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Cordyceps sinensis: A caterpillar fungus

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Abstract

Ophiocordyceps sinensis which is substantially known as *Cordyceps sinensis* is generally known as caterpillar fungus, or by the most prominent name yartsa gunbu. It's an entomopathogenic fungus that grows on insects. It's substantially plant in the meadows above 3500 meters on Tibetan Plateau in Southwest China and Himalayan zone of Bhutan and Nepal. It parasitizes larvae of ghost moth and produces a fruiting body which utilized to be valuated as an herbal remedy and in traditional Chinese drug. The entire fungus-caterpillar combination is hand- collected for curative use. They're currently cultivated on an artificial scale for their use in classical Chinese drug. In pastoral Tibet, yartsa gunbu has become the most important source of cash earnings. costs have hyped continuously, specifically since the late 1990s. In 2008, 1 kilogram traded for US\$ for minimum quality to over US\$ for the best quality, largest larvae.

Keywords: *Ophiocordyceps sinensis*, rural economy, biodiversity, mycology

Introduction

Ophiocordyceps sinensis (*syn. Cordyceps sinensis*) (Berk)G.H. Sung, J.M. Sung, Hywel-jones and Spatafora, a caterpillar fungus (Hajek and Leger, 1994; Kim *et al.*,) belonging to the order Hypocreales of the family Clavicipitaceae (Sung *et al.*,) infecting and ultimately destroying the mummified lepidopteran larvae (Hajek and Leger,) generally that of the Himalayan Bat Moth, *Hepialus armonicus* (Holliday *et al.*,). Some of the species of *Cordyceps* grow on hypogean *Elaphomyces* species. It has existed long known by its reverse *Cordyceps sinensis* in scientific and non-scientific communities but was lately transferred to *Ophiocordyceps*. Historically, this drug was mentioned as Bhu-Sanjivani in ancient Ayurvedic literature, like Atreya Samhita and Charak Samhita, which were written about 3000 times ago. The fungus has been honored as a medicinal output in China at least 2000 times (Zang *et al.* 1990; jones 1997; Zhu *et al.* 1998; Halpern 1999; Kinjo and Zang 2001; Liu *et al.* 2001. Liand Tsim 2004; Holliday *et al.* 2005; Li *et al.* 2006; Esteban 2007; Winkler 2008) ^[41].

Cordyceps was discovered about 1500 ages ago in Tibet by herders who observed that their livestock turned vigorous after ingesting an unspecified mushroom. About 1000 years afterward, Emperor's physicians in Ming Dynasty learned about this Tibetan miracle and applied this wisdom with their own perception to develop an important and implicit remedy. Original stories of *Cordyceps* as the remedy is as ancient as the Qing Dynasty in China and showed up in *Ben-Cao- Cong-Xing* (New Compilation of Materia Medica) around 1757. During the final 300 years, professionals, and scholars, similar as preachers, entomologists, tourists, and chemists, embarked on the scientific disquisition of natural *O. sinensis* samples and their medicinal properties. Mycologists started to research this fungus around the middle of the nineteenth centuries. Although

O. sinensis is traditionally called "*dongchong xiacao*" in Chinese, its original English term was initially graded by Pereira (1843) as summer- plant winter-worm or summer- plant, winter- insect (Pereira 1854; Gray 1858). At current, it's further generally known as Chinese caterpillar fungus, caterpillar fungus, Chinese insect herb, insect herb, or *Cordyceps* mushroom in English.

Taxonomy

English name: - Caterpillar fungus, Phylum: - Ascomycota

Class: - Ascomycetes Order- Hypocreales Family- Clavicipitaceae

Related species- *Cordyceps milliaris*, *Cordyceps barnesii*, *Cordyceps ophioglossoides*, *Cordyceps hyphae* etc.

Vernacular names/Local name – Yarsa gumba, Yarcha gumba

Nepali name – Keera jhar, Jeevan buti, Keeda ghass, Chyou kira, Sanjeevani Bhooti Chinese name – Dong Chong xi Cao Japanese name - Tocheikasa

