

A Peer Reviewed of General Literature on *Chlorophytum borivillianum* Commercial Medicinal Plant

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Abstract

Chlorophytum borivillianum Santapau & Fernandes (Liliaceae) is a very popular herb in traditional Indian medicine and constitute a group of herbs used as 'Rasayan' or adaptogen Thirteen species of *Chlorophytum* have been reported from India [2,14,17,18,] All these species differ in appearance, native species are sold as 'Safed musli' in the Indian drug market. Major biochemical constituents of safed musli are carbohydrates 42%, protein 80-90%, fibres 3 - 4%, saponins 2 -17% and alkaloids 15 - 25% [3]. Primarily saponins and alkaloids impart medicinal value. *Chlorophytum borivillianum* has therapeutic application in ayurvedic system of medicine [2,3,17] Fasciculated roots of *Chlorophytum borrivillianum* is used as tonic and constitute and important ingredient of 20 ayurvedic and unani preparation. Roots are used for the preparation of nutritional tonic used in general sexual weakness. Administration of *Chlorophytum borivillianum* root powder also increased the activities of antioxidant enzymes and vitamin C levels which may have enhanced the antioxidant capacity of the live]. *Chlorophytum tuberosum* Baker commonly referred as Safed Musli has been widely used as a potent "Rasayna" drug in Ayurveda as a rejuvenator and tonic . The aqueous extract of *Chlorophytum borivillianum*(250mg/kg for 7 days) significantly reverted levels of plasma glucose, triglycerides, cholesterol and serum corticosterone and also reduced the ulcer index, adrenal gland weight more as effectively as standard drugs (diazepam) in rats.

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Introduction

Indian herbal industry is at a blooming stage now-a-days^[1,2,3] . There is an increasing awareness towards consumption of herbal medicines. The world health

organization has estimated that more than 80% of the world population in developing countries depends primarily on herbal medicines for basic healthcare needs [4]. Large number of plants have medicinal properties like Aloe, Jatropha, Satavari, Digitalis lanata, D. lanata, P. saivum, Datura pinnata, T. Indica, Piper methystium, Ginkgo etc. One such important medicinal plant is *Chlorophytum borivilianum* [3]. *Chlorophytum borivilianum*, commonly known as Safed musli (Fig. 1) is a traditional medicinal plant which belongs to family liliaceae. The genus includes about 300 species, which are distributed throughout the tropical and subtropical parts of the world. Tropical and subtropical Africa are the probable centre of origin of the genus, where about 85% of the species are found. In India *C. borivilianum* is mainly distributed in Southern Rajasthan, North Gujrat and Western Madhya Pradesh [3]. Plant tissue culture is one area of biotechnology that had a dramatic impact on agriculture. Plant tissue culture is the only way to increase the number of plant within a short time period [5,6,7,8]. Theoretically, a single cell or piece of plant tissue can produce an infinite number of new plants. Because plant tissue culture requires a minimum amount of plant material to start with, significant saving can be realized by reducing investment in stock plants and growing facilities[. The main industrial goal of plant tissue culture is to produce a large number of plants in a month in stead of years. *Chlorophytum borivilianum* (Safed musli) is endogenous medicinal plant to India and distributed in eastern part of India (Assam, Eastern Ghats, Eastern Himalayas, Bihar and Andhra Pradesh [9,10,11]

Thirteen species of *Chlorophytum* have been reported from India [12,13]. All these species differ in appearance, native species are sold as 'Safed musli' in the Indian drug market. Amongst these, *Chlorophytum borivilianum* produces the highest yield and highest saponin content Other important

