eight *Chlorophytum* species were screened for antimicrobial activity using agar diffusion method against bacteria *E. coli*, *S. aureus*, *P. vulgaris*, *B. subtilis* and fungi *A. niger*, *C. albican*. Leaves of *C. tuberosum* showed outstanding antimicrobial activity against bacteria and fungi tested (Ghorpade & Thakare 2014).

### 6.3. Anticancer activity

Saponins are a group of naturally derived compounds, which have showed considerable cytotoxic activity. So, various researchers made their efforts to evaluate possible anticancer effect of saponins of different plant species. One such effort was made on evaluating the possible effect of various *Chlorophytum* species on leukemia cell lines (Deore et al. 2015). *In vitro* anticancer action of methanolic extract and saponins of *C. borivilianum*, *C. comosum*, *C. tuberosum*, *C. laxum* and unidentified *Chlorophytum* species was studied (SRB assay method) on HL60 leukemia cell line. Result showed that methanolic extract of *C. comosum* inhibited the growth of HL 60 cells to certain extent. Other species extracts and fractions do not possess anticancer potential against leukemia, but may act as anticancer agents against other cancer types.

### 6.4. Immunomodulatory activity

During early times, a large number of plants were used to cure human ailments due to the presence of immunomodulatory potential. The use of traditional

plants has been reported in Ayurveda and other traditional medicine systems for immunostimulatory activities (Yamaguchi 1992; Yang 1996; Agarwal & Singh 1999; Dhanukar et al. 1999; Kumar et al. 2011; Thakur et al. 2012; Sivagurunathan et al. 2012; Yadav & Gupta 2014; Tribble 2015; Chittam et al. 2015; Deore et al. 2015; Shinde et al. 2016). Inulin type fructans rich extract of *C. tuberosum* was found to possess strong immunomodulatory activity with  $IC_{50}$  values being 225.31, 888.44, 809.22 and 422.97 g/ml for scavenging of DPPH, nitric oxide, lipid peroxidation and ferric bi-pyridyl complex, respectively (Thakur et al. 2012).

### 7. Tablet Formulation:

Plants act as source of binder for tablet formulation in Pharmaceutical Industries worldwide. A preliminary study has been carried out for establishing powdered tubers of *Chlorophytum tuberosum* as a tablet binder. Tablets were prepared by wet granulation method using Paracetamol as a drug, Bentonite as a diluent and 3.5% talc as a glidant and concentration of 0.25% (w/w), 0.5% (w/w), 0.75% (w/w) and 1% (w/w) of the tablet binder were introduced in different formulations. Determination of various physicochemical parameters such as thickness, friability, hardness weight etc. of the tablets prepared with different concentrations of tuberous material was done. Comparison was done with the already prepared tablets using 5% starch (paste) as standard binder. Tubers showed the presence of carbohydrates which helped it to act as a binding agent. 0.5% concentration of the above binder showed better drug release pattern which suggests that the tubers of this plant can be used as a tablet binder in minute concentration for tablet formulation in pharmaceutical industries (Chakraborty et al. 2009).

### 8. Nutritional uses

Since the time immemorial edible wild plants have played a very important role in supplementing the diet of the people. The dependence on these food plants has now gradually declined. But many people in rural and tribal areas still rely on these plants for supplementing their food. Besides their traditional use of food, potentially they have many more importance. They are having good nutritional value, which provides proteins, carbohydrates etc and many other minerals like sodium, magnesium, potassium, calcium, iron, phosphorus etc. Special attention should be paid for the maintenance and improvement of this vital source of food. Tubers of *Chlorophytum tuberosum* are washed, sliced and cooked as vegetable curry with onion and tomato by tribals in Orissa (Misra et al. 2013). In Andhra Pradesh tender leaves of *C. tuberosum* are eaten as vegetable. Tubers are also edible and after drying are used as tonic (Lakshmi et al. 2013; Ahirwar 2015). Flowers, young buds and tubers of this plant are

used in ethnic food in India (Dobriyal & Dobriyal 2014). Roots are eaten raw and also cooked as vegetable in Maharashtra (Khyade et al. 2009).