Habitat

Cordyceps species have been reported from numerous regions of the world. Substantially occurs in the alpine ecosystem on the Tibetan plateau and enclosing the Himalayas. Genetic divergence in *O. sinensis* has been observed applying distinguishable molecular markers and the southern populations were found further diverse than that of northern populations (Jiao,). It's also suspected that *O. sinensis* spreads from the center of origin (the Nyingchi District) to southern regions and later to northern areas (Zhang *et al.* 2009). Native occurrence of the fungus is confined to high Himalayan peaks in Tibet, Nepal, and India, at an elevation ranging from 3000 to 5000

meters height above ocean level, and in some provinces of China. The most usual occasion of the fungus is between 3500 and 4500 m elevations in a chilly and dry climate. In interior peaks, *C. sinensis* is generally known as 'yarsa gumba' a Tibetan name; winter (yarsa) and summer (gumba). In Indian mountains, this is popularized as 'keera jhar' (insect herb). Reliance on livestock herding on the Plateau has amplified the habitat of the caterpillar fungus mainly through the continued raise of its pastoral regions at the expense of forestland ecosystems.

This fungus is parasitic in nature, the host being the larvae of a fragile moth, *Chong-Cao* bat (*Hepialus armoricanus*, family Hepialidae). The mycelium of the fungus grows in the soil and colonizes the buried larvae (caterpillar) of the moth. The caterpillar becomes mummified by the growth of the mycelium. When alpine grasses start sprouting during summer, the mycelium of the fungus forms a fruiting mass which, interestingly, consistently emerges from the head of the larva. This resembles green sprouting, but the difference is in the color which is a dark blue to black. Generally, caterpillar fungus is a spring fungus, like morels (*Morchella* spp.). The fruiting season beginnings as early as mid-April on the eastern inclines of the Tibetan Plateau, but in utmost other places in May, and lasts locally around six weeks. Still, the fruiting is lagged locally with adding altitude, therefore the fungus can be collected for closely two months at different altitude in some regions.

Medicinal Properties

The remains of the insect and fungi have been hand-collected, dried, and used in classical Chinese medication for centuries to serve fatigue, illness, kidney illness, and low sex drive. Regarding the application of *O. sinensis* parts, in the primitive days, people, who are living in the upland district of Nepal and Tibet, used to collect just the raised fungal portion in big bamboo baskets. People have their own wisdom for the application of *C. sinensis* for diverse purposes. Practically, the utmost of the upland indigenous communities is using this fungus for the treatment of different disorders like diarrhea, headache, rheumatism, liver illness, and importantly as an aphrodisiac. The initial understood description of Yarsagumba is by Nyamnyi Dorje, a Tibetan physician and lama who lived from 1439 to 1475. His textbook, An Ocean of Aphrodisiacal Qualities, characterizes Yarsagumba as a sexual tonic. *In vitro* studies have displayed that Yarsagumba contains bioactive substances with immunomodulating, anti-inflammatory, and antitumor properties. Supplements and

products holding *Cordyceps* extract have come hastily popular due to their numerous health benefits.

According to the study which was conducted between June 2008 and September 2009 substantially to experience the medicinal applications of the fungus by regional people and folk healers says the classical healers of Sikkim have been using the fungus for further than eighteen conditions, with maximum use in form of tone- drug and the recommendation of the folk healers for aphrodisiac use. The strength of the claims is estimated by the number of stoners for an illness. This fungus can be used by both manly and womanish for sexual dysfunction, to restore the general health and appetite, and to promote life in launching and Lachen area of Sikkim traditionally. The direction for consuming is the person of both sexes generally uses one fragment of *C. sinensis* with one cup of milk for enhancing their sexual energy and desire. The Bhutia communities put one piece *C. sinensis* in one cup of locally made alcohol (chang) and leave for one hour and drink in the morning and evening as an aphrodisiac. Some use hot water rather than alcohol. According to the original people, the fungus is more possible than Ginseng and also used in the treatment of cancer, fatigue, to relieve chronic pain, tuberculosis, and to treat liver and ordered affections. The original people of Sikkim have been accepting that this drug has been used by their forefathers before the Chogel period in between 1200-1600 BC. but mindfulness has only increased after 1995. From 1997 to 2009 prices have increased by 500 on normal of over 205 per year in Tibet.

Of more than 400 species of *Cordyceps* discovered, two have become the focus of health research: *Cordyceps sinensis* and *Cordyceps militaris*. Some of the medicinal properties of *Cordyceps sinensis* based on research and study are:

Boost exercise performance: *Cordyceps* is thought to increase the body's production of the molecule adenosine triphosphate (ATP), which is essential for delivering energy to the muscles. This may improve the way our body uses oxygen, especially during exercise. *Cordyceps* have been shown to improve measures of exercise performance in older and younger adults, but not in well- trained athletes.

