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A Review on Medicinal and Therapeutic Potency of *Cordyceps militaris*

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Abstract

This review looks at the potency of Cordyceps species, especially *Cordyceps militaris*, concerning the history and medicinal value in the world. The genus of this species belongs to so many categories mainly C.militaris is belongs to Clavicipitaceae. Cordyceps contains so many species *C.sinensis,C.submilitaris,C.militaris, C.sphingum,C.rosea,* etc. and all have contained and perform unique efficacy.Cordyceps is a pleomorphic fungus that can be found in tropical forests and humid temperate regions all around the world. Medicinal properties of cordyceps in therapeutic use are its bioactive compounds extracted from cordyceps are as cordycepin, polysaccharides, ergosterol, mannitol, and adenosine. Cordyceps is a special bioactive compound and received much attention from most of the bio-industrial applications such as pharmaceuticals, food and manufacturing processing, and cosmetics due to its valuable potency. The cordycepin production is improved and achieved by mutated cordyceps with UV irradiation. Cordycepin's pharmacological activities involve antioxidant, anticancer, antimicrobial, anti-inflammatory, and immunomodulatory effects.

Key Words: Cordyceps, entomopathogenic fungus,Cordycepin, Clavicipitaceae, Lepidopteran pupa and Hepialu larva.

INTRODUCTION

The genus Cordyceps is an entomopathogenic fungus with high nutritional and therapeutic value that is known in China as Dong Chong Xia Cao

(Das et al., 2008) and YartsaGunbu (Das et al., 2008). (Tibetan). Clavicipitaceae is the family of *Cordycepsmilitaris*and genus Cordyceps.

Around 600 species of Cordyceps can be found all over the world, along with C.catenianulata, C.sinensis, C.militaris, C.brasiliensis, C.acridophila, C.cateniobliqua, C.bifusispora, C.albocitrin, C.blackwelliae, C.coleopteroru m, C.cicadae, C.coccidioperitheciataCordyce

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ps is high valued fungus due to its high altitude at above 3800 meters above Mean Sea Level (MSL) in the cold, grassy, alpine meadows in the Himalayan Mountains. It is highly expensive due to its difficulties facing at the time of harvesting. It is one of the species of Cordyceps which contain valuable sources of natural bio components possessing so many biological activities in the various domains like nutritive food, therapeutics, and various biomedicines (Gibson et al., 2014). Despite the fact that Cordycepsmilitaris and Cordycepssinensis have many similar characteristics, they vary in colour and host. And their respective hosts are Lepidopteran pupa and Hepialu larva. The host Cordycepsmilitaris is a Lepidopteran pupa with yellow and orange fruiting bodies, whereas the Cordycepssinensis is a Hepialu larva with dark brown fruiting bodies. There is one essential bioactive compound Cordycepin which is less productive in *Cordycepssinensis* but it becomes more productive in *Cordyceps militaris*. The cordycepin production is improved and achieved by mutated cordyceps with UV irradiation (Xiao et al., 2013). The countries China and Tibet use Cordyceps as a high valued staple component in many traditional medicines. *Cordyceps militaris* is an edible mushroom and serves many more in highly nutritional and therapeutic uses. *Cordyceps militaris* is a macro fungus and it is essential for medicinal purposes and highly active in therapeutic uses. *Cordyceps militaris* contains so many therapeutic and medicinal bioactive components are polysaccharides, proteoglycans, terpenoids, phenolic compounds, steroids, lectins, cordycepin, cordymin, ergosterol, glycoprotein, etc.Cordycepsmilitaris bioactive component has a wide range of therapeutic potential in medical fields, which include cell proliferation inhibition, thrombolytic activity, anti-oxidative property, and anti-inflammatory properties. (Du et al., 2010), anti-microbial agent, fertility enhancer, anti-cholesterol agent, anti-diabetic property, melanogenesis,anti-cancerous, immune boosters, anti-aging, etc.

Taxonomy

Kingdom: Fungi

Division: Ascomycota

Class: Sordariomycetes

Order: Hypocreales

Family: Cordycipitaceae

Genus: Cordyceps

Species: C.militaris

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fig.1: Cordyceps militaris

PHYTOCHEMICALS

Cordycepin, Adenosine, Polysaccharide, tocopherol, Mannitol, Trehalose, tocopherol, B-(13)-D-glucan and Polyunsaturated fatty acids, are some of the phytochemicals found in it.