### 9. Ethnomedicinal Uses:

Medicinal herbs continue to play a vital role in revolutionizing the treatment of sexual disorders. *Chlorophytum tuberosum* is believed to have effective aphrodisiac effect and considered as the most powerful revitalizing herb in Indian traditional medicine. Table 3 shows the traditional medicinal uses of various parts of this plant species for the treatment of various ailments. Whole plant has been traditionally used for its aphrodisiac properties (Sugiyama & Koman 1992; Maiti & Geetha 2007). Paste made from Tubers was reported to be used for curing centipede bites and poisonous bites by Hooralis tribe in Sathyamangalam forest division, Western Ghats of Tamil Nadu (Revathi et al. 2013). Tuber extract (250 ml) of *Chlorophytum tuberosum* is given orally thrice a day during loose motion & muscle cramps by Tharu tribe (Kumar & Kumar 2014). This plant is used for the treatment of cholera by the inhabitants of Dudhwa National Park, India (Kumar & Kumar 2014). The root powder is used as tonic (Rai 1987). Juice of Roots/tubers of Safed musli plants is reported to be used by the Taungya community in the Terai Arc Landscape (U.P) as tonic (Poonam & Singh 2009). The powder of tuber or raw tuber is considered to be highly energetic (Lakshmi et al. 2013; Shinde 2015). Its roots are powdered with that of *Bombax ceiba*, *Capparis sepiaria* and fruits of *Pedaliium murex* and taken with water as a tonic (Upadhyay et al. 2010). The drug obtained from its tubers of is considered to be an important nervine and general tonic for strength and vigour. Dried tubers are used as tonic (Lakshmi et al. 2013). The root of Safed Musli after crushing with twigs of

*Pedaliium murex* and seeds of *Sida spp.* has been reported to be used for the treatment of leucorrhoea (Upadhyay et al. 2010). The tuberous roots are used as tonic during fatigue, general weakness and tubers are used to cure leucorrhoea (Narsimhan et al. 2006). Tribals use the extract of the roots crushed in rice water to cure dysmenorrhoea (Batugal et al. 2004). Root powder is given to women after delivery for strengthening (Sainkhediya & Ray 2014). The root of *C. tuberosum* in combination with small twigs of *Pedaliium murex* and *Sida* seeds are used to cure nocturnal emission (Upadhyay et al. 2010). Seminal debility can be cured by taking 1 teaspoon dry powder of cladodes of this plant with 1 glass of milk every day (Abhyankar & Upadhyay 2011). Root is used to cure impotency and low sperm count (Kaundal et al. 2016). Root paste after mixed in water and taken against sexual debility in man and woman (Upadhyay et al. 2010). Decoction of leaves and root of *C. tuberosum* is used to cure immune disorders in Vindhya Region of Eastern U.P., India (Singh et al. 2014). Decoction of leaves and root is used for the treatment of diabetes and some immune disorders (Singh et al. 2014). It is believed that roots and tubers of *C. tuberosum* plant possess activity to dissolve kidney stones (Dashahre et al. 2014).

**Table 3**

#### Figure Captions:

**Figure 1:** *Chlorophytum tuberosum* plant.

**Figure 2:** Map showing distribution of *C. tuberosum* (<http://www.eol.org>)

**Figure 3: Some of the chemical compounds of *C. tuberosum*:** (a) 4-Methoxy 8 Methyl 7-O- $\alpha$  L Rhamnopyranoside bis Isoflavone, (b) Sitosterol (c) Stigmasterol

