Silk is nature’s gift to humankind and a commercial fibre of animal origin other than wool. Being an eco-friendly, biodegradable and self-sustaining material; silk has assumed special relevance in present age. Promotion of sericulture can help in ecosystem development as well as high economic returns. The term silk was mentioned in the Rigveda, Ramayana and Mahabharat. Silk represents holiness and symbol of prestige, richness, honour, tradition and crowned as “The queen of textile”. Natural silk is unique with its own importance, it is comfortable to wear, smooth and good for health. Although there is synthetic silk production, but synthetic fibre has no match to natural silk because the elegants feature of silk thread is due to its fine luster and soft touch. India is the second largest producer of raw silk after China and the biggest consumer of raw silk and silk fibre. The silk production suggests that sericulture has better prospects for growth in the developing countries rather than in the advanced countries. Silk production in the temperate countries like Japan, South Korea, USSK etc. is declining steadily not only because of the high cost of labour and heavy industrialization in these countries (Gangopadhyay, 2008), but also due to the climatic restrictions imposed on mulberry leaf availability that allows only two cocoon crops annum. But, India has a distinct advantage of practicing sericulture all through the year, yielding a stream of about 4-6 crops as result of its tropical climate.

In India sericulture is not only tradition but also the living culture. It is a farm based, labour intensive and commercially attractive economics activity falling under the cottage and small scale sector. It provides income and employment to the rural poor especially farmers with small land-holdings and the marginalized and weaker section of the society. Several socio economic studies have affirmed that the benefit-cost ratio in sericulture is highest among comparable agricultural crops (Gangopadhyay, 2008).

In India, Sericulture is essentially a village based industry providing employment to a sizable section of the population. India is the second largest producer of silk in the world with an annual silk production of around 20,410MT in 2010-2011 (http://csb.gov.in/assets/uploads/pat-files/note on seri pdf). India has distinction of being the only country producing all four kinds of silk- Mulberry, Eri, Muga, and Tasar. However, mulberry silk contributes more than 87% of the country’s silk production.
Therefore, silk production has tremendous growth potential in India, which could provide additional employment opportunities for up to 4 million rural families.

At present, approximately 8 million families (of these 80% are rural poor) are involved in silk production as part of their livelihood, engaging in sericulture as an agro-based cottage industry. Due to favorable agro-climatic conditions (suitable temperature and humidity), traditional skills and market potential, silk production is mostly confined to states like Karnataka, Andhra Pradesh, West Bengal and Jammu and Kashmir. About 96% of mulberry acreage and 99% of cocoons raw silk production of country comings from these states only (Jhanshi Lakshmi, 2003).

The predicted demand growth for silk could generate self-employment and remunerative livelihood opportunities for the most disadvantaged sections of society, especially for small and marginal farmers and the landless poor through silkworm rearing, reeling of yarn, weaving of fabric, and value-addition as non-farm activities. Maharashtra, a state without a tradition of silk production, has a large gap between demand and supply of raw silk and more than 4,0003 silk weavers in Yeola, Paithan, and Mohadi areas source their raw silk from neighbouring states, amounting to a total value of ‘imports’ of Rs. 2,500 to 3,000 million (USD 50 to 60 million) per year. This demand for raw silk could become a source of rural employment within Maharashtra (Patil et al., 2009).

Introduction of sericulture was tried out in Maharashtra way back in the year 1959 by Maharashtra Khadi and Village Industries Board, and later by a separate Directorate, established by Maharashtra Government. However, these initial attempts to introduce sericulture were not successful and the industry did not expand to any significant extent in the state. The main constraints to sericulture in Maharashtra state were: lack of mulberry varieties adapted to local agro-climatic conditions, lack of suitable silkworm races, and lack of knowledge and skills among the farmers. Moreover, management practices were poor, leading to diseases and low productivity 10-20kg/100DFL (Sericulture development in nontraditional area, Girish Sohani and Kamte, 1993).
In 2005 there were 3,000 families maintaining 4,200 acres of mulberry plantations spread over 1,004 villages of 20 districts in Maharashtra. In 2008, the number of families adopting sericulture had increased to 8,000 with over 10,000 acres of mulberry plantations, however with low productivity (30kg/100DFL). Among the traditional mulberry silk producing states in India, Maharashtra occupies the seventh position and first position among the nontraditional silk producing state.