USES

Cordyceps is a pleomorphic fungus widely used in various regions and countries from ancient times. China and Tibet used one of the species of the Cordyceps i.e. *C.militaris* as a staple traditional medicine in therapeutics. *C.militaris* carry so many therapeutic and medicinal efficacy and potency and serve various countries (Chai et al., 2010). *C.militaris* contains one of the valuable bioactive components Cordycepin which is significant in several immune boosters and serves valuable nourishments in various domains. Cordycepin and cordycepic acid is used by skilled professional athletes to boost and sharpening their stamina. Cordycepin is valuable because of their natural bio component and effectiveness so it is used by many bio-industries like medicines, foods, and cosmetics, etc.Cordycepin is used as a natural herbal Viagra for weak sexual empowerment humans.

PHARMACOLOGICAL PROPERTIES

Anti-cancer activity

It is very much known that cancer is one of the most dangerous diseases and more likely to cause the death of a person suffering from it because even after a lot of research there is still a need for some curable treatment or medicine for it. It has been discovered that Cordycepin obtained from C. militaris can play a significant role in the treatment of non-curable chronic diseases, AIDS, swine flu, and so on.With the help of analysis done by SDS PAGE and gel filtration, it is observed that they strongly inhibit cancer cells such as MCF-7 cells (*Park et al., 2009*). Similarly, MCMP Strain isolated from mycelium has the potential to induce anti-tumor activity after incubating it against Hep-G2 cells, hela cells and mesangial cells for 48 hrs. (*Zhang et al., (2010)*). Cordycepin, a protease purified from *C. militaris* has shown anti-proliferative function in the case of breast cancer cells i.e. MCF-7. The A3 adenosine receptor (A AR) is a member of the AR family and it becomes overexpressed

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in cancer and inflammatory cells then leading in the development of the new agent for the treatment of such disorders. (*Wong et al. (2011*)).

Anti-oxidative activity

Fungus-like mushrooms are known for accumulating compounds such as phenolic compounds or secondary metabolites that have anti-oxidative properties, particularly polyphenols, due to their biological actions such as free radical scavenging, metal chelation, enzyme modulation activities, and suppression of LDL oxidation. *(Rodrigo and Bosco, 2006).* Fruiting bodies of C. militaris show the anti-oxidant property, which can be artificially cultivated under optimized conditions *(Li and Xu (1997)).*When researching in vivo, *C. militaris* had a significant impact on the activities of catalase (CAT), anti-hydroxyl radicals, glutathione peroxidase (GPx) andsuperoxide dismutase (SOD). It has been studied that C. militaris can inhibit injury and swelling of mitochondria,activated by (+) - L-Cysteine and superoxide anion has quite a major scavenging effect. Besides, it has also been documented that the function of catalase (CAT), anti-hydroxyl radicals, glutathione peroxidase (GPx) andsuperoxide dismutase (SOD)in mice liver has the potential to increase by *C.militaris* significantly. The results obtained indicate that it protects mitochondria by scavenging reactive oxygen species that help to inhibit mitochondrial swelling and increase the activity of antioxidants. It is reported that this fungus has pharmaceutical importance for the protection of mitochondria protection and anti-aging properties *(Dong et al. (2010))*.

Anti-microbial activity

One of the most significant scientific achievements in the area of the health sector is the development of antibiotics. These secondary metabolites play their role in different ways such as by interfering in metabolic processes or getting involved in the cell structures of the organism *(Fuchs, 2004)*. The mechanism of action includes interferences in the cell wall synthesis, modifying the permeability of the plasmatic membrane, causing mutation in chromosome replication or translation *(Tenover, 2006*). The protease extracted from C. militaris has been shown to inhibit Fusarium oxysporum growth in a concentration-dependent manner.The cytotoxic antifungal protease extracted from C.militaris fruiting bodies has been shown to have major antifungal activity against Fusarium oxysporum, Bipolarismaydis, Mycosphaerellaarachidicola, Rhizoctoniasolani, and Candida albicans.It is also suggested that *C. militaris* when grown on germinated soybeans can produce an acidic polysaccharide that has therapeutic effects against influenza virus infection *(Patel and Ingalhalli (2013)*). It is also reported that HIV-1 reverse transcriptase can be inhibited by cordycepin which is a protease extracted from *C. militaris*, thus treating AIDS.