**Figure 1**



Figure 2

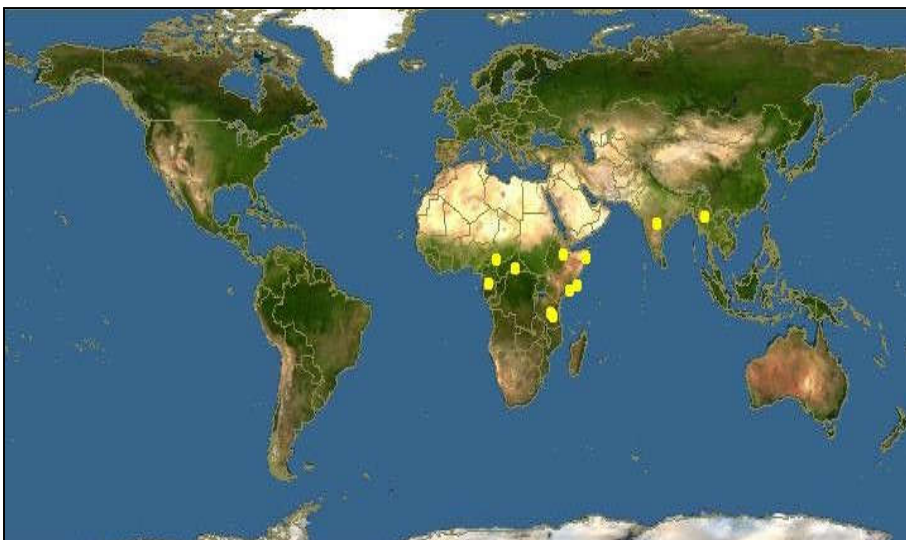


Figure 3

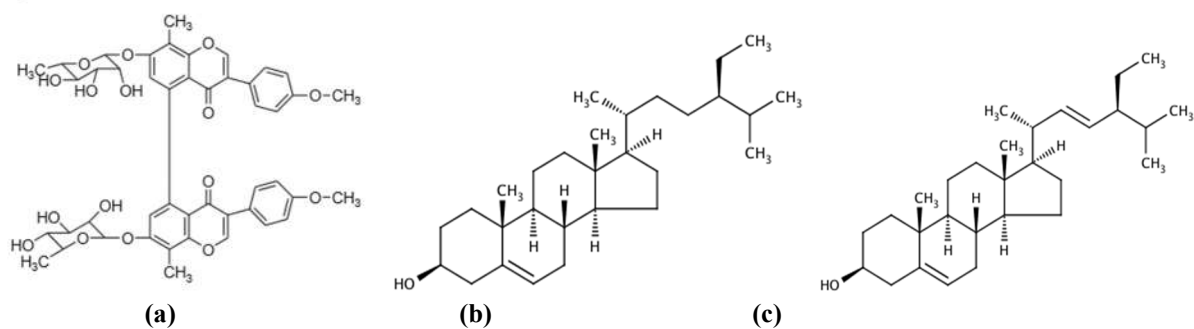
**List of tables:**

Table 1: Antibacterial Activity (Yadav &amp; Gupta 2014).

| S. No. | Test Bacteria                        | Diameter of inhibition | Control* |
|--------|--------------------------------------|------------------------|----------|
| 1      | <i>E. coli</i><br>at 250 µg/disc     | 12                     | 18       |
| 2      | <i>B. subtilis</i><br>at 250 µg/disc | 14                     | 24       |

\*Streptomycin against gm<sup>+</sup> and gm<sup>-</sup> Bacteria

Table 2: Antifungal Activity (Yadav &amp; Gupta 2014)

| S. No. | Test Fungi                  | Diameter of inhibition | Control* |
|--------|-----------------------------|------------------------|----------|
| 1      | <i>Rhizopus stolonifer</i>  | 8                      | 17       |
| 2      | <i>Aspergillus niger</i>    | 7                      | 15       |
| 3      | <i>Penicillium expansum</i> | 5                      | 11       |

\*β naphthol (20.0 ppm)

Table 3: Uses of different plant parts of *Chlorophytum tuberosum* in folk and traditional medicine.

| Plant Part        | Common Use                                       | Mode of Consumption  | Reference   |
|-------------------|--|--|---|
| Whole plant       | Gynaecological disorders                         | Decoction used as general tonic, in post-natal care to increase the fertility and in diseases pertaining to females.   | Kapale et al. 2011  |
|                   | Sexual disorders                                 | Decoction  | Gupta et al. 2013   |
| Tuber             | Centipede bites and poisonous bites.             | Paste made from Tubers is applied on the affected area.  | Revathi et al. 2013   |
|                   | Loose motion & muscle cramps                     | Extract (250 ml) of tuber thrice a day is given orally   | Kumar & Kumar 2014  |
|                   | Tonic  | The powder of tuber or raw tuber is considered to be highly energetic as good as tonic.  | Shinde 2015   |
|                   |  | Dried Tubers   | Lakshmi et al. 2013; Kamble et al. 2016; Alluri et al. 2006 |
|                   | Cholera  | Dried form   | Kumar & Kumar 2014  |
|                   | Nervine and general tonic                        | Drug obtained from tubers  | Lakshmi et al. 2013   |
|                   | Leucorrhoea                                      | Dried tubers   | Narsimhan et al 2006  |
|                   | Kidney stones                                    | Dried roots and tubers   | Dashahre et al. 2014  |
|                   | Asthma   | 250 g tubers of <i>C. tuberosum</i> are mixed with 5 g of each of <i>Crocus sativus</i> and <i>Syzygium aromaticum</i> in an earthen pot, mouth of which to be made air tight with clay. This pot is then kept in heap of cow dung for 5 days. 6 g of this paste obtained, is given with cow milk twice daily for 6 months | Singh & Siddiqui 2007                                       |
|                   | Waist pain                                       | Rhizome of <i>Dicranopteris linearis</i> and about 5 g of rhizome <i>C. tuberosum</i> and root of <i>Bombax ceiba</i> are made into paste which is given for one month for waist pain as tonic.  | Singh et al. 1989   |
| Seminal debility. | Tuber powder with milk given in seminal debility | Devarkar 2010  |   |
| Root              | Tonic  | The root powder is used as tonic   | Rai 1987; Dashahre et al. 2014                              |
|                   |  | 2 teaspoon of juice obtained from fruits given twice daily   | Poonam & Singh 2009   |
|                   |  | The root powdered with that of <i>Bombax ceiba</i> , <i>Capparis sepiaria</i> and fruits of <i>Pedalium murex</i> and taken with water   | Upadhyay et al. 2010  |