The present global scenario clearly indicates the enormous opportunities for the Indian silk industry. The need of the hour is to produce more bivoltine silk with reduced cost of production to meet the growing demands of quality silk. Realising this, the Govt. of India is taking all out efforts to boost bivoltine production in the country with the technical support from Japan International Co-operation Agency. The larva of mulberry silk moth, *Bombyx mori*, is a domesticated form which feeds on the leaves of mulberry tree, *Morus indica*. The larva of mulberry silk moth grows for about 20-23 days feeding mulberry leaves. The fully matured larva spins to protect itself just before the pupa stage, a cocoon out of the most expensive and purest of threads, silk. The trend of sericulture development in India clearly depicts a quantum jump in mulberry silk production during the last three decades. Renditta (Quantity of Silk Cocoons required to produce 1 Kg of raw silk) in 1960 was as high as 16-17, which came down to 6-7 in 2010. This was possible mainly because of advancement and improvement in mulberry genotypes and cultivation practices.

Till recently, India had no system of authorisation of silkworm hybrids, which caused undue delay in release of breeds / hybrids evolved by the breeders with great caution. This also deprived industry from the benefits of having wider choice of silkworm hybrids for commercial exploitation.

The mulberry silkworm *Bombyx mori* evolved from a wild species of silkworm, *Bombyx mandarina*. Its rearing started in China around 2700 BC and enjoined the fruits of it for many centuries, as it were closely guarded secret until it spread to other countries. In India, this species might have been introduced to Kashmir via Tibet around 2nd century AD (Ganga and Chetty, 2004). It is belived that the sericulture was practised in the foothills of sub-himalayas much eariler.
During Mughal period (16-17 Century) Sericulture was the livelihood for many in Kashmir and West Bengal. Since the silkworms are being reared under various climatic conditions over thousands of generations, they have been evolved in to several varieties/races. Though Indian sericulture is ancient, nothing is known about indigenous silkworm races and their characteristics. Very few silkworm races are indigenous to India and the surviving races are all multivoltine, whereas univoltine and bivoltine are rare. Even the popular races like Nistari and Pure mysore now naturalised in India were also introduced from China (Ganga and Chetty, 2004).

Sericulture has attained unique status as an important cash crop in several states in India. However, despite the best efforts and implementation of modern techniques, the overall return from the sericultural activities is quite discouraging, mainly due to the incidence of various diseases like Protozoan, Bacterial, Viral, and Fungal. High temperature and humidity prevalent in tropical regions is conductive to proliferation of these diseases.

The abiotic or environmental factors such as temperature, relative humidity, photoperiod etc. have direct effects on health of silkworm during its larval stage and unfavorable weather conditions that lead to poor harvest of mulberry. The abiotic factors affect the growth and development of silkworm and predispose the silkworm to the biotic causes i.e. infectious diseases. The biotic factors responsible for low cocoon crop production are the silkworm diseases caused by Protozoan, Bacterial, Viral and Fungal (Jhanshi and Kaiser, 2002).

It is well-known that silkworms are exposed to infectious diseases during larval stage, multivoltine breeds such as pure Mysore are less susceptible to diseases compared to bivoltine breeds. In India, the annual crop loss due to disease has been estimated to be around 35 - 40%. In Karnataka, 5-20% of crop loss occurs due to muscardine, in that more than 20% of Chawki worms suffer from muscardine, followed by 5% due to grassarie and 7.3% due to pebrine. The cocoon crop loss due to flacherie disease alone contributes 20-40%. It is well known that, all disease causing pathogens attack silkworm during early or chawki stage and the bad effects are manifested during late stage (Dinesh, 1995). Out of 5-6 crops per year at least two cocoon crops are usually lost due to
diseases. Outbreak of disease is major problem for progress of sericulture industry in India (Dinesh, 1995).

Silkworm diseases:

Silkworms are infected by the following groups of pathogens-

1. Protozoa:

   Among the silkworm diseases, Pebrine disease is caused by the parasitic protozoan, *Nosema bombycis* responsible for enormous crop loss to sericulture. Pasteur (1870) recognized three modes of transmission of this disease i.e. oral, contact and transovarial transmission. The infected larvae initially exhibit loss of appetite and appearance blackish brown pepper like spots on the skin and white pustules in the silk gland are the most characteristic symptoms of the disease (Sharma, 1991).