Anti-Aging properties: The elderly have traditionally used *Cordyceps* to reduce fatigue and boost strength and sex drive. Several studies have found that *Cordyceps* increases antioxidants in aged mice, helping improve memory and sexual function.

Potential anti-tumor effects: *Cordyceps* potential to slow the growth of tumors has generated significant interest in recent years. Researchers believe the fungi may exert anti-tumor effects in several ways. Test-tube and animal studies suggest *Cordyceps* may have the potential to treat cancer, as well as some side effects of cancer treatments. However, these effects have not been shown in humans, and more research is needed.

Benefits for heart health: As research emerges on the effects of *Cordyceps* on heart, the benefits of the fungi are becoming increasingly apparent. In fact, *Cordyceps* are approved in China for the treatment of arrhythmia, a condition in which the heartbeat is too slow, too fast, or irregular. The researchers attributed these findings to the adenosine content of *Cordyceps*. Adenosine is a naturally occurring compound that has heart-protective effects.

Help fight inflammation: *Cordyceps* is said to help fight inflammation in the body. Although some inflammation is good, too much can lead to diseases like heart disease and cancer. Research has shown that when human cells are exposed to *Cordyceps* special proteins that increase inflammation in the body become suppressed.

Dosage for the consumption of *C. sinensis*

As clinical data on *Cordyceps* is quite new, and indeed additionally so in Western nations, recommended lozenge conditions may differ, depending on the source. Overall, clinical trials have been carried on using 3-4.5 g of *C. sinensis* per day, except in cases of tough liver complaint, where the lozenge has commonly been advanced, classified from 6 to 9 g per day. There are some interpreters who understood to this author who keep their cancer cases on 30-50 g of *Cordyceps* per day. Although this may seem inordinate, the clinical outcomes seen with this treatment authority are promising, and *Cordyceps* related toxin has no way been reported.

It has traditionally been taken in tea or eaten entire, either by itself or cooked with a diversity of flesh. Moment, in addition to the showed traditional measure of consumption, pulverized mycelium, and mycelial extracts are similarly available encapsulated and non-capsulated forms. At current, there are no reliable morals by which to compare different brands, but in general, the quality of *Cordyceps* is perfecting, as styles of additional efficient lifestyle are excavated, and as more clinical trials are conducted, a clearer picture of recommended tablets for a particular condition will approach more standardized. Considering the quality of developed *Cordyceps* on the request moment and the trouble of principal exposure, as well as the cost of the wild *Cordyceps*, the use of natural *Cordyceps* over the basically cultivated variety, is not recommended. Carrying *Cordyceps* from a reliable source, with complete logical data handed, is the secure way to buy *Cordyceps*.

Distribution and Abundance

Concentrating on China, the disbursement regions span the Tibet Autonomous Region (TAR), Qinghai, Sichuan, Gansu, and Yunnan Provinces. For the Himalayans region, it's collected in Nepal, Bhutan, and India (especially Uttaranchal, Sikkim, and Himachal Pradesh). It's distributed in grass and shrubland that receive a minimum of 350 mm moderate yearly hustle. Based on collectors' information, *Cordyceps* is distributed in around 72 km² (1.01 of the total geographical area, 7096 km²) of Sikkim and is committed to the North (56 km²) and East districts (16 km²) along 3800 – 5000 masl. In the East District, it's introduced in and around Yakla, Thegu, Serethang, Nathu La, Doklam, Bhutan, and Lam Pokhari. The comprehensions on the accessibility of *Cordyceps* differed among the collectors. The collectors felt that experimental activities, specifically, the structure of a road network, army agreements, and labor camps in the alpine areas, were the main dangers to the natural niche of *Cordyceps*, while premature harvest, climate change, and natural disasters had little effect. They denied overexploitation and bothered that grazing cannot be considered a danger to its natural population. hazards to *Ophiocordyceps sinensis* saw by the collectors in Lachen, Lachung, and Gnathang in Sikkim, Northeast India (based on survey with harvesting homes, n = 149). In total, 104 stromata of *Cordyceps* were recorded in 4 population locales covering 480 m² area in total (density 9 ± 1 per 40 m² or 0.22 ± 0.02 per m²), the elevation of which

ranged from 3938 to 4282 masl. The habitat was a gentle slope with luxuriant grassy foliage. In these population sites, the yield was evaluated to be 2167 individualities (0.471 kg) per hectare.