indigenous species are: *C. arundinaceum*, *C. tuberosum*, *C. laxum*, and *C. breviscapum*. *Chlorophytum borivilianum* is a small perennial herb with a full crown of radical leaves appearing over the ground with the advent of summer rain. Its root tubers are fleshy, fascicled and directly originates from the stem disc devoid of any fibrous structure. They are cylindrical and 5 -20 in number. It has 6 -13 radical leaves spirally imbricate at the base, sessile in nature, linear or ovate with acute apex and slightly narrowed at the base. The leaves spread horizontally, with smooth surfaces, wavy margins and parallel venation. Flowers of *Chlorophytum borivilianum* are small, white, bracteate, pedicillate, 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 -10.5 cms long; pedicle whitish and 6 -10 mm long. It bears green to yellow coloured fruit which is almost equal in length and breadth. Seeds are endospermic, onion-like, black coloured and angular in shape. Major biochemical constituents of safed musli are carbohydrates 42%, protein 80-90%, fibres 3 - 4%, saponins 2 -17% and alkaloids 15 - 25% [14]. Primarily saponins and alkaloids impart medicinal value. *Chlorophytum borivilianum* has therapeutic application in ayurvedic system of medicine [12,13,14]. Generally, it is considered very good to increase general body immunity. Its aphrodisiac properties has proved very much useful for the people suffering from erectile dysfunction and to increase male potency. It has spermatogenic property and helpful in curing impotency as they are rich in glycosides.

Safed musli is considered as a curative of natal and post natal problems and a cure for diabetes and arthritis. Its root powder is fried in the ghee and chewed in case of apthae of mouth and throat. It is effective in curing rheumatism and joint pains. It is an essential part of a traditional diet of mothers

(after delivery) in the form of "Laddoos". Efforts in countries like U.S.A and England are also on to convert it into chips/flakes to use it as a nutritious breakfast. Gujarat State Forest Development Corporation launched a potency drug by name NAI CHETNA (The Indian Express, 1st December 1999) that has been enjoying widespread publicity with increasing acceptance as an alternative to "Viagra".

Safed musli is traditionally used for lack of libido male impotency, oligospermia. It is also widely used as a general health promotive tonic and for delaying the ageing process. Varying its common use for health promotion, it is also used for increasing lactation, treating various gynecological disorders, arthritic conditions and to control diabetes melitus. As such, safed musli has no adverse effect if taken in a proper dose while hyper dosing may lead to gastrointestinal disorders. It grows naturally in most 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, 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 [15]. Cultivation of Safed musli usually begins with land preparation in the months of April/May. After the field is ploughed, available farmyard manure or any form of compost is applied and mixed well with the soil. The soil can also be enriched by growing a green manure crop such as sunhemp and incorporating it at the flowering stage. If the soil is too dry, the field can be irrigated to ensure easy decomposition of green manure. Safed musli is sown with the onset of the monsoon. Fingers are separated from the bunch of tubers with the crown and disc kept intact. They are planted at a distance of about 25 cm within the row. The planting density is about 80,000 fingers per ha, weighing approximately 400-500 kg. Before planting, the

fingers can be treated with 50 g of Bavastin, that is mixed with 15 litres of water to prevent fungal attack. Leaves turn yellow and fall off after 3.0 to 3.5 months, but they should be left in the field for some more time for ripening which increases their medicinal properties. During this period, the soil moisture status must be maintained. The skin of the tubers turns dark brown by January-February when they are ready for harvest. Mature tubers should be dug out at this stage while the smaller ones are left untouched, to be used as planting material for the next season. 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. Although Indian forest are rich in safed musli demand is increasing rapidly in Indian and international drug market. Foreign demand has been estimated as 300-700 tonnes annually [15] a quantity that Indian forest cannot sustain. Moreover obnoxious weeds like Parthenium and Lantana are taking its place. This has created a pressure on Indian forests and it is predicted that if steps for timely conservation are not taken, the Indian forests will lose this valuable plant. Therefore, to avoid the pressure on the natural forests, attempts have been made to cultivate safed musli. However to undertake mass scale cultivation large quantity of quality planting material is required. The tuberous roots of safed musli are the only propagule which can either be sold in the market for economic gains or saved for commercial cultivation year after year. This has created a severe shortage of quality planting material for cultivation. Also the seed germination has been reported to be very poor (14-16% only). So to fill the gap of demand and supply, and to provide genetically uniform planting material from a known source, micropropagation is one of the most desirable option. The technique of tissue and organ culture is being used for rapid multiplication of elite plants. In

comparison to conventional propagation, micropropagation has the advantage of mass scale propagation in limited time and space, maintenance of disease free germplasm and round the year propagation of quality planting material. Attempts have been made to develop in vitro propagation protocol for safed musli wherein some of the parameters have been worked out. However, in order to propagate the quality planting material from the selected elite plants, further studies are required to investigate the various factors which influence large scale multiplication and subsequent acclimatization. Micropropagation has the potential for large-scale propagation of elite trees, but there is a risk of getting somaclonal variation. Keeping in view the huge need for the quality planting material, the present study was designed on the following objectives:

