

USE OF BRINJAL IN ALTERNATIVE AND COMPLEMENTARY SYSTEMS OF MEDICINE IN INDIA IS A FACTOID

C Kameswara Rao

Foundation for Biotechnology Awareness and Education

Bangalore

pbtkrao@gmail.com

EXECUTIVE SUMMARY

The activists opposing the commercialization of *Bt* brinjal have asserted that *Bt* brinjal would seriously affect the use of brinjal in the Alternative and Complementary Systems of Medicine (ACSM) in India, through 'loss of synergy'. The Minister for Environment and Forests (MoEF), Government of India (GoI), repeatedly echoed this view. While there was no appropriate and substantial documentation to justify this highly sensationalized claim in the MoEF's *Bt* brinjal moratorium document (MD) of February 9, 2010 or elsewhere, the much repeated high decibel noise has clouded public mind and it became necessary to examine the issue in detail.

This article analyzes the issues raised and provides a detailed survey of authentic literature on the use of brinjal (*Solanum melongena*) and other species of *Solanum* in the ACSM in India, in particular *Ayurveda*, *Siddha*, *Unani* and Homoeopathy. The issues addressed are a) Alternative and Complementary Systems of Medicine, b) Problems in establishing the identity of Indian medicinal plants, c) Patterns of distribution of therapeutically active chemical compounds in plants, d) Establishing identity of medicinal plant species cited in classical literature, e) Reliability of sources of information on medicinal plants, f) Botanical and vernacular nomenclature of brinjal and relevant species of *Solanum*, g) Dr G Sivaraman's letter to the MoEF, and his reference to the CSIR publication Wealth of India, and Nair and Vasudevan's book, h) Use of species of *Solanum* in *Ayurveda*, *Siddha*, *Unani* and Homoeopathy, i) Other issues raised by Dr Sivaraman (synergy, use of raw brinjal in medicine and safety of cooked *Bt* brinjal), j) a concluding statement and k) 36 references. The more important sources consulted are a) the Ayurvedic formulary of India, b) the Ayurvedic Pharmacopoeia of India, c) *Siddha Materia Medica*, d) Formulary of *Siddha* Medicines and e) an extensive compilation, the Database of Medicinal plants, among a host of others.

There is a lot of confusion in the botanical identity and nomenclature of several species of *Solanum* occurring in India. Several names of brinjal in *Sanskrit*, *Tamil*, *Arabic*, *Persian* and *Urdu* are also applied to other species of *Solanum* in the classical literature on *Ayurveda*, *Siddha*, and *Unani*, which is the main reason for erroneously considering some other species of *Solanum* as equivalent to *Solanum melongena* and attributing the medicinal uses of the former to the latter. While there can be honest errors of judgment, this state of confusion is being used deliberately, to oppose commercialization of *Bt* brinjal.

The bottom line is that while such wild species as *Solanum indicum*, *Solanum nigrum*, *Solanum surattense* and *Solanum xanthocarpum* are used in different ACSM both as single

drugs or in formulations, brinjal (*Solanum melongena*) is not a significant drug and is not an ingredient in any formulation, in any of the ACSM. While every system indicated certain negative effects of brinjal including its allergenic potential, the *Siddha* system prohibits its consumption in certain disease conditions. The claim that brinjal is an important medicine in treating respiratory diseases has no basis in literature. The other claim that brinjal reduces cholesterol was clinically disproved in Brazil. The assertion that the transgenic *Bt* gene affects synergy in medicine using brinjal is irrelevant when brinjal is not used in medicine. The stray mention of some insignificant uses of brinjal as medicine was probably based on the properties of brinjal available centuries ago when the texts of classical medicine were compiled. These minor uses are no longer relevant as the present day cultivated brinjal (there is no wild brinjal) has undergone extensive genetic modification in conventional breeding during domestication through selection of more palatable and safer varieties, which means minimal active principles. In effect, *Bt* brinjal does not pose any threat to the use of non-*Bt* brinjal in medicine, as the scope for gene flow from *Bt* brinjal to non-*Bt* brinjal is almost non-existent.

I. INTRODUCTION

I have been writing about *Bt* brinjal since September 2006, starting with a submission in support of *Bt* brinjal to the Genetic Engineering Approval Committee's (GEAC) First Expert Committee on *Bt* brinjal, but was not aware of the contention that *Bt* brinjal will jeopardize the use of brinjal in Alternative and Complementary Systems of Medicine (ACSM), till the public consultation exercise of the Minister for Environment and Forests (MoEF), Government of India (GoI), was in place in October 2009. The Primer issued at the 'National Consultations' meetings states that '*In Ayurveda around 14 varieties of the brinjal are being used for medicinal preparations*' (Anonymous 2009a, p 17). This highly exaggerated view, unsubstantiated by any reference to Ayurvedic sources, is misinformation. The issue was sensationalized by the activists to disproportionate emotional levels and was supported by the MoEF, as it eminently suits his policy.

At the 'National Consultations' meeting at Bangalore on February 6, 2010, a participant asserted that over 2,500 (medicinally) important chemical compounds were isolated from brinjal, a grossly exaggerated claim unacceptable to those who know some phytochemistry. Another participant claimed that brinjal is a very important ingredient in several Ayurvedic medicines. I did not get a chance to speak at this meeting to counter these claims. There may have been participants who have raised the same issue in meetings at the other centres, but there is no indication of this in the report on 'National Consultations' (Anonymous, 2010).

The report on 'National Consultations' on *Bt* brinjal stated that '*No assessment has been made on the potential impacts (toxicity or ineffectiveness) of Bt brinjal on Indian systems of medicine, given that brinjal and related plants are used in Ayurveda, Siddha, and so on*' (Anonymous, 2010, item 329, p. 41). However, the report had noted on an earlier page that '*The issue of the Bt gene having effect on the medicinal properties of other Solanum species is erroneous and unscientific*' (Anonymous, 2010, item 251, p. 36). While the argument that *Bt* brinjal would single handedly seriously affect the use of brinjal and other species of *Solanum* in all the Indian

systems of medicine is a factoid, the claim that *Bt* brinjal affects the medicinal use of brinjal (*Solanum melongena*) needs to be addressed.

On February 9, 2010, the MoEF issued a 19 page text (referred as MD here) and 535 pages of four Annexures, at the time declaring a moratorium on *Bt* brinjal. This massive documentation was reviewed point by point (Kameswara Rao, 2010), including the issue of use of brinjal in ACSM (paras 105-109, pp. 31-32).