|          |                                  |   |                           |
|----------|----------------------------------|---|---------------------------|
|          | Leucorrhoea                      | Roots of Safed Musli after crushing with twigs of <i>Pedalium murex</i> and seeds of <i>Sida</i> spp. is used for the treatment of leucorrhoea. | Upadhyay et al. 2010      |
|          | Fatigue, general weakness        | Decoction made from tuberous roots  | Narsimhan et al. 2006     |
|          | Mental retardation               | Root tuber are boiled and given for mentally ill person. The tuber is boiled with milk in case of impotency and weakness.                       | Kumar 2015                |
|          | Dysmenorrhoea                    | Extract of the roots crushed in rice water.   | Batugal et al 2004        |
|          | Post delivery Tonic              | Root powder is given to women after delivery for strengthening  | Sainkhediya & Ray 2014    |
|          | Nocturnal emission               | The root of <i>C. tuberosum</i> in combination with small twigs of <i>Pedalium murex</i> and <i>Sida</i> seeds.                                 | Upadhyay et al. 2010      |
|          | Impotency and low sperm count    | Root powder   | Kaundal et al. 2016       |
|          | Increase masculinity             | Powder of roots is given to drink every day   | Kokni et al 2016          |
|          | Weakness Sexual vitality         | Root  | Kushwaha et al. 2013      |
|          | Sexual debility in man and woman | Root powder made into paste by mixing in water.   | Upadhyay et al. 2010      |
|          | Tonic                            | Dried root powder mixed with milk or water is taken orally once a day in early morning in the empty stomach for a month.                        | Alawa et al. 2016         |
|          | Diarrhoea and dysentery          | Roots are used to treat diarrhoea and dysentery and also used as demulcent and galactagogue   | Dabur et al. 2007         |
| Cladodes | Seminal debility                 | 1 teaspoon of dry powder of cladodes of this plant with 1 glass milk every day  | Abhyankar & Upadhyay 2011 |
| Leaf     | Immune disorders                 | Decoction of Leaf and Root  | Singh et al. 2014         |
|          | Diabetes                         | Decoction made from fresh leaves is orally given to Diabetic persons.   | Singh et al. 2014         |
|          | Cutaneous                        | Paste of leaf applied on the affected area  | Phondani et al. 2009      |

## 10. Conclusion

It is evident from the published literature that *Chlorophytum tuberosum* is a very important plant for its large number of medicinal properties as well as medicinally important chemicals such as saponins, tannins, glycosides, alkaloids, flavonoids, phenolics, triterpenes, triterpenoids, gallotannins. The plant shows many pharmacological activities like aphrodisiac, antimicrobial, antioxidant, hepatoprotective, galactagogue, antidiabetic, adaptogenic etc. Many traditional uses are also reported like treating various ailments such as diabetes, diarrhoea, cholera, leucorrhoea, kidney stones, sexual disorders, general debility etc. Despite the widespread use of *C. tuberosum*, controlled clinical trials have not been conducted for the evaluation of the toxicity of this plant. Hence in this review article, effort has been taken to collect and compile the details on *Chlorophytum tuberosum* which will be useful to the society to project into a field of alternative systems of medicine. This plant is quite promising as a multipurpose medicinal agent so, more and more clinical trials should be carried out to prove its efficacy.

### Conflicts of Interest

Authors do not have any conflict of interest.

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