Fasciculated roots of *Chlorophytum borivillianum* is used as tonic and constitute and important ingredient of 20 ayurvedic and unani preparation [16]. The production of high quality planting material propagated from vegetative parts has created global trading area, benefited growers, farmers, nursery owners and improved rural employment. However, there are still major opportunities to produce and distribute high quality medicinal plants *Chlorophytum borivilianum*. The main advantage of tissue culture technology lies in the production of high quality planting material that can be multiplied round the season basis under disease-free conditions. This species perpetuates both vegetatively by tubers and sexually through seeds. It has a sluggish perpetuation through seed on account of poor seed germination (25%). Further, seed-raised progenies display an appreciable spectrum of variation due to its preferential out crossing nature. It is uneconomic as the tubers constitute the commercial product and as a consequence, there is always scarcity of the propagating material. In this situation, plant tissue culture offers an effective means for rapid multiplication of this species through meristems and

tip culture. In conventional cultivation, plantation is possible only once a year (June July). Micropropagation of medicinal plants through tissue culture technology has been previously described but most of them have reported on micropropagation by means of stimulating auxiliary shoot from shoot tip as a explant and in vitro regeneration of medicinal plant have been reported by many authors [17,18,19,20]. Clonal improvement of plant and conservation of genetic resources has been described by many research workers [17,21,18,22]. Micropropagation offers an opportunity to achieve plant stock that is free of disease and pest. Genetic integrity of plants is maintained through proper protocol for commercial propagation of *Chlorophytum borivilianum*. In vitro plants are usually susceptible to genetic alteration due to culture stress [23,24,25,26]. Propagation of medicinal plants through tissue culture technology has been described but most of them have reported on micropropagation by means of stimulating auxiliary shoot from shoot tip as a explant [29,30,31,32]. Safed musli is a Hindi term for botanical herb name *Chlorophytum borivilianum*. Safed musli is an annual herb with tubers, crown leaf and flower as different parts. Safed musli has very good ayurvedic medicinal use. Safed musli is a traditional medicinal plant has worldwide acceptability. It is a rich source of over 25 alkaloids, vitamins, minerals, proteins, carbohydrates, steroids, saponins and polysaccharides [27]. A number of health tonics (sexual tonics) are prepared from safed musli. *Chlorophytum borivillianum* has active constituents especially steroidal sapogenins which possess adoptogenic and aphrodisiac attributes [28]. It is an essential part of a traditional diet of mothers (after delivery) in the form of laddoos. Efforts are made in countries like USA, England, to convert it in to chips to use it as a nutritious breakfast. Roots are used for the preparation of nutritional tonic used in general sexual weakness. Administration of *Chlorophytum borivilianum* root power also increased the activities

of antioxidant enzymes and vitamin C levels which may have enhanced the anti-oxidant capacity of the live^[32]. *Chlorophytum tuberosum* Baker commonly referred as Safed Musli has been widely used as a potent "Rasayna" drug in Ayurveda as a rejuvenator and tonic^[33]. The aqueous extract of *Chlorophytum borivillianum* (250mg/kg for 7 days) significantly reverted levels of plasma glucose, triglycerides, cholesterol and serum corticosterone and also reduced the ulcer index, adrenal gland weight more as effectively as standard drugs (diazepam) in rats. I have reported an efficient regeneration system via multiple shoot bud induction from shoot crown explants in *Chlorophytum borivillianum* and standardized optimum protocol for rapid mass scale propagation^[38].

2.1 Description

Safed musli (*Chlorophytum borivillianum*) is an important ayurvedic medicinal plant^[12,13, 34,45]. The small seedlings of musli are found in forests during rainy season. Leaves are slightly yellowish and white flowers with 6 petals are arranged on the flowering stalk which emerge from the centre of the plant. About 20-25 flowers on the flowering stalk appear in July. The seed is very small, black and enclosed in the holes. In one hole, there are about 10-12 seeds. The seed is very light in weight. Tubers emerge at the bottom of the plant, 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. Tubers are white, and hence it is called as safed musli.