Dr G Sivaraman, Member, National Siddha Pharmacopeia Committee, Chennai, has made a very lengthy submission to the MoEF (MD, Annexure IIIA, pp. 209-224) and opposed *Bt* brinjal on the grounds that it affects the use of brinjal in Indian systems of medicine. Dr Sivaraman has appended pages from Wealth of India (WoI), a CSIR publication officially described as a 'dictionary of Indian raw materials and industrial products' (Chadha, 1972; vol. ix, pp. 383-390), and from a book by Nair and Vasudevan (a concise dictionary of medicinal plants, date of publication untraceable), in support of his arguments, but neither of the publications can be taken as an authentic source for any indigenous system of medicine.

The MoEF was very much concerned with this as he had observed in MD (text para 20, p. 13) that "*I have also been informed that Indian systems of medicine, including ayurveda, siddha, homeopathy and unani, use brinjal as a medicinal ingredient both in raw and cooked form for treatment of respiratory diseases and that the entire brinjal plant is used in such preparations. There is fear that Bt brinjal will destroy these medicinal properties due to loss of synergy, differences in the alkaloids and changes in other active principles.*" The MoEF re-emphasized this concern in an interview later (Indian Express, February 24, 2010).

The MoEF referred to a submission (Annexure IIIA, pp. 225-231) from 'Doctors for Food Safety' qualifying it as "*a network of Around 100 doctors across the country*" (MD 20, p. 13). I could not trace this 'network', but six doctors, including Dr G Sivaraman, signed this submission which opposed *Bt* brinjal on the usual anti-tech grounds, and echoed Dr Sivaraman's concern that the investigators and inventors of *Bt* brinjal assumed as if nobody uses raw brinjal, for which *Dasamoola asava* in *Ayurveda* and *Dasamoola choornam* in *Siddha* were cited.

There is vast diasporous literature on the medicinal plants, attributing an extensive range of therapeutic benefits to plants and some may also mention their negative effects on health. Most often this information, which is frequently contradictory, cannot be traced to any of the classical source texts of indigenous medicine.

It boils down to that it was only Dr Sivaraman who submitted a written statement with some pages from two publications in support of medicinal uses of brinjal, while all the others who raised this issue have not substantiated their claim with literature from any source. Nevertheless, there is a need to convince the public and the new Committee of the GEAC which is currently concerned about the relevance of the claim of the use of edible and cultivated brinjal (there is no wild brinjal) in any system of medicine, which is the objective of this article.

II. ALTERNATIVE AND COMPLEMENTARY SYSTEMS OF MEDICINE

There are over 125 Alternative and Complementary Systems of Medicine (ACSM), of which less than a dozen are plant based systems in any wider use. Only *Ayurveda*, *Siddha*, *Unani* and Homoeopathy, which are formal and organized ACSM, are contextual to the issue of brinjal in medicine in India. Kameswra Rao (2000, 2002) provides a detailed treatment of the principles and practices of these systems, giving important literature sources.

Among the Indian ACSM, *Ayurveda* is the most important and most widely in India. The core literature of *Ayurveda* (source texts and commentaries) is in *Samskrith*, but translations of these are available in English (for example, Ray and Gupta, 1980; Ray *et. al.*, 1980) and regional languages (see Kameswara Rao, 2000 for details).

The *Siddha* system of medicine is claimed to be more ancient than even *Ayurveda*. Conceived by 18 *Siddhars*, it is intricately connected with the Dravidian culture and tradition (Kameswara Rao, 2000, 2002). The core *Siddha* literature is in Tamil and the system is popular among the Tamil populations in India and abroad. *Siddha* and *Ayurveda* have many commonalities both in principles and practices. A number of formulations have similar composition and names in both the systems, as for example *Dasamoola churnam* and it is often difficult to say whether a particular formulation is from *Ayurveda* or *Siddha*. The significant difference between the two systems is the prominent use of minerals and metals such as gold, silver, mercury and arsenic, many of which are very poisonous (iatrochemical formulations), and some vegetable toxins, in the *Siddha* system. The support given by the Government of Tamil Nadu to the development of the *Siddha* system is laudable.

The *Unani Tibb* system is traced to Greek medicine and is often referred as the 'Greco-Arab' system. The *Unani* system, popular among the Muslim populations around the world, owes its development primarily to the Arab and Iranian physicians and to a very considerable extent to the Indian *Hakeems*. *Unani* has absorbed what was best in the contemporary medicine in Egypt, Syria, Iraq, Persia, India and China, as well as the Middle and Far Eastern countries (Kameswara Rao, 2000, 2002). *Unani* has substituted Indian plant species for those Middle Eastern species not available in India. The bulk of *Unani* literature is in Persian, Arabic or Urdu.

There has been a close interaction and integration over centuries between and among *Ayurveda*, *Siddha* and *Unani* systems in India, resulting in the use of identical species in treating similar diseases.

Homoeopathy originated in 1796 in Germany and owes its origin to Doctor Christian Samuel Freidrich Hahnemann. One of the cardinal principles of Homoeopathy is '*Similia similibus curentur*' meaning that a particular substance which produces a specific symptom in a healthy individual, cures the same symptom in a sick individual. Homoeopathy is also based on the concept of '*minimal dose*' that considers progressively smaller doses as increasingly powerful. Single dose remedies predominate in Homoeopathy while formulations are extremely rare and are of recent origin. All these three issues are in contrast to the principles of *Ayurveda*, *Siddha* and *Unani*. Homoeopathy is in use in many countries except China, Taiwan and Maldives and is actually banned in Israel and Muslim countries, as the mother tinctures are extractions in ethyl

alcohol, whose consumption is a taboo. In India both the urban and rural populations patronize Homoeopathy. (See Kameswara Rao, 2000, 2002, for a comprehensive discussion on Homoeopathy).

III. PROBLEMS IN ESTABLISHING THE IDENTITY OF INDIAN MEDICINAL PLANTS

One of the major problems in the study of Indian medicinal plants is establishing their correct scientific identity basing on plant descriptions in classical texts and other sources. The descriptions of plants and their uses given in the source texts are either in *Sanskrit (Ayurveda)*, Tamil (*Siddha*) or Persian/Arabic/Urdu (*Unani*). The meaning and import of the language used for the names and descriptions of medicinal plants centuries ago, have to be interpreted and understood correctly, handicapped by our current understanding of and proficiency in the respective languages. The current form of these languages is vastly different from that of the classical. Any errors in this process will seriously affect the efficacy of the medicine and the credibility of the medical system, jeopardizing research on and utilization of medicinal plants.