2. Bacteria:

   Bacterial diseases is called as Flacherie it is categorized into the four different diseases-
   
i) **Bacterial Flacherie or gastric injury Flacherie:** Bacterial flacherie is also known as ‘bacterial disease of digestive organ’ is caused due to the multiplication of different kinds of bacteria like *Streptococci coliaverogenous* bacilli and Protease group bacilli in the alimentary canal, disturbing the normal functions of the gut.

   ii) **Septisemia:** Septicemia is caused due to the bacterial infection of *Bacillus, Streptococci* and *Staphylococci* bacterial species in the haemolymph and usually infects through the wound of larva, pupa and moth.

   iii) **Sotto:** Sotto disease is caused by the different strains of the *Bacillus thuringiensis*. Their spores produce toxic substances which dissolve in the alkaline gut juice and are absorbed through the gastric wall affecting the nervous system leading to spasm and paralysis.

   iv) **Court:** This disease is also called ‘Rangi’ in India because of the colour produced in the dead larva and it is caused by bacterium, *Serratia marcescens*. This bacterium causes fatal infection when inoculated and harmless when taken orally. Larva and pupa are affected by this disease (Ganga and Chetty, 1992).
Major responsible factor for outbreak of flacherie is found to be the environmental conditions mostly temperature, rainfall and humidity percentage which cause to disinfection of alimentary canal and encourage outbreak of flacherie (Nataraju, 2005). Similarly other factors like plant leaves with poor nutritive value fail to provide antibacterial and antiviral factor. Because of poor quality of leaves it results in high rate of multiplication of infectious bacteria and development of flacherie disease (Soso et al., 1991; Nataraju et al., 2002, 2005). Steinhouse in (1949) reported the type of bacteria that indused flacherie includes Bacillus spp., Straptococcus spp., Staphylococcus, Micrococcus spp., Proteus spp. etc. the symptoms of flacherie include loss of appetite, sluggishness and lack of mobility.

The bacteria have been placed in the kingdom prokaryotae (Buchman and Gibbons, 1974). Most pathogenic bacteria occurs in the families Bacillaceae, Psedomonadaceae, Enterobacteriaceae, Streptococceae and micrococceae (Steinhause, 1949; Bucher, 1961; Krieg, 1961 a and b, Angus, 1965; Buchman and Gibbons, 1974; Savanumath et al., 1992; Tanada and Kaya, 1993).

Microorganisms are used to control the insect is first reported by Agostino Bassi in 1838. The large numbers of association between insect and bacteria have been reported (Steinhause, 1947, 1949, 1959 and 1963). Pasteur (1870), Wachlt and Kornauth (1993) reported the alimentary canal of silkworm during first stage of infection was full of micrococci.

Bacillus thuringeinesis are pathogenic to B. mori larvae and their histochemical and histopathological effects have been demonstrated earlier (Angus and Heimpel, 1960; Endo and Nishiitsutsuji-Uwo, 1980; Mathavan et al., 1989). During the past two decades mode of action of Bacillus thuringeinesis subspecies has been studied. protoxin produced by spore forming bacilli during sporulation and these toxin proteins are deposited on the surface of the spore. When this spores is ingested by susceptible larvae (i.e. Lepidoptera and Diptera) the protoxin is solubilised in the alkaline environment (Waterhouse, 1949; Lecadet and Martouret, 1967; Berahaum, 1988; Dow, 1984). The protoxin is converted into toxin because midgut also content protease. Latter on the toxin bind with midgut epithelial cell surface receptors and initiate their action (Fast et al., 1978; Huber and Luthy, 1981; Davidson, 1983; Knowels et al., 1984; Bravo et al., 2005, Pigott and Ellar,
Upon the ingestion by the susceptible insect, the insoluble bipyramidal crystalline toxin is solubalised in the gut which has high alkaline pH of more than processed by midgut protease (Knowles, 1994; Cooper et al., 1990; Carrol and Ellar, 1993). Crystline toxins after that passed through the peritropic membrane and bind to specific receptors are located on brush border membrane vesicles (BBMv) of target tissue (Hoffmann et al., 1988; Lereclus et al., 1989; Cooper et al., 1990). Midgut epithelia cells rapidly swells and lysed once the activation of toxin (Ebersold et al., 1978, De Barjac, 1978, Endo and Nishiitsutsuji-Uwo, 1980, Percy and Fast, 1983; Sacchi et al., 1986; Sangodala et al., 1994). Endo and Nishiitsutsuji-Uwo (1980) have observed temporally sequential changes in the structure of the epithelial cells of silkworm treated with Btk endotoxin. Mathavan et al., (1989) recorded the pronounced hypertrophy and extreme cytoplasmic vacuolation in midgut cells of *B. mori*. As result of the cell membrane damage, loss of coenzyme and electrolyte movements takes place and water accumulated intracellularly. This accumulation of water produced swelling of cell and increase in their dimension. This is called as hypertrophy which is indeed the onset of cellular disintegration and necrosis (Chiang et al., 1986; Fast and Martin, 1980). Some of these nuclear changes are reversible, other denotes cells death. This results destruction of the gut integrity finally toxicated insect stop feeding and death of insect occur due to septismia (Waterhouse, 1949; Faust, 1977; Berebaum, 1988; Dow, 1984, 1992; Heirson et al., 1986; Knowles and Dow, 1993; Lovgren et al., 1990; Gill, 1992; Cavados et al., 2004; Zhang et al., 2005, 2008).
3. Fungi:

Fungal diseases of silkworm are called muscardine. The characteristic feature of this disease is the mummification of the infected larvae till and after death by deposition of calcium oxalate salts. Hence this disease is also called Calcino.