Safed musli is a Hindi term for botanical herb name^[15] *Chlorophytum borivillianum*. Safed musli belongs to the family of liliaceae. Safed musli is a herb with sub-erect lanceolate leaves and tuberous root system. It can grow upto a maximum height of 1.5 ft. Tubers can grow upto a depth of 10". Safed musli is a tiny annual herb that grows well in tropical and sub-tropical climates with altitudes upto 1500

meters. Safed musli has its origin in the India subcontinent. It is a traditional medicinal plant found in natural forest right from east, western and southern region in India. Safed musli is a healthy plant with the ability to withstand severe fluctuations in climatic conditions.

Safed musli is an annual herb with tubers, crown, leaf and flowers as different parts. Naturally occurs in forests of Gujarat, Madhya Pradesh and Maharashtra. States which are listed in the endangered species of India^[15]. There are around 256 varieties of *Chlorophytum* in the world which are yet known. In India, we have around 17 of them, of which, *borivillianum* has got a good market demand.

Safed musli belongs to family of Liliaceae. It was originally grown in thick forest in natural form, and is a traditional medicinal plant. Mainly its tuberous roots are used in ayurvedic medicines. Roots are used for the preparation of nutritive tonic used in general sexual weakness. These roots contain spermatogenetic, spermatorrhoea and chronic leucorrhoea due to some chemical content. It is partly a herb with sub-erect lanceolate leaves. Nowadays, there is a very vast demand all over the world (Specially gulf countries and cold countries). Due to its vast demand it is very costly. Safed musli has very good Ayurvedic medicinal use. It is a rich source of over 25 alkaloids, vitamins, minerals, proteins, carbohydrates, steroids, saponins and polysaccharides etc.

2.2 Distribution

Medicinal plant *Chlorophytum borivillianum* (Safed musli) is endogenous medicinal plant in India and distributed in eastern part of India (Assam, Eastern Ghats, Eastern Himalayas, Bihar and Andhra Pradesh^[9,10,11]

2.3 Climatic Requirements

As Safed musli grows naturally in the most part of the central region of India, the normal climate of the

central region suits the crop most and it can grow successfully in the wide range of the temperature and rainfall. Sandy loam soil with proper drainage system facilitates its growth^[15,34].

2.4 Physical tolerances

Chlorophytum borivilianum tolerates severe fluctuations in climatic conditions and temperature^[15,34]. It can withstand surface soil temperature as high as 42-45°C and air temperature around 40-42°C. As Safed musli grows naturally in most parts of the central region of India, the normal climate of the central region suits the crop most and it can grow successfully in the wide range of temperature and rainfall. Sandy loam soil with proper drainage system facilitates its growth. Safed musli is found growing in thick forests in its natural form. It is partly a herb with sub-erect lanceolata leaves. There are about 256 varieties of *Chlorophytum* and 17 among them are found in India. Among these, *Chlorophytum borivilianum* has good market both indigenously and globally. The medicinal plants board has recognized Safed musli as the sixth important herb to be protected and promoted. Optimum pH of the soil is 6.9-7.8. Safed musli can grow upto 8.6 pH. *Chlorophytum borivilianum* do not tolerate water logging condition in the soil. Relative humidity should not be more than 90%. This crop is very much susceptible to fungus during high moisture content in soil and air.

2.5 Conventional plantation

As musli grows naturally in most parts of central region of India, the normal climate of the central region suits the crop most and as per practical experience it can also grow successfully in the wide range of temperature and rainfall ^[15,30] . Sandy loam soil with proper drainage system facilitates its growth. We can divide the cultivation in four major parts namely:

- ❖ Land Preparation

- ❖ Plantation
- ❖ Maintenance
- ❖ Harvesting

Land Preparation

Land preparation takes almost 2-3 months: Deep Ploughing, Tilling is must to give land a better pulverization and dryness in the month of March and April. At least twenty trollys of Cow dung manure should be mixed in the month of April or May. Raised beds should be prepared (as per planning of plantation) in the end of Month May. All the raised beds should be well irrigated before sowing the planting material.