For purposes of research and international scientific communication, the correct botanical identity and nomenclature of the plants used in medicine are essential. This is the job for a professional taxonomist (specialists in the area of identification, naming and classification) and not even for a general botanist.

IV. PATTERNS OF DISTRIBUTION OF THERAPEUTICALLY ACTIVE CHEMICAL COMPOUNDS IN PLANTS

Medicine functions in terms of chemical compounds and their interaction with the body. The distribution of chemical compounds in plants has several unpredictable and diverse patterns. While there are several compounds in a particular species, one or a few compounds come to be considered important, depending upon their therapeutic potential. Some compounds like carotenoids or saponins or the flavonoids kaempferol, rutin, quercetin, etc., occur in a large number of diverse plant groups. Some others may occur exclusively in one species, or species of a single genus, or different genera of a family or in very diverse and botanically unrelated taxa, as exemplified below:

- a) Cannabinoids occur only in *Cannabis sativa* (*ganja*, Cannabidaceae) and in no other species.
- b) The opium alkaloids occur only in *Papaver somniferum* among over 100 species of the genus *Papaver* (Papaveraceae). Opiates are present only in the wall of the poppy fruit and nowhere else, not even in the seeds, the reason for poppy seeds being freely available in the market while opiates are severely restricted. Yet people use poppy seeds in different foods and feel drowsy on consumption of such food, as faith is more powerful than fact.
- c) The alkaloids of *Rauvolfia serpentina* (Apocynaceae), are also present in varying quantities, in related Indian species such as *Rauvolfia tetraphylla*. *Rauvolfia vomitoria* in West Africa, has more reserpine than the Indian favourite *Rauvolfia serpentina* (Ayensu,

1986). Reserpine also occurs, though in small quantities, in *Alstonia scholaris*, an Indian species of the same family.

- d) The vinca alkaloids, vincristine (leucocristine) and vinblastine (vincaleucoblastine), occur in *Catharanthus roseus* (= *Vinca rosea*, Apocynaceae), from Madagascar, now naturalized or cultivated in India. But another Madagascan endemic *Catharanthus coriaceus* seems to contain much more of vincristine than *Catharanthus roseus* (Ayensu, 1986).
- e) The sweet saponin liquorice (glycyrrhizin, 60 times more sweeter than canesugar), occurs in the roots of *Glycyrrhiza glabra* (Fabaceae), the classical source of the compound, and in *Glycyrrhiza uralensis*, both of which are exotics cultivated in northern India. The leaves of the common Indian species, *Abrus precatorius* (crab's eye, Fabaceae), also contain liquorice, in far greater quantities than in the roots of species of *Glycyrrhiza* (Oliver-Bever, 1986; Kameswara Rao and Sangeeta, 1993).
- f) The original source of the anticancer alkaloid camptothecin is the Chinese plant *Camptotheca acumunata* (Nyssaceae) and has been discovered in and exploited from an unrelated Indian species *Nothopodytes nimmoniana* (= *Nothopodytes foetida*, Icacinaceae).
- g) The alkaloid ephedrine, widely used in bronchial problems, originally discovered in the species of the gymnosperm *Ephedra*, also occurs in the distant angiosperm species of the genus *Sida* (Malvaceae). This discovery was based on similar use of the species in *Ayurveda*.

These patterns of distribution would have been missed without correct botanical identities, which are essential not only to establish the original source, but also to make subsequent collections of the plant material and to identify suitable substitutes, when necessary.

V. ESTABLISHING IDENTITY OF MEDICINAL PLANT SPECIES CITED IN CLASSICAL LITERATURE

There are two ways of establishing the identity of medicinal plants from the classical sources.

- a) One is basing on the names and descriptions given in the source texts. The correct identification of the water weed and fern, *Salvinia natans*, was established on a reinterpretation of the descriptions in *Charaka Samhitha*. An error in interpretation resulted in the use of a wrong species earlier (Professor B A Hegde, Kolhapur, personal communication). The risk of misunderstanding the descriptions is of a major concern in this method.
- b) The second method is to obtain a sample of the plant material from reliable and authentic users and establish its botanical identity. The basis is continued traditional identification and use. An age old misinterpretation or a substitute being used in the original name for a long time due to the paucity of the original material, deliberately or out of ignorance, are

the risks in this approach, besides the problem of determination of who or what is an authentic source. Many competent people are very secretive and unhelpful.

Repeated verification and reconfirmation are the safer means of establishing plant identities. Botanical identities should be established based on complete specimens and whole plants and just not the part which is the source of the drug such as the roots, leaves, bark, fruits or seeds. By and large the identities have been verified for a large number of medicinal plants (Vaidya, 1982; Sivarajan and Balachandran, 1994), yet several problems persist, a few of which are given here:

a) The identity of *brahmi* is a long standing controversy. The confusion is between *Centella asiatica* (Apiaceae) and *Bacopa monnieri* (Scrophulariaceae), which are botanically unrelated. Both the species prefer water logged soils and in both, the active principles are saponins, though qualitatively different. They are used for various purposes, more importantly as memory enhancers. Another name *Hydrocotyl asiatica* also appears in literature, which is considered as a synonym of *Centella asiatica*. It is now generally agreed that *Centella asiatica* is *brahmi* as used in south India and *Bacopa monnieri* is *mandukabrahmi*, more popular in the north India. Nevertheless, doubts are raised now and then.

b) Another infamous example of a deep rooted mistaken identity is the *ashoka* tree, whose bark is an important ingredient in Ayurvedic formulations such as the *ashokaarishta*, widely used to treat menstrual problems. The correct identification is *Saraca asoca* (= *Saraca indica*, Caesalpiniaceae) but a very large number of people and manufacturers of Ayurvedic drugs erroneously consider the unrelated *Polyalthia longifolia* (Annonaceae), one variety of which is a common avenue tree, as the *ashoka* tree. In consequence, the wrong plant is used either out of ignorance or even deliberately, as a far cheaper but inappropriate substitute. The therapeutic consequences of such substitutions are any body's guess.

c) The *sanskrit* names *tavakshira* and *tvaksira* are orthographic variants of the same name applied to two different species. One is *Bambusa arundinacea* (Poaceae, a bamboo) and the other is *Curcuma angustifolia* (Zingiberaceae), unrelated to bamboo but a relative of the turmeric plant. The rhizomes of the two species which are used in medicine look alike when dry. Arguments persist in this case, though the bamboo rhizomes do not contain any essential oils, while those of the other species do, which should be of help.

d) The *sanskrit* name *svarna kshira* (golden milk) refers to the golden yellow milky latex, basing on which two unrelated species are indicated for use: *Euphorbia thomsoniana* (Euphorbiaceae) and *Argemone Mexicana* (Papaveraceae). *Euphorbia thomsoniana* is an Indian species, while *Argemone Mexicana*, now a common weed, was introduced from South America less than two hundred years ago, and so could not have been incorporated into the Ayurvedic practice. This is an easier issue, yet many do not agree, probably because the exotic species is abundant, easy to collect and costs nothing.