Different infecting fungi produce different colored spores and accordingly there are white muscardine, black muscardine, yellow muscardine, red muscardine and so on. But modes of infection and symptoms are the same for all muscardine infections. The fungus *Metarrhizium anisopliae* (Metsch) Sorokin causes green muscardine in Europe in Japan. The diseased larvae look white in beginning but turns green and gradually to dark with production of conidia after infection. The cadaver gets covered with bright greenish conidia within 2 to 3 days after death.

The fungus, *Paecilomyces farinosus* causes yellow muscardine. The causal agent of red muscardine is the *Sporosperella uvella* fungus. The infected larvae occasionally showed red coloured patches, a few hours before days. The fungi *Sterrignatocystis japonica* (Aoki) and *Sterrignatocystis fulva* (Mont) Sacc cause the orange muscardine. The infected larvae become compact and lustrous and die soon.

White muscardine is caused by different species of *Beauveria*, of which the most virulent is *Beauvria bassiana*. The characteristic feature of the disease is mummification of infected larvae till and after death by deposition of calcium oxalate salts so this disease is also called ‘Calcino’ in Italy and ‘Sannakaddi’ or Sunnakattarga’ in Karnataka. This disease develops rapidly in larvae. The infection takes place mainly through skin -10% infection alone occurs through the mouth or through the spiracles (Devaiah, 1994). White muscardine is the earliest known disease of silkworm caused by an entomopathogenic fungus *Beauveria bassiana* Bassi (1835) and more than 150 insect species are attacked by this fungus (Bell, 1974) due to this disease a total loss of 10 - 40% accounted to sericulture industry in Japan and India (Janakiramman, 1961, Ayuzawa et al., 1972).

According to Walstad et al., (1970) the optimum environmental conditions required for the effective germination, growth and sporulation of white muscardine fungi *B. bassiana* are 92.5% RH and 25 - 30°C temperature. In recent years, the incidence of white muscardine has reached an alarming status. Its occurrence is more in cold weather rather than in rainy season. Generally, bivoltine races are less resistant to *B. bassiana*
than multivoltine races (Devaiah, 1994). All larval stages are susceptible to *B. bassiana* and the susceptibility varied among the instars. The integument of an insect itself acts as a barrier for many microbes such as viruses, bacteria and protozoas. It is not only waterproof physical barrier but also contains chemical that inhibit the growth and penetration of microorganism (David, 1967).

The fifth instar larvae are more susceptible than other instar larvae reported by (Steinhaus, 1949; Reddy, 1978). Within the same instar, ecdysed larvae are more susceptible than those approaching the moult. The most common route of infection is through the external integument, although infection through digestive tract is possible (Gabriel, 1959). Yanagita (1987) reported on the oral infection of silkworm with *B. bassiana* and Yanagita and Iwaslita (1987) studied the histology of silkworm inoculated orally with the fungus. Mainly the conidia attach to the cuticle, germinate and penetrate the cuticle (Boucias *et al.*, 1988; Lefebvre, 1934). The infection process such as germination penetration and invasion was also studied by (Vineet Kumar *et al.*, 1999) haemocoel, the mycelium ramifies throughout the host, forming yeast like hypal bodies (Masera, 1952).

**4. Viruses:**

Among the silkworm diseases, nuclear polyhedrosis virus (NPV) of *Bombyx mori* (BmNPV) is known to occur in all larval instars and more commonly in 4\textsuperscript{th} and 5\textsuperscript{th} instars during all seasons and causing 20-50% cocoon crop losses (Vaidya, 1960; Chitra *et al.*, 1975; Samson *et al.*, 1990; Sivaprakasam and Rabindra, 1995).

Among the viral diseases two common diseases are found these are nuclear polyhedrosis and cytoplasmic polyhedrosis. *Borellina* virus cause nuclear polyhedrosis, which is principally the symptoms are skin become very thin, fragile and shiny and larvae become restless. Their skin rupture easily and a milky white fluid (haemolymph) oozes out through the holes. Turbidity of haemolymph is the conspicuous sign of the jaundiced larvae. The haemocytes of diseased larvae rapidly decompose hydrogen peroxide. The catalase activity of haemocyte increases when polyhedral body appears in the nuclei of the haemocytes in the diseased larvae, (Hisao Aruga, 1994). Smithia virus caused cytoplasmic polyhedrosis disease and it is commonly called white flacherie disease. The
signs of the disease are similar to those of flacherie. This disease occurs from the first to fifth instar larvae.