Plantation

The complete yield depends upon the plantation of crop. Planting material required per acre is 500kg which has to be booked before as it is given on first-come-first-serve basis. Separate the material from sand which is given by us from the godown. This material is then operated in pieces of 15 to 20 gms. This technique must be observed at the farm in Indore before trying it on any farm. These cutted piece are of two to three fingers approximately attached to a part of crown. This is the actual planting material which is then treated with growth harmones for better germination & contact fungicide to protect it from any kind of fungus. Then each single piece is sowed at a distance of 10 inches X 12 inches on the raised bed. The actual sowing method must be observed at our farm.

Maintenance

Weeds should be controlled either by weeding by labour or at the time of land preparation. Any kind of deficiency should be immediately traced and the required element should be supplied. Some few especial techniques practiced have to be observed either by training or by frequently visiting. The first three months from the sowing date are very

important and the field needs most care. The complete maintenance of Safed musli cultivation per acre amounts to 1 lakh approx.

Harvesting

Harvesting is nothing but combination of three process namely:

Digging: This means digging the bunch of safed musli from ground. This process involves around 60-70 mens per day to dig one acre land. The complete process should be seen by the labour so as to enable him to get the complete yield safely. **Drying:** Part of the yield dogged out is peeled and then dried to almost 20%. This dried musli is then sent to the market. There should be a clear understanding of this process.

Replantation: As the experience regarding the crop cultivation is gained therefore the planting material obtained from the digging process should be sown in the ready fields within two days. With the end of this process you enter into the cultivation - circle of safed musli.

2.6 Reproductive characteristics

Conventionally 'safed musli' is propagated by cutting roots with leaf base and by germinating seeds in some species [14,15]. This is an extremely endangered species. The dormant roots have sprouted in April 2001 and plants are growing satisfactorily in greenhouse. *Chlorophytum borivilianum* has already sprouted and grown in complete plantlet. The plant material / seeds of these species will be available in July/August 2001 for tissue culture. This is an important achievements since the occurrence of this species is in problem seeds of the species *Chlorophytum borivilianum* can be collected in September. Seeds can be germinated in vitro on Murashige and Skoog half strength medium. The germinated seedlings are now being used to standardize in vitro shoot multiplication and plant production. Meristem tip were used for the initiation

of invitro culture for mass scale propagation. The plant material / seeds of these species will be available in July/August. *Chlorophytum borivilianum* is available seasonally in soutrern,western northern, and eastern belt of India.

2.7 Ayurvedic and pharmacodynamic properties [14,15]

1. Rasa: Sweet, Bitter
2. Guna: Moist, Unctuous,
3. HeavyVirya: Cold
4. Vipaka:(post-digestive effect): Sweet
5. Doshakarma: VP-, K+

2.8 Bio-chemistry of safed musli [15,34]

- ❖ Steroid
- ❖ Carbohydrates (35-45%)
- ❖ Proteins (5-10%)
- ❖ Fibre (25-35%)
- ❖ Saponins (2-20%)
- ❖ Alkaloids (15-25%)

2.9 Uses as home remedy

1. Its Laddu preparation, 50 gm, is widely used in female after her delivery. It is so beneficial to the same to cure her indigestion, loss of appetite and arthritis during postpartum. [15]
2. It is also useful in a postpartum female to increases the breast milk.
3. In obstruction of the urine, its seeds should be taken along with jaggery or water.

2.10 Medicinal uses

Safed musli has very good ayurvedic medicinal use[12,13,15]. It is a rich source of over 25 alkaloids, vitamins, minerals, proteins, carbohydrates, steroid, seponins and polysaccharides etc. Faciculated roots of *Chlorophytum borrivillianum* is used as tonic and constitute and important ingredient of 35 Ayuurvedic and unani prepration[27]. A number of health tonics (sexual tonics) are prepared from safed musli. *Chlorophytum borrivillianum* has active constituents