There are several such problems with Indian medicinal plants. Recognizing the brinjal plant or the fruit is not the problem, but the vernacular names used in classical texts of different systems for species of *Solanum* are.

VI. RELIABILITY OF SOURCES OF INFORMATION ON MEDICINAL PLANTS

The major classical authentic texts on *Ayurveda*, *Siddha* and *Unani* in the respective languages of their origin are not too many while commentaries are aplenty (see Kameswara Rao, 2000). Reliable translations of these in English and regional languages are also available since a long time. Additions to the species of medicinal plants in the literature come from research, in phytochemistry and pharmacology, published in standard journals. Basing on such research one may put together some species of plants to constitute an effective medicine, which is being done by many companies misleadingly calling it Ayurvedic medicine. This is herbal medicine but cannot be labelled as *Ayurveda*, *Siddha* or *Unani*, as this medicine is not based on the specific and rather rigid principles and practices of the respective classical systems.

During the past quarter century, there has been a spurt in amateur activity resulting in a very large number of repetitive lists of medicinal plants, in English and various regional languages, either as articles or even books. These publications mostly serve the personal interests of the authors, as they only contain information that has been merely copied from earlier compilations (such as by Kirtikar and Basu, 1918 and Nadkarni, reprint of third edition 1954), without any verification, substantiation or authentication. Such publications do not strengthen literature support to the subject. One needs to be very careful in using this kind of free-lance literature. Another problem is that the several very informative, important and popular publications of early 20th century such as by Kirtikar and Basu (1918) and Nadkarni (reprint 1954) were reprinted several times and unscrupulous publishers cite only the date of the reprinting but not the original date of publication, misleading the reader into believing that they are recent.

As far as *Ayurveda*, *Siddha* and *Unani* are concerned it is essential and safe to go to the original texts and also to focus on formulations rather than use of plants as single drugs.

VII. NOMENCLATURE OF BRINJAL

1. Classification and nomenclature of species of *Solanum* occurring in India:

The botanical classification and nomenclature of the species of *Solanum* have undergone substantial changes over time, as is the case with several other plant groups and ignorance of recent literature makes ample room for confusion. *Solanum melongena* var. *incanum* (L.) Kuntze and *Solanum melongena* var. *insamum* (L.) Prain are confused to be varieties of brinjal by many, but they are well established species, *Solanum insamum* L., and *Solanum incanum* L., distinct from *Solanum melongena* L. *Solanum khasianum* var. *Chattarjeeanum* Sen Gupta, which has been projected as the most important source of the alkaloid solasonine (solasodine is the aglycone) used in the commercial production of steroidal compounds, is now *Solanum viarum* Dunal (Babu and Hepper, 1979). *Solanum ferox* L., is the currently valid name for

Solanum indicum L., (Anonymous, 2009b). *Solanum xanthocarpum* Schrad . & Wendl. , is regarded as a synonym of *Solanum surattense* Burm.f., (Anonymous, 1978, 2007), which is open to question as *Solanum surattense* Burm. f., itself is regarded as a synonym of *Solanum virginianum* L., (Anonymous, 2009). The multilingual multiscript plant name database of the University of Melbourne (Anonymous, 2009b) may be consulted for the current status of specific and vernacular names of species of *Solanum*.

If I use the currently valid names in this article meant for a wide range of readers, it would affect clarity in referring to classical literature on ACSM adding to some more complexity, and hence I reluctantly use the familiar old names, fully conscious that it is not a scientifically sound practice.

2. Vernacular names of species of *Solanum* occurring in India:

Correct vernacular names are critical in issues of plant utilization. Folklore taxonomy is important as it led to scientific taxonomy, the latter being essential for international communication. For example, it is the vernacular name apple first and then the scientific name *Malus domestica* Borkh., (= *Pyrus malus* L.). Widely distributed and commonly used species of plants acquire several names, often in the same language, or the same name applied to different species as is the case with the cultivated African *Solanum aethiopicum* L., which is also known as the aubergine or egg plant. Both the situations confuse.

Overlapping vernacular names, as for example *brihathi* (or its orthographic variants) in *Samskrith* as given below for *Solanum indicum*, *Solanum torvum*, *Solanum violaceum* and *Solanum virginianum*, may result in misidentification and/or substitution. Similar is the problem with the Tamil name *karimulli* for *Solanum indicum* and *Solanum violaceum*, and *kandakathri* for *Solanum surattense*, *Solanum virginianum* and *Solanum xanthocarpum*. The Tamil name for brinjal (*kathri* and its orthographic variants) is also the suffix of the Tamil name *Kandakathri* which leads to problems in species identification in the *Siddha* system. The *samskrith* name 'rajakooshmanda' (King's egg, alluding the fruits of the pure white variety to an egg, as with English name egg plant) also was applied to brinjal (Jagga Rao *et al.*, 1933), but when the ash gourd (*Benincasa hispida*, Cucurbitaceae) is known by the *Samskrith* name 'kooshmanda', an uncritical approach would lead to mix up of identity and medicinal uses .

The *Samskrith* (S), Tamil (T) and Arabic (A) / Persian (P) / Urdu (U) names of species of *Solanum* of present concern, taken from diverse medicinal plant literature sources are given below. These languages are chosen because the discussion here is related to the use of brinjal in *Ayurveda*, *Siddha* and *Unani* medicine.