Harvesting and Trade

Cordyceps was collected from the second week of May to the earliest week of August. The collectors started foraging for *Cordyceps* beforehand in the morning and continued if the weather was conducive or until evening. They either kneeled or lay on the ground and intensely scanned the region. When the *Cordyceps* was outlined, the grasses and soil were gently taken off from around it, and, gripping the caterpillar firmly with fingers, it was precisely pulled out along with the soil without breaking up it. In the evening, the soil patches clinging to *Cordyceps* were removed plainly with a toothbrush, and the cleaned materials were disseminated on a plate for air drying till the collectors returned to the village or camp. On reaching the village, the materials were vended to the sub-regional merchandiser on a per-piece base. The merchandiser comprehensively cleaned and dried them at room temperature by spreading them on a newspaper, which was changed from time to time. The dried materials were then wrapped in tissue paper and kept in a leakproof vessel until they were sold. Caterpillar fungus has been collected for centuries in substantial quantities. In recent years'

worth and collection, intensity retain immensely boosted its value amplified by 900 between 1997 and mid-2008. In mid-2008, intermediate quality vended for ¥ (\$) per jin (500g), while top-quality vended for over to ¥ (\$) per jin in Lhasa. In Shanghai, the same quality yartsa gunbu at that time cost up to ¥ (\$).¹⁶ The enormous worth of this commodity has led to ever-adding collection pressure. For the recent marketing value, the collectors must compensate around royalties for every one kg collection of Yarsagumba. The evaluated price of Yarsagumba per kilogram in Nepal is Rs 25000 in 2018. Still, in the foreign demands, the price reaches up to \$ 130000 per kilogram. In India, the recent updates on *C. sinensis* are 15 lakh per kg.

The collectors vend their crop to the sub local dealer, who sells it to the regional dealer. Through them, it reaches public and foreign demands in various ways as depicted. At the source of origin, raw *Cordyceps* is vended at a mean price of US\$1.34 per piece (small 0.97; large 1.67) to the sub local dealer, who sells it (semi-dried; 2300 pieces per kg, as discovered by the sub-regional dealer) to the regional dealer at a lump-sum rate. this relies on the color; *Cordyceps* plant in Sikkim are frequently straw or golden, and thus the lump-sum rate paid by the regional dealer amounts to US\$ 2975 (ca. US\$1.29 per piece) for the straw variety and US\$ 3967 per kg (ca. US\$

1.72 per piece) for the golden variety. The regional dealer sells it to the foreign merchandisers from Nepal, Bhutan, and Tibet at US\$ 7934 (US\$3.45 per piece) to US\$ per kg (US\$4.6 per piece) locally and at US\$ (US\$14.37 per piece) to US\$ per kg (US\$17.25 per piece) in Kathmandu. Sometimes, the sub-regional dealer sells it to a regional company or a nonlocal company through their agent at US\$1.88 per piece (small US\$1.39; large US\$2.09), but the limited amount requested means this is frequently not a preferred route. National and foreign trade routes of *Ophiocordyceps sinensis* (based on open-ended interviews with sub-local and regional dealers).

***Cordyceps* Species and its artificial cultivation**

Till the date there are further than 680 registered species of *Cordyceps* that are found in all six inhabited mainland's and in numerous climatic parts and habitats and feeding off a range of host. As the exploration and studied has been made it came to that the medicinal properties of the *Cordyceps* aren't bonded to only one species *C. sinensis*. Among the diverse species of *Cordyceps*, those presently being developed for medicinal purposes and use in health supplements include *C. sinensis*, *C. militaris*, *C. sobolifera*, *C. subssesilus*, *C. ophiolossoides*, and others.

Due to the peculiarity and high charges of the wild-collected variety (2008 price in San Francisco and different major U.S. metropolises was as high as \$ per kilogram), attempts have long been made to cultivate *Cordyceps*. By the mid-1990s, the maturity of *Cordyceps* attainable in the world's business was basically cultivated because of the evolution of modern biotechnology- predicated civilization styles, the vacuity of this previously rare health supplement has nobly amplified in the last 20 times. The demand for *Cordyceps* has similarly compounded exponentially, in this same time frame, partly due to the opening of China to trade with the West in the 1970s, exposing multitudinous additional people around the world to the generalities and practices of TCM. As *Cordyceps* has consistently been largely deified in TCM, it's sensible that with enlarged exposure to TCM, the demand for this seasoning has also increased. Such an increase has led to over-harvesting of the wild stocks and a hinder deficiency of wild-collected species of *Cordyceps*.