especially steroidal sapogenins which possess adoptogenic and aphrodisiac attributes [16]. It is an essential part of a traditional diet of mothers (after delivery) in the form of laddoos. Efforts are made in countries like USA, England, to convert it into chips to use it as a nutritious breakfast. Safed musli is a traditional medicinal plant. Its tuber roots are used in ayurvedic medicines. Roots are used for the preparation of nutritional tonic used in general sexual weakness. There is a vast demand of safed musli all over the world. Of late, Pfizer's Viagra has been a sensation all over the world for its aphrodisiac qualities. It has proved to be highly useful for people suffering from erectile dysfunction. But as the drug has a chemical base it has many potential side effects. It is reported to have serious effects on nerves and grave repercussions for cardiac patients. On the other hand, Safed musli is a safe and effective drug with similar benefit and without any side effect. Gujarat State Forest Development Corporation launched a potency drug by name NAICHETNA, (The Indian Express on 1st December 1999) that has been enjoying widespread and increasing acceptance as an alternative to Viagra. Administration of *Chlorophytum borivillianum* root powder also increased the activities of antioxidant enzymes and vitamin C levels which may have enhanced the antioxidant capacity of the liver [38,42,43]. *Chlorophytum tuberosum* Baker commonly referred as safed musli has been widely used as a potent "Rasayna" drug in ayurveda as a rejuvenator and tonic [33,43]. The aqueous extract of *Chlorophytum borivillianum* (250mg/kg for 7 days) significantly reverted levels of plasma glucose, triglycerides, cholesterol and serum corticosterone and also reduced the ulcer index, adrenal gland weight more effectively than standard drugs (diazepam) in rats [45].

2.11 Main uses of safed musli. [12,13,14,15,34]

1. For Therapeutic application in ayurvedic, unani and allopathy.

2. As a curative for physical weakness and many other illnesses.
3. As a curative for natal and post natal problems.
4. As an aphrodisiac agent and vitalizer
5. For therapeutic application in ayurveda, unani and allopathic medicines.
6. As a curative for physical weakness and many illnesses.
7. As a curative for natal and post-natal problems.
8. As an aphrodisiac agent and vitalizer.
9. As an effective alternative to The Indian Herbagra.
10. As a general sex tonic.
11. As an Immunity-improving drug.
12. As a remedy for diabetes.
13. As a remedy for arthritis.

2.12 Recent studies

The scientific evidences collected from the study supports the traditional claims behind usage of the herb *C. borivillianum*, which is being cultivated and marketed extensively in India and abroad for medicinal purposes [15,34]. The study affirms that *C. borivillianum* root extract is an effective immunostimulatory principle. The inference that can be drawn from the present study is that the total ethanolic extract is superior over sapogenin fraction of the plant as far as immunostimulatory activity is concerned. The extract does not only potentiate non-specific immune response, but is also effective in improving humoral as well as cell-mediated immunity.

Use of herbs for improving the overall resistance of body against common infections and pathogens has been a guiding principle of Ayurveda. *Chlorophytum* spp. have been used and reported in many such formulations. The increase in survival rate is a general marker exhibiting potency of the ethanolic extract to overcome infectious condition. Increased

carbon clearance is an indicator of enhanced in vivo phagocytic activity and competency of granulopoietic system in removal of foreign particle, thereby an indicator of enhanced immunological response against foreign particles or antigens. Increase in percent neutrophil adhesion is attributed due to marginalization of phagocytic cells, i.e. improved defensive response under normal circumstances. This study, apart from confirming the immunostimulant activity of *C. borivilianum* also, presents evidence for the presence of the substance other than saponin which induce stimulation of immune response in treated animals. Therefore, the plant holds promise for being used as an immunostimulating agent and an in-depth study on various fractions of the extract effective as immunomodulating entities from the plant is warranted to determine the most potent immunostimulating fraction from *C. borivilianum*. Thus, the study validates the traditional use of herb as a 'Rasayana' in ayurvedic system of medicine.



Fig: Dry Safed musli root

2.13 Market of safed musli

The largest global markets of safed musli are China, France, Germany, Italy, Japan, Spain, UK and USA. Japan has the highest per capita consumption of botanical medicines in the world [14,15,45]. In the US and Europe, the trade has typically been growing at an average of 10 per cent per annum, partly because of the popularity of alternative treatments and partly because there is increasing official recognition of the benefits of traditional medical systems involving

herbal preparations. The International Council for Medicinal and Aromatic Plants expected world growth during 2001 and 2002 to be approximately 8-10 per cent a year. The US has recently been an exception, with a sharp drop in sales. In 1997, the five top-selling species in the US were Echinacea, Garlic, Ginkgo, Golden seal and Saw palmetto. In 1999, the world market for herbal remedies was US\$19.4 billion, with Europe in the lead (US\$6.7 billion), followed by Asia (US\$5.1 billion), North America (US\$4.0 billion), Japan (US\$2.2 billion) and the rest of the world (US\$1.4 billion).