The appearance of NPV polyhedral bodies (PIBS) in the blood cells of infected silkworm was described first independently by Maestri (1856) and Cornalia (1856). Bivoltine high yielding races are more susceptible to grasserie as compared to multivoltine low yielding races (Liu, 1984; Sivaprasam and Rabindra, 1995). NPVs remain in a stable infectious state in the environment even after death of NPV infected host and a large number of progeny NPV particles are released due to rupture of its cuticle, which transfers to other susceptible individuals (Richards et al., 1999). The released NPV particles must remain viable to occur secondary transmission, which is accomplished in part by the polyhedrin protein matrix that surrounds the infective units, the virions and provides some degree of protection against environmental degradation (Rohrmann, 1986).

In lepidopteran insects, the early evidence for vertical transmission came from observation of infection in the larvae of pest insects armyworm, *Mythimna separata* and gypsy moth *Lymantria dispar* (Shaprio and Robrtson, 1987). Recently, Fuxa et al., (1999, 2002) demonstrated the vertical transmission of NPV in *Trichoplusia* population during rearing. The virus transmitted in the progeny either may kill the larvae at an early stage or would remain in the latent form and express at late stage with the favourable fluctuations in the environmental conditions. Among the silkworm disease, white muscardine is caused by *B. bassiana* causes the heavy economic loss to the sericulture industry in India. The climatic conditions in the tropic are responsible for survival, infection and spread of this disease. All the life stages of silkworm, namely egg, larvae, cocoon, pupa and adult are found susceptible to the fungal pathogen, *B. bassiana* (Chandrasekharan, 2008).

Several attempts have been made to control white muscardine disease by application of chemicals and fungicides. By dusting of ceresin lime on the silkworm body has been effective for control of the white muscardine disease. *In vitro* studies on twenty seven different chemicals in different concentrations were found to be effective for white muscardine disease (Samson and Mummigutti, 1979). Presently lime dusting and application of certain recommended fungicides are being used for the control of *B. bassiana* (Byrareddy et al., 1991; Balavenkatasubbaiah et al., 1994).
Medicinal plants have become the focus on study in terms of validation of their traditional uses through the determination of their actual pharmacological effects.

The control of infectious diseases is a seriously threatened by the continuous increases in the number of microorganisms that are resistance to the chemical antimicrobial drugs (Nenaah and Ahmed, 2011). The chemical based disinfectants and drug formations used for prevention and control of this disease are not economic, eco-friendly and have many limitations to be effective in open and outdoor rearing. Due to this reason disinfectants/drug formation are ineffective to control this disease at field level. Kagawa (1980), Reddy et al., (1990), used the chemical disinfectants and antibiotics for managing the disease in silkworm. In view of high cost of chemicals and antibiotics and their hazardous consequences, plant extracts has been on the top priority for control of disease (Jespers and Waard, 1993, Kumar et al., 1999).

Now days the efforts were made to promote the use of botanicals as possible alternatives to treat infectious diseases (Mohsenzadeh, 2007; Jazani et al., 2009; Chanda, 2011). The natural products were found to possess promising antimicrobial activities when applied alone or in combination with conventional antimicrobial drug (Jazani, 2009). Kumar et al., (2009) and Manimeghalai et al., (2000) used plant products and succeeded to grasserie disease (caused by nuclear polyhedrosis virus) in mulberry silkworm, Bombyx mori.

The present work has been undertaken on the management of the fungal and viral disease causes damage silkworm. The ethanolic plant extracts used for management of disease the plants having antimicrobial activity showed the positive results. Hence the present study aimed at the following objectives.
1. Screening of plant extracts against Beauveria bassiana and NPV in vivo in disease induced animal.
2. To identify the plant extracts with antifungal effects/properties.
3. To identify the plant extracts with antiviral effects/properties.
4. To study the economic parameters such as Cocoon weight, Shell weight, Shell ratio, Silk filament weight, Silk filament length, Denier.
5. With reference to economical characters of expression, study the active extracts for further experimentation.
   a. **Haemolymph studies** - Haemocyte and Biochemical parameters viz., protein, carbohydrate and lipid.
   b. **Organs studies** - Midgut, silk gland and fat body Biochemical parameters viz., protein, carbohydrate, lipid, DNA and RNA.
   c. Histopathology of midgut, silk gland, fat body and integument.