i) *Solanum ferox* L.: S: *garbhanda*, *svetakantakaari*; T: *aanaichundai*, *molakkai*

ii) *Solanum indicum* L.: S: *bhantaki*, *brahat*, *cundaa*, *sauhika*, *simhi*, *vrihati*; T: *chiru vazhutralai*, *karimulli*, *mullamkatti*, *papparamulli*; U: *katali*

iii) *Solanum melongena* L.: A: *badanjan*, *amb*, *qahqab*; P: *badangan*, *badinjan*, *kahlat*, *kahkan*; S: *bartaku*, *bhantaki*, *hingoli*, *jukutam*, *nattimgan*, *vartakka*, *peetaphalam*, *rajakooshmanda*,

varтахu, vartakam, vatinga, vatingnah; T: *kathri, kathrikai, kattri, kattrikai, veluthalai*; U: *baingan*

iv) *Solanum nigrum* L.: A: *enab edh dhib, enab eth thalab, ribriq, unnab us sau 'lab*; P: *rubhatareek*; S: *kaakamaachika, kakamischluka, kaakini*; T: *mantakkali, milaguthakkali*; U: *makoi, makoya*

v) *Solanum surattense* Burm. f., (considered as a synonym of *Solanum virginianum* L.) : S: *dhivane, dusparsa, kantakaarika, kaudri, nidigdhika, vyaghre*; T: *kandangatri, kandanghathiri, kandankatri*

vi) *Solanum torvum* Sw.: S: *brihati*; T: *sundaikkai*

vii) *Solanum trilobatum* L.: S: *achunda, agnidamani, alaarka, , kaarika, swethabrihati, valliharta*; T: *nittidam, sandunayattam, surai, thuthuvalaikeerai, tunduvalai*

viii) *Solanum violaceum* Ortega: S: *brihati, kantakin, simhi*; T: *karimulli, cheruvalutanai*

ix) *Solanum virginianum* L.: S: *bhantaki, brahati, kantakaari*; T: *kantankathiri, kandakathri*

x) *Solanum xanthocarpum* Schrad. et Wendl.: S: *dhavani, dusparsa, kankapatrika, kantakaari, kantakaarika, nidigandha, nidigandhika, ksudra, vaartakee, vyaghri*; T: *kandakathri*; U: *kandiari*

VIII. DR G SIVARAMAN'S CONTENTION

1. Letter to the MoEF:

In the four page letter he submitted to the MoEF, Dr Sivaraman noted that “**there are two major varieties, i.e., *Solanum melongena* and *Solanum indicum* are in the pharmaceutical applications in traditional medicine**’ (emphasis in bold is mine). This is not correct as *Solanum indicum* is a well established species, both in *Ayurveda* and botany, distinct from brinjal (*Solanum melongena*) and not a variety of the latter, even according to WoI (Chadha, 1972, IX, p. 381). But there is another hitch in WoI’s recording, that mentions four main ‘botanical varieties’ of *Solanum melongena* (*incanum, melongena, depressum* and *serpentinum*) (Chadha, 1972, IX, p. 385). This does not constitute sound taxonomy, since *incanum* is a distinct species and *depressum* is an obsolete name, leaving *melongena* and *serpentinum* (the name for the group of very long cylindrical brinjal) as subgroups under brinjal.

Dr Sivaraman wrote that ‘**In southern part of India, especially *Solanum melongena* (Brinjal—*Kaththirikkai*) has been used as a substitute for *Solanum indicum***’ (emphasis in bold is Dr Sivaraman’s). Systems of medicines are plagued with problems created by the use of substitutes, either deliberately or out of ignorance. Some examples were already mentioned. While some substitutes may be functional, many a time a substitute would result in nonfunctional or even

dangerous medicine. Substituted use of brinjal cannot be the basis for a major decision affecting a crop cultivated nationwide.

2. Wealth of India:

Dr Sivaraman submitted to the MoEF photocopied material on *Solanum melongena* (see Annexure IIIA, pp. 213 to 220) from WoI (Chadha, 1972; vol. IX, pp. 383-390), which cannot be taken as an authentic source for *Ayurveda* or *Siddha*. Dr Sivaraman had kindly sent me pages 381-382 from Chadha (1972), that contain information on *Solanum ferox*, *Solanum giganteum*, *Solanum hispidum*, *Solanum indicum*, *Solanum khasianum*, which are not a part of MoEF's documentation. Chadha (1972) contains some references to the use of these species in indigenous medicine. There are no references to authentic texts of any of the ACSM but only to Kirthikar and Basu (1918) and other such publications, which again cannot be taken as sources for ACSM. As will be shown in the present article, brinjal is not used in the indigenous systems in any significant way and certainly not in any formulation. Most of the information cited by the activists comes from Kirthikar and Basu (1918) or WoI (1972) or folklore literature. WoI gives botanical, phytochemical and pharmacological information, but since the date of publication of WoI is 1972, such information is rather dated. For example, it is stated that '*Brinjal, leaf and fruit, fresh or dry, produce a marked drop in cholesterol level*', the '*action is attributed to the presence of magnesium and potassium salts in the plant tissues*'. However, it was admitted that '*experimental results have not been confirmed by clinical trials.*' If the small quantities of magnesium and potassium salts as can be obtained from vegetables like brinjal can control cholesterol levels, no one would suffer from high levels of cholesterol, since we consume large amounts of chlorophyll from green parts of vegetables and magnesium is at the heart of chlorophyll. A variety of foods, including wheat and rice, contain more than two per cent of potassium salts. Two reports from Brazil (Ribeiro Jorge *et al.*, 1998; Guimarães P.R., *et al.*, 2000) claimed that egg plant extracts and orange juice had a beneficial effect on cholesterol levels, lipid peroxidation and endothelial function, but a later study based on human clinical trials dismissed the whole concept (Praca *et al.*, 2004).

There are references in WoI and elsewhere to the adverse effect of brinjal alkaloids basing on the changes in the ratio of body and liver weights in mice. The activists have blown this up ignoring the fact that the mice were fed with purified alkaloids at much higher doses than the possible dietary intake through brinjal. Friedman *et al.*, (1996) reported that the increase in relative body and liver weight induced by solanidine and solasodine in potato, tomato and egg plant (brinjal) is a reversible adaptive response, dropping to control levels on discontinued alkaloid intake. Considering the low levels of these alkaloids in currently cultivated brinjal and the quantity and frequency of brinjal intake make this hardly be an issue. Somehow the presence of nicotine in brinjal was totally missed.

3. Nair and Vasudevan's book:

The second publication from which Dr Sivaraman provided photocopied material to the MoEF is Nair and Vasudevan (date of publication unavailable in spite of Dr Sivaraman's efforts to find it, at my request), called a concise dictionary of common medicinal plants. The authors gave only the names of supposedly medicinal species, without mentioning their medicinal properties at all.