Anti-inflammatory activity

Inflammations are the result of a complex process of interaction between adhesion molecules and inflammatory responses in specific tissues as a result of stress, disorders, or postischaemic, inflammatory, or autoimmune injury. (*Nathan, 2002*). According to a report, a hot water extract of C. militaris found in conventional herbals

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has anti-inflammatory properties by inhibiting macrophage-derived inflammatory mediator activity.It also had an impact on the output of NO, IL-6, TNF, and LPS in RAW 264.7 cells when they were stimulated with LPS. (*Wol et al. (2010*)). In vitro and in vivo models of inflammation using mice, polysaccharide and cordycepin obtained from C. mililtaris show anti-inflammatory effects, most likely due to humoral immunity suppression.When the amount of pro-inflammatory cytokine mediator was reduced, C. militaris caused a substantial increase in testosterone concentration in rat serum (p 0.05).So, it can be concluded that reproductive diseases caused by an insufficient level of testosterone in human males can be treated by integrative medicine produced from fruiting bodies of *C. militaris (Fung and Ko (2012)).*

Fertility Enhancer

Infertility is dominating issue in recent time which affect many peoples due to which we need medical support with less no. of side effects. We prefer herbal extracts over synthetic drugs explained the effect of the role of cordycepin from this fungus is in enhancingabout the sperm quantity as well as its quality also. Supplementing with this fungus has been shown to enhance the serum cordycepin levels while also raising estradiol-17 and testosterone levels, resulting in a higher concentration of motile sperm cells.Cordycepin, according to Patel and Ingalhalli, may be responsible for the increased semen production and sperm quality in boars. Militaris on testosterone production in male mouse rats. Militaris p.

Melanogenesis

Tyrosinase-related protein-1, tyrosinase-related protein-2, and tyrosinase are the three enzymes involved in melanogenesis.Mainly the tyrosinase is a copper-containing glycoprotein and plays a key enzyme in melanin synthesis, and it shows at the rate-limiting enzyme in this position level and it can catalyze three various reactions viz. The hydroxylation of tyrosine to 3, 4- dihydroxyphenylalanine, the oxidation of dopa to dopa-quinone changes to dopa-chrome, and then to dihydro-indolizine or indole 5,6-quinone2-carboxylic acid. Trp-2 catalyzes the conversion of dopa-chrome to dhica. The extract exhibited a suppressing effect on melanin production by tyrosinase inhibitory activities. The water extract of c militaris has been reported to give 71%inhibitory activity against tyrosinase, 40% l-dopa oxidation, and over 50% melanin biosynthesis in b16 mouse melanoma cells. Cordycepin has been shown to inhibit melanin synthesis-related enzymes such as tyrosinase, tyrosinase-related protein-1, and tyrosinase-related protein-2 trp-2.0-msh and ibmx, and to improve melanin synthesis.Militaris on melanogenesis was attributed to the enhancement of tyrosinase degradation.

CONCLUSION

In this review, we discussed Cordyceps and their various species which are found to be worldwide in their unique medicinal and therapeutic potency. The medicinal effectiveness of *C.miltaris* depends on its natural bioactive chemical components i.e the cordycepin and polysaccharides and their fruiting body and mycelium. *C.militaris* is to be used as a general promoter of body health and its longevity in traditional

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medicine.Cordyceps is a macro fungus and i t comes under an edible mushroom and thus it can be used as a food additive and supple ment also play an important role in the treat ment of metabolic diseases brought about by a variety of illnesses.A major challenge that comes in the *Cordyceps militaris* is to be their cost as a comparison to other funguses and its awareness and scientific knowledge regarding their conservation. Among all of their Cordyceps species, *C.militaris* contain the highest content of one of the bioactive constituents like Cordycepin which exhibits various activity immuno-modulation, anti-inflammatory, anti-cancer, anti-diabetic, anti-oxidative, radical scavenging, anti-aging effects, anti-tumor, sexual potentiator.

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Ethical issue

No

Conflict of interest

no

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