The market in China is large and shared between public and private ownership. Thirteen of the top companies producing Traditional Chinese Medicines (TCMs) are listed publicly on the domestic stock exchange. Fourteen are state-owned. China's total output of medicinal plants from both cultivated and wild-harvested sources is 1.6 million tonnes. The total value of the finished TCM sector in 1996 was US\$3.7 billion. This estimate excludes domestic consumption, the inclusion of which would result in a far higher figure. Overall sales of botanical medicine products in China in 1995 were estimated at US\$5 billion. The botanical medicine market in Japan in 1996 was estimated at US\$2.4 billion. Japan has the highest per capita consumption of botanical medicines in the world, and sales have grown rapidly in recent years, in part because doctors increasingly incorporate TCM as a complement to western medicine. In 1983, 28 per cent of doctors used TCM, but by 1989 this figure had risen to 69 per cent. India is a major exporter of raw MAPs and processed plant-based drugs. Exports of crude drugs from India in 1994-95 were valued at US\$53,219 million and of essential oils US\$13,250 million. Important crude drugs included *Plantago ovata* (psyllium), *Panax* spp. (ginseng), *Cassia* spp. (senna) and *Catharanthus roseus* (rosy periwinkle). Essential oils included *Santalum album* (sandalwood), *Mentha arvensis* (peppermint) and *Cymbopogon flexuosus*

(lemongrass). Seventy-five per cent of total exports from India are sent to six countries – France, Germany, Japan, Switzerland, UK and USA. Other major importers are Bangladesh, Pakistan and Spain.

2.14 The demand of safed musli

In ayurvedic literature, safed musli is renowned as divya aushad with enormous importance in the preparation of over one hundred different medicines [14,15,45]. There is no gainsaying the fact that safed musli is an inevitable ingredient in any immunity-strengthening drugs. By virtue of being the home of ayurveda, India has naturally been a huge market for safed musli [21]. Also in western India, especially in Gujarat, people are given to the habit of taking a spoon of safed musli along with milk twice a day as a part of routine health-care. There are also instances of safed musli being used in various ways in varied parts of the country. That underlines the reason for a great deal of demand for safed musli in India. Many countries in the Gulf, Europe including USA have been major importers of the dry roots of safed musli for a very long time, for its use in the making of various herbal products and thinks to the increasing awareness and appreciation of the goodness of herbal products. The demand for safed musli has been phenomenally growing across the globe.

2.15 Immunomodulatory activity of *Chlorophytum borivillianum* Sant.

[14,46,47,48,49,50,51,52,53]

Chlorophytum borivillianum (Santapau & Fernandes) (Liliaceae) is a very popular herb in traditional Indian medicine and constitute a group of herbs used as 'Rasayan' or adaptogen. Ethanolic extract of the roots and its sapogenin were evaluated for their immunomodulatory activity. Effect of azathioprine-induced myelosuppression and administration of extracts on hematological and serological parameters was determined. Administration of extracts greatly improved survival

against *Candida albicans* infection. An increase in delayed-type hypersensitivity response (DTH), % neutrophil adhesion and *in vivo* phagocytosis by carbon clearance method was observed after treatment with extracts. Immunostimulant activity of ethanolic extract was more pronounced as compared to sapogenins. The results, thus justifies the traditional use of *C. borivillianum* as a rasayana drug. Scientific literature is continuously reporting plant drugs having immunomodulatory activity. Most of the leads for this activity are from traditional medicines from different parts of the world. The Indian system of medicine 'Ayurveda', conceptualizes a category of drug activity known as 'Rasayana'. The word Rasayana is composed of two words 'Rasa' meaning elixir and 'Ayana' meaning house. The word therefore signifies property of the plant that helps to rejuvenate the system, i.e. adaptogenic activity [37]. 'Rasayan' therapy prevents diseases and counteracts the aging process by means of optimization or homeostasis. Many plants have been extensively used as 'Rasayana' drugs in Ayurveda for the management of neurodegenerative.

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