The book lists *Solanum nigrum*, *Solanum ferox*, *Solanum violaceum*, *Solanum virginianum*, *Solanum capsicoides* (= *Solanum aculeatissimum*) *Solanum tuberosum* (potato) and *Solanum melongena* (pages 108-109). The names of some species given here are no longer scientifically valid. *Solanum aculeatissimum* Jacq., is a valid species, not to be synonymized with *Solanum capsicoides* All., and *Solanum xanthocarpum* Schr. et Wendl., is valid and not to be synonymized with *Solanum virginatum* L. The book also cites *Solanum melongena* var. *insanum* and *Solanum melongena* var. *incanum*. As already mentioned, these are not varieties of brinjal (*Solanum melongena*) but recognized species. Treating them as varieties of *Solanum melongena* leads to the belief that these are varieties of brinjal and that brinjal is medicinal, as both *Solanum incanum* and *Solanum insanum* may have some medicinal uses, basing on phytochemistry and pharmacology, though not in ACSM. Potato (*Solanum tuberosum*), an introduced species, is also listed as a medicinal plant in this book. Basically this book is an uncritical and unreliable listing of supposedly medicinal species.

IX. USE OF SPECIES OF *SOLANUM* IN ACSM

1. In *Ayurveda*:

Jagga Rao *et al.*, (1933), taking from Ayurvedic sources, stated that brinjal has a cooling effect on the eyes, neutralizes acidity and removes calcium. The side effects of brinjal are, it increases phlegm, darkens the skin and causes skin irritation. Other recorded negative effects of brinjal are headache, increased body heat, increased intestinal parasites, pain in the rib cage, nausea, and obstruction of liver and spleen (Jagga Rao *et al.*, 1933). Can a medicine that increases phlegm cure respiratory diseases as claimed by the activists and the MoEF? People who suffer from respiratory diseases have been consuming brinjal routinely, yet suffer from them.

i) **Ayurvedic Formulary of India:**

The Ayurvedic Formulary of India (AFI, Anonymous, 1978a), was compiled by the Ayurvedic Pharmacopoeia Committee consisting of 22 experts, constituted by the Government of India. This compilation was strictly confined to Ayurvedic source texts and listed 444 formulations (as against 341 drugs in *Charaka Samhitha* and 395 in *Sushrutha Samhitha*), that use 351 plant species, among which *Solanum indicum*, *Solanum nigrum* and *Solanum xanthocarpum* were mentioned in different formulations but not *Solanum melongena* (brinjal).

ii) **The Ayurvedic Pharmacopoeia of India:**

The Ayurvedic Pharmacopoeia of India (API) is an official two part publication of the Government of India, compiled by a large Committee with several sub-Committees, under the Central Council for Research in Ayurveda and Siddha, of the Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), Ministry of Health and Family Welfare (Anonymous, 1978b, 2007). Four volumes of Part I contain information on 324 plant species used as drugs and two volumes of Part II contain details of Ayurvedic formulations. The API included monographs only on *Solanum surattense* (Part I, volume I, p. 59) and *Solanum indicum* (Part I, volume II, pp. 27-28) and no other species of *Solanum*, which means that brinjal is not of any concern in *Ayurveda*. Unfortunately, there is an error in the taxonomic treatment: *Solanum xanthocarpum* was treated as a synonym of *Solanum surattense* (Anonymous, 2007,

Part I, vol. I, pp. 59), which is incorrect. *Solanum surattense* is treated as a synonym of *Solanum virginianum* by some taxonomists (see Anonymous, 2009b), but not of *Solanum xanthocarpum*. The API (Anonymous, 2007) did not stick to the name *Solanum surattense* in all formulations that contained it, but used the name *Solanum xanthocarpum* (which compilers themselves considered as a synonym of *Solanum surattense*), in some formulations such as *Chyavanaprasa* (Part II, vol. I, p. 13), *Dasamoola palaka ghritha* (Part II, vol. 1, p. 68) and *Dhanvantara ghritha* (Part II, vol. I, p. 80), under the *Samskrith* name *kantakaari*.

iii) Ayurvedic Formulations:

Dr Sivaraman specifically mentioned about '*Dasamoola*' (roots of 10 species) and formulations based on it as using brinjal. '*Dasamoola*' contains 72 ingredients, including both *brihati* (*Solanum indicum*) and *kantakaari* (*Solanum xanthocarpum*) but brinjal is not one of them (Anonymous, 1978a). So is the case with *Dasamoola* based formulations such as *Dasamoolaharitaki* (*Ashtangahridaya*), *Dasamoolarishta* (*Sarangadhara samhitha*), *Dasamoola katuthriya kvatha churna* (*Sahasrayoga*), *Dasamoola panchakoladi kvatha churna* (*Sahasrayoga*), *Dasamoola ghritha* (*Ashtangahridaya*) and *Dasamoola satpalaka ghritha* (*Chakradatta*), the formulations based on the Ayurvedic source texts given in parenthesis above (Anonymous 1978a, pp. 10, 33, 46, 71, 72, 74).

In API (Part II, vol. I, Anonymous, 2007) the following formulations contain *Solanum indicum* and/or *Solanum surattense* (the latter as *Solanum xanthocarpum* in some): *Chitraka haritaki* (p. 10), *Chyanavaprasa* (p. 13), *Vyaghri harithaki* (p. 35), *Dasamoola ghritha* (p. 65), *Dasamoola palaka ghritha* (p. 68), *Kalyanaka ghritha* (p. 75) and *Dhanvantara taila* (p. 117).

Dr Sivaraman also mentions *Dhanwantara kashayam* and *Dhanwantara tailam* as containing brinjal. *Dhanwantara ghritha* (from *Ashtangahridaya*, containing *brahati*, *Solanum indicum* and *kantakaari*, *Solanum xanthocarpum*), *Dhanwantara gutika* (from *Sahasrayoga*, containing only *brahati*) and *Dhanwantara taila* (from *Vaidyayogarathnavali*, containing *brahati* and *kantakaari*), were listed in Anonymous (1978a; pp 71, 73, 108, 148) but brinjal is not an ingredient in any one of them.

I have looked into other publications, as for example *Vaidya Yoga Ratnavali* (Ramalingayya, 1968) and did not find even a single mention of brinjal, while the use of the other species of *Solanum* (*Solanum nigrum*, *Solanum indicum*, *Solanum surattense* and *Solanum trilobatum*) was indicated. I have also consulted well qualified and practicing Ayurvedists who could not recall even a single formulation in which brinjal is an ingredient.

