



Review

Naga chilli: A potential source of capsaicinoids with broad-spectrum ethnopharmacological applications

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ABSTRACT

Capsicum species are not only cultivated as vegetable and condiment crops but are also incorporated into a number of medicinal preparations in the ancient literature around the world. 'Naga chilli' or 'Bhoot Jolokia' (*Capsicum chinense* Jacq.) is a chilli variety indigenous to the northeast region of India and has been recognized as the hottest chilli in the world. It has also been used conventionally in treating various human ailments since time immemorial by the indigenous people of the northeast India. Despite being an important crop of the northeast India, the information on the biology and cultivation of Naga chilli is very scanty and scattered. The present article reviews the scientific literature on above aspects with particular emphasis on identifying the key regional issues which need to be addressed urgently by the policy makers in order to harness its potential as an important source of capsaicinoids. Further, an attempt has been made to collate the potential of capsaicinoids in various ethnopharmacological applications such as pain therapy, body temperature regulation, anti-obesity treatments, anticancer therapy and as antioxidant and antimicrobial agent. We anticipate that this literature analysis of traditional medicinal uses and experimental trials of *Capsicum* using modern scientific approaches shall provide a basis for suggesting important areas where sincere research efforts are warranted to bridge the gap between traditional medicinal knowledge and modern biomedical knowledge.

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Abbreviations: CNS, central nervous system; DGCI & S, Directorate General of Commercial Intelligence and Statistics; GI, gastrointestinal; HPLC, high performance liquid chromatography; IARC, International Agency for Research on Cancer; NAD, nicotinamide adenine dinucleotide; OC, oleoresin capsicum; PDR, pleiotropic drug resistance; PMOR, plasma membrane NADH-oxidoreductase; PPAR, peroxisome proliferators activated receptor; RAPD, randomly amplified polymorphic DNA; ROS, reactive oxygen species; SHU, scoville heat unit; STAT, signal transducer and activator of transcription; TRPV1, transient receptor potential channel vanilloid type 1; VEGF, vascular endothelial growth factor.

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1. Introduction

Dietary spices are important ingredients commonly prescribed in Indian systems of medicine including Ayurveda, Siddha and Unani systems (Pruthi, 1976; Anon., 1994; Kochhar, 1996) and during the past years have received renewed attention for treating chronic and acute diseases. One of such dietary spice is the fruit of *Capsicum chinense* a source of the highly pungent capsaicinoids and of antioxidants, which may play a role in preventing or reducing chronic and age-related diseases. The genus *Capsicum* (Solanaceae) consists of five domesticated species: *Capsicum annuum* L., *Capsicum baccatum* L., *Capsicum chinense* Jacq., *Capsicum frutescens* L. and *Capsicum pubescens* Ruiz & Pav as well as around 25 wild species (IBPGR, 1983). *Capsicum annuum* is one of the major vegetable and spice crops cultivated world wide. However, the 'Naga chilli', which is native to the northeastern part of India, has received the attention of world scientific community due to its extremely high pungency and unique aroma. It is known by various names in different regions such as 'Bhoot jolokia' or 'Bih jolokia' in Assam, 'Naga king chilli' in Nagaland, 'Omorok' in Manipur and 'Ghost pepper' by the western media. It is also known by the names, 'Saga jolokia', 'Indian mystery chilli' and 'Indian rough chilli' (after the chilli's rough skin). It has been acknowledged as the hottest chilli in the world (Guinness World Records, 2006). It has also been used conventionally by different ethnic communities of the northeastern India in treating various human ailments (Bhagowati and Changkija, 2009). In Nagaland, *Capsicum* spp. including Naga chilli are used to tone up body muscles after heavy workouts whereas hot infusions are used for toothache and muscle pain (Bhagowati and Changkija, 2009). Ethnobotanical literature around the world contains a wide array of information on traditional uses of different *Capsicum* species in treating various maladies (Table 1). The dried fruits of *Capsicum frutescens* are used by the 'Garó' ethnic community of Bangladesh in preparation of fermenting medium for their traditional liquor (Anisuzzaman and Rahman, 2007).

The extremely hot or burning sensation of chilli is due to the presence of capsaicinoids found only in *Capsicum* (Hoffman et al., 1983). The capsaicinoids present in the *Capsicum* fruit are predominantly capsaicin and dihydrocapsaicin (Fig. 1) making up 80–90%. The ratio of capsaicin to dihydrocapsaicin ranges between 1:1 and 2:1 (Govindarajan and Sathyanarayana, 1991). In northeastern India, the Naga chilli has been cultivated in a traditional manner since time immemorial and there exists a considerable amount of

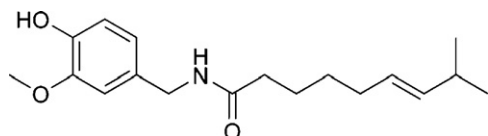


Fig. 1. Chemical structure of capsaicin.

genetic variability among the landraces (Bhagowati and Changkija, 2009). The capsaicin content of fruits of *Capsicum chinense* has been found to be very high in comparison to the fruits of the other chilli species (Sanatombi and Sharma, 2008). The pharmaceutical applications of capsaicinoids are attributed to their analgesic, antiarthritic, anticancer, and antioxidant properties (Prasad et al., 2005). In fact, capsaicin has been at the centre of intense research for elucidating the basis of its pharmacological properties and exploiting the therapeutic potential (reviewed by Prasad et al., 2005). Capsaicin has become a promising molecule for the development of a new generation of analgesic-anti-inflammatory agents targeting the nociceptive primary afferent neurons (Szolcsanyi, 2003). It has also been reported to inhibit the growth of prostate cancer cells (Mori et al., 2006). The antioxidative capacity of chilli is higher than ginger, garlic, mint and onion (Shobana and Naidu, 2000), which may play an important role in the process of chemoprevention (Yu et al., 2002).

1.1. Objectives of this review

In the present review, we have carried out an in-depth literature analysis on the ethnopharmacological applications and the medicinal properties of Naga chilli. Further, we have discussed some of the key issues, which need to be addressed by the policy makers in order to harness its potential as an important source of capsaicinoids for various pharmacological applications.

2. The origin and the introduction of chilli into India

Capsicum is believed to have originated in the area bordered by the mountains of Southern Brazil to the east, by Bolivia to the west, and by Paraguay and Northern Argentina to the south. All the major domesticated species within the genus *Capsicum* are being cultivated in this area, which is reported to have the highest concentration of wild species of chilli in the world (DeWitt and Bosland, 1996). Heiser (1976) stated that between 5200 and 3400 B.C., the Native Americans were growing chilli plants. As revealed recently by the analysis of their starch grains, chilli peppers were first cultivated 6100 years back in lowland rainforests of Western Ecuador (Perry et al., 2007). Christopher Columbus is given the credit for introducing chilli to Europe and subsequently to Africa and Asia (Bosland, 1996). However, Pickersgill (1984) mentioned the pre-Columbian migration of these pungent fruits according to which, the Mongoloids from northeastern Asia, when migrated to the Western Hemisphere during the last Ice Age, found the capsaicin widespread. These plants might have been carried by their natural dispersal agents, principally birds, from their nuclear area in Southeastern Bolivia or Southwestern Brazil to other regions (Pickersgill, 1984). Similarly, Hjelmqvist (1995) published an article in 'Svensk Botanisk Tidskrift' presenting the evidence for the

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