Multitudinous companies currently produce artificially developed *Cordyceps* productions, both from the mycelium as well as from the fruit bodies. The expansion in force has given preference to variations in chastity and grade, creating a situation in which there are a bulky number of fake and thinned products being sold. Recently, new styles for analyzing the quality of *Cordyceps* products have been acquainted. The large variations in quality plants in cultivated *Cordyceps* have directed multitudinous consumers to accept the wild-collected variety is medicinally better than the cultivated type. But with new enhancements in biotechnology, this is fleetly varying. One manufacturer is indeed growing *Cordyceps* in a man-made area exactly cloning the natural growth conditions of *Cordyceps* (the high-elevation air composition and low-temperature plant on the Himalayan plateau). This low-temperature hypoxia society in an atmosphere agreeing originally of nitrogen, carbon dioxide, carbon monoxide, and only low scenes of oxygen allows the non-natural civilization of *Cordyceps*, which replicates the chemical anatomizing of wild *Cordyceps* as closely as can be refereed by moment's most delicate logical implements, making developed *Cordyceps* a realistic cover for the significant advanced priced wild *Cordyceps*. These unique civilization protocols, coupled with the developments of new strains and hybridization between strains, are carried out in *Cordyceps* of yet unknown quality and consistency.

Contamination and Adulteration of *C. sinensis*

Being a high-priced and precious drug there are numerous effects regarding the impurity of the *C. sinensis* which has been diminishing the class of the fungus. Issues like super eminent Contamination, stemming from reports of principal poisoning from consumption of *Cordyceps* by people in China and Taiwan. A separate practice of impurity, lengthly practiced by the collectors of natural *Cordyceps*, introduces extravagant

principles into the organism. As a plant in its natural state, *Cordyceps* is fixed to the mummified mass of the caterpillar from which it turned out. It's gathered whole in this way, dried, and drag-plied into the request. Because *Cordyceps* is sold by weight, the collectors have historically fitted a small bit of branch into multitudinous of the caterpillars, bringing off in an increase in weight. Better grade *Cordyceps* traditionally had lower fitted sticks; still, the practice has been so wide for so long that it's nearly impossible to find wild collected *Cordyceps* without this stuffing's fitted. This is presumably a harmless practice if the thing fitted is from a nontoxic source. But modern collectors have plants that further weight can be built up if a bit of column is fitted into the caterpillar, rather than the conventional branch. If the string is a sword, such a practice, as is the case with the forenamed timber insertion, is apparently not too risky. Unfortunately, the line of choice is now direct solder. A cautious examination of the ends of the caterpillars will constantly expose the openings where the sticks or line have been fitted, and anyone who chooses to use the wild-collected *Cordyceps*, preferably than the cultivated variety, would be well advised to disrupt each one of the caterpillars in half before usage so that any bits of foreign matter can be readily discerned and put off.

Although the presence of principal or different sub-stances in the growth medium easily could be absorbed by any growing organism, these authors have carried on chemical analyses on multitudinous thousands of *Cordyceps* samples over the times, and it has been our observation that *Cordyceps* does not have any added of a tendency to collect lead or other heavy substance than any different fungi. *Cordyceps* cultivated by any of the usual modern practices are truly secure from any massive substance contamination.

General Nutritional Components of *C. sinensis*

C. sinensis consists of a wide range of factors that are esteemed nutritive. It contains all of the necessary amino acids, vitamins E and K, and the water-soluble vitamins B1, B2, and B12 in addition, it consists of numerous sugars, like mono-, di, and oligosaccharides, proteins, sterols, nucleosides, and macro-and microelements (K, Na, Ca, Mg, Fe, Cu, Mn, Zn, Pi, Se, Al, Si, Ni, Sr, Ti, Cr, Ga, V, and Zr.)

Conclusion

C. sinensis has been one of the important sources of medicine to fight against a vast number of diseases and help to boost human energy. It is a natural source but not unlimited; because of the increasing popularity of the *sinensis*, researchers as well as the people who have been cultivating or we can say collecting the fungus are now concern on fulfilling the humans demands. As *sinensis* has been contributing to the local people economy are now decreasing because of the climatic changes and not taking proper precaution while collecting the fungus on high altitude; makes the *C. sinensis* more expensive in the international market. Becoming endangered is one of the concerned The topic for the *sinensis*. Even though because of genetic engineering and advanced biotechnology researchers are now able to produce *sinensis* in a controlled environment; still, a great focus should be provided on the *C. sinensis* production and collection. There are still many ways and ideas by which *sinensis* can contribute to improving the country's economy and health problems.

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