2. In Siddha:

- i) Dr Sivaraman stated that '*CSIR, in its Wealth of India publications clearly mentioned that 'vazhuthunangkai' is a synonym (Malayalam) for Solanum melongena*' (MD, Annexure IIIA, p. 209). I have looked into WoI (Chadha, 1972, IX, p. 383), Nair and Vasudevan (publication date not known, p. 109) and the *Siddha Materia Medica* (Murugesu Mudaliar, 1988, p. 218), all of which cite only *vazhuthana* as the Malayalam name for brinjal and not *vazhuthunangkai*. Besides, there is no reason to

- take a Malayalam name as a lead in preference to *Samskrith* and Tamil names which are the authentic source languages for Ayurvedic and *Siddha* medicines, respectively.
- ii) Dr Sivaraman sent me pages 218-221 relevant to brinjal from *Gunapadam (Siddha Materia Medica*, in Tamil by Murugesu Mudaliar, 1988), which are not a part of MoEF's MD. Dr Gurumurti Natarajan, an agricultural scientist and native Tamilian helped in translating this material. Finding that the Tamil used in *Gunapadam* to be archaic, he had to take the help of a Tamil scholar.
- a) *Gunapadam* praises brinjal as a medicinal vegetable which will solve health problems, causes no harm even on consuming three times a day, and can be consumed without hesitation. Heated or dried and fried brinjal fruit cures stomach ache and de-worms cattle (contrary to Ayurvedic opinion that it promotes intestinal parasites). Burnt or charred brinjal fruit helps digestion, reduces acidity and gas. Poked with a needle and fried in sesame oil, brinjal cures dental problems (a use not mentioned by any other source). Brinjal removes mucous (contrary to Ayurvedic opinion that it increases phlegm) and removes bile (contrary to Ayurvedic opinion that brinjal obstructs liver and spleen). The brinjal root-in-oil preparation (*thailam*) cures gastric problems. The seed induces sleep and removes phlegm (contrary to Ayurvedic opinion that brinjal increases phlegm). Brinjal in a mud pack, is also used in tempering (hardening) metals and alloys used in some *Siddha* formulations.
- b) *Gunapadam* also lists a host of side effects of brinjal which are enough to consider a ban on brinjal cultivation. Brinjal produces body heat (contraindicated in several health conditions), induces purging, causes skin itching, eruptions, pimples, eczema, and skin diseases akin to leprosy (as also indicated in *Unani*), and affects fertility.
- c) There are many contraindications in *Gunapadam*. It was stated that *vazhuthalai* cures hard breathing, panting and mucous but also causes inflammation of the liver and gall bladder, and produces body heat, infertility and leprosy. The problem here is that the name *vazhuthalai* is the Tamil vernacular for *Solanum indicum* and not for *Solanum melongena*. There is a reference to *kandan (kantana) katthri* suggested as a good medicine for liver problems, but *kandan katthri* is the Tamil vernacular name for *Solanum virginianum (=Solanum jacquinii)*. The reference to the Tamil vernacular name *aakasha kathri*, which is not mentioned in any other publication referring to brinjal or species of *Solanum*, is another problem as this was equated with the totally unrelated *Hibiscus longifolius*, which is botanically untenable. Obviously, there is a lot of confusion between brinjal and brinjal-like plants and their names in the ancient medical literature.
- iii) The Formulary of *Siddha* medicines (Anonymous, 1989) does not mention any medicinal uses of brinjal. In addition to *Solanum indicum* and *Solanum xanthocarpum* used in *Ayurveda*, *Solanum trilobatum* is also used in *Siddha*

medicine, and the number of Tamil names for this species indicates its wide distribution in Tamil Nadu.

- iv) The *Siddha* system considers brinjal as allergenic. Several web postings on health caution the patients undergoing *Siddha* treatment not to consume brinjal and tomato, which aggravate skin ailments and rhinitis, as they are allergic reactions. Many respiratory diseases such as asthma are caused by allergens. The website of the Indian *Siddha* Medical Graduates Association, Chennai, that offers professional advice on diseases and their treatment in the *Siddha* system, cautioned in the context of allergic rhinitis, that '*important thing during the course of Siddha medicine is food restriction. Certain foods must be avoided*' and listed a dozen foods including '*brinjal and vegetables belonging to its family*' (Anonymous, 2011). Brinjal does not go into home remedies for it is allergenic. Allergy is an individualistic issue as there is no single allergen that affects everyone and not everyone is affected by any/or all allergens, but caution is the watch word till the offending agent is identified and individual's response ascertained.

3. In Unani:

Many Indian publications do not cite Arabic, Persian or Urdu names for medicinal plant species nor make references to their uses in the *Unani* system, which makes it difficult to connect. Added, there is paucity of literature on *Unani Materia Medica* in English.

Fathima (1994) compiled a glossary of plants used in *Unani* medicine, under the joint supervision of four experienced teachers and practicing physicians in *Ayurveda* and *Unani*. Depending upon the availability of information, she has given *Unani* formulations in which the plant species are included and also the uses in *Ayurveda* separately and included information on action, therapeutic uses, harmful effects, etc. Only *Solanum melongena* (pp. 102-103) and *Solanum nigrum* (pp. 308-309) were treated in this compilation but no other species of *Solanum*. Uses of *Solanum nigrum* in *Ayurveda* were recorded but none for brinjal; obviously there are none. There is no information on the uses of these two species in any *Unani* formulations, as none were indicated in the vast *Unani* literature she looked into. There are suggestions in one *Unani* source that brinjal cures eczema, piles and splenic tumours (Fathima, 1994), contrary to the side effects cited in *Ayurveda* and *Siddha*. As in *Siddha*, *Unani* too considers that brinjal causes leprosy (Fathima, 1994).

4. In Homoeopathy:

Homoeopathic literature indicates the use of *Solanum nigrum* and *Solanum xanthocarpum* but not brinjal (Boericke, 1991, among several other publications). That brinjal is not used in homoeopathy was also confirmed by the Director General of the Central Council for Research in Homoeopathy (Indian Express, February 24, 2010).

5. Database of Medicinal Plants:

The Database of Medicinal plants contains long lists of species (including introduced ones) indicated for use against specific disease states, in the ACSM or based on modern phytochemistry and pharmacology (see Appendices, Kameswara Rao, 2000, 2002). These lists are intended to form the basis for scientific evaluation through modern research of the species indicated therein. Those states that involve species of *Solanum* are given below:

Analgesic: *Solanum stromonifolium* Jacq., *Solanum surattense* Burm.f., *Solanum torvum*

Anthelmintic, nematocidal and antifilarial: *Solanum indicum*

Antifungal: *Solanum nigrum*

Antiinflammatory and astringent: *Solanum melongena*, *Solanum nigrum*, *Solanum surattense*, *Solanum torvum*

Antiviral: *Solanum indicum*, *Solanum xanthocarpum*

Dental care: *Solanum indicum*, *Solanum stromonifolium*, *Solanum surattense*, *Solanum torvum*

Depressants of central and autonomous nervous system: *Solanum nigrum* L.

Emesis and purgation: *Solanum indicum*, *Solanum nigrum*, *Solanum xanthocarpum*

Gastro-intestinal disorders: *Solanum nigrum*, *Solanum surattense*, *Solanum violaceum*

Geriatric care: *Solanum torvum*

Immunomodulatory: *Solanum torvum*

Solanum nigrum, *Solanum torvum*, *Solanum indicum* and *Solanum surattense* seem to be the most important species in ACSM. In all this, brinjal's single effect as an anti-inflammatory and astringent is marginal, for which there are dozens of other more effective species.

Ultimately, it looks that I have searched for a needle in a haystack, without the needle being there.

X. OTHER ISSUES RAISED BY DR SIVARAMAN

In addition to what has been discussed, Dr Sivaraman has raised the following issues:

1. Synergy:

Dr Shivaraman raised the issue of 'synergy' stating that the alkaloidal comparison shows significant differences between *Bt* and non-*Bt* brinjal, which 'can affect the entire synergy of the

plant' (MD, Annexure IIIA, pp. 210). This view was highlighted by the MoEF (MD, text para 20, p. 13), and repeated on February 24, 2010. In the absence of a clarification on what Dr Sivaraman and the MoEF mean by '*synergy of the plant*', I am at a loss to understand the objection which cannot be taken on its face value.

The Primer on 'National Consultation' inaccurately translated the Ayurvedic term '*prabhava*' as '*synergetic property*' (Anonymous, 2009a, p. 17). As per Ayurvedic sources, '*prabhava*', the effectiveness or potency of a substance, means '*the characteristic and specific actions of substances which can't be explained in terms of the pharmacological actions of their various individual constituent principles taken out separately*' (emphasis in bold mine; Anonymous, 2009c). So the effect of a formulation is not the same as that of the components.

Synergy, a concept of science, means that '*when several elements, such as A and B are combined, the result is greater than the expected arithmetic sum of A+B*'. The concept of synergy is applied in diverse situations such as biology, pharmacology, chemistry, management, sports and others, and the elements involved can be chemical compounds, drugs, organisms in ecosystems, people, hardware, software, facilities, etc. Corning (1998) provides a detailed analysis of the concept of synergy.

One frequently quoted example of drug synergy is the use of codeine and ibuprofen together, whose combined effect in pain relieving is several times more than the individual effect of either of the drugs. Synergy can also cause negative effects, such as when valium and alcohol are taken together, which can be fatal.

Consequently, the view of Dr Sivaraman and the MoEF and that of science, on what constitutes synergy are at variance.

It is understood for a long time that the whole of the food, drink or medicine we consume function holistically on all parts of the body system, on the balance of all synergetic and antagonistic interactions, not just among the constituents of the intake but also, more importantly, with the gastro-intestinal chemical environment and that of the target organ/tissue as well. Accordingly, there are liquid vehicles (*anupaana*, taken with, before or after drug intake) to promote drug delivery to the target site, foods that are complementary to the medicine (*pathya*) and foods that should be avoided as they are antagonistic to the medicine (*apathya*), recommended by physicians.

In the context of plant based medicine the situation is extremely complex as each species contains thousands of different chemical compounds, the majority being products of metabolism (secondary metabolites). For example, coffee decoction contains over 600 different chemicals. Most of these compounds are plant defense products, occurring at higher concentrations in times of stress (pathogens, temperature, drought, etc.). A chemical compound may be nutritional, therapeutic or even toxic depending upon dosage and concentration in the body system.

The formulation *Dasamoolaarishta* contains 72 different plant species. The complexity of chemical constituents in this formulation is staggering and their interactions can only be

imagined, even taking that some species such as *Solanum indicum* and *Solanum xanthocarpum* in it may contain identical compounds,

It is well established that there is a natural qualitative and quantitative variation in the chemical constitution of plants within individual plants and populations and between populations and varieties, at different times of the day, season and the lifecycle. In addition, the method of preparation of the medicine may bring in some chemical changes. Too many parameters are involved resulting in an extremely complex situation.

In drug synergy two or more chemically characterized compounds whose effect is identical, would produce the same effect but much enhanced. Both codeine and ibuprofen are pain killers that produce a vastly enhanced pain killing effect in combination. Allopathy uses chemical compounds whose structure and therapeutic effects are known. This situation does not occur in plant based indigenous medicine as no one knows all the individual chemical components, or their concentrations and so their effects, in any plant used, as the systems are not based on chemical analysis, characterization and the effects of each one, though the effect of the whole plant is known based on experience gained from its long use. The combinations and quantities of the ingredients in a formulation were determined basing on extensive experience through trial and error. The synergetic and antagonistic effects of the constituents in indigenous medicine could only be surmised, since there has been no experimental demonstration of synergy from any of the classical medical preparations.

When the edible and cultivated *Solanum melongena* (there is no wild brinjal) is not an ingredient of any medicine, the question of *Bt* brinjal affecting synergy does not arise. The other species of *Solanum* used in different ACSM do not come into the picture. Those who contend that *Bt* brinjal affects ACSM should first convincingly show that cultivated brinjal is an ingredient of indigenous medical formulations and demonstrate synergy in the formulations and that synergy was affected in formulations using *Bt* brinjal. In the context of indigenous medicine, the expression ‘entire synergy of the plant’ is out of context and scientifically untenable.

2. Use of raw brinjal in medicine:

When brinjal is not used in any medicine, this question does not arise. However, since Dr Sivaraman was emphatic on the use of raw brinjal in *Siddha* (*Dasamoola choornam*) and *Ayurveda* (*Dasamoola asava*) (MD, Annexure IIIA, pp. 212), a response is needed. *Choornam* is fine powder and the ‘fresh and raw’ brinjal has to be thoroughly dried to pulverizing it, and *aasava* is a product of fermentation of decoction of powdered ingredients. The process of preparing the two formulations does not retain the ‘fresh and raw’ nature of the ingredients.

3. Safety of cooked *Bt* brinjal:

Dr Sivaraman raised another issue, that brinjal is cooked in India in different ways (such as using tamarind) and that the biosafety of *Bt* brinjal in the cooked preparations is not demonstrated (MD, Annexure IIIA, pp. 211-12). Brinjal has centuries of history of safe human consumption, though excessive consumption may cause some adverse effects, recognized in all the indigenous systems of medicine as already mentioned. The antidotes are ghee, jaggery, mustard, ginger,

tamarind and *garam masala* (Jagga Rao *et al.*, 1933), and *jeera*, *ajwain*, curds and oil (Fathima, 1994). The recipes to cook brinjal contain one or more of these antidotes to make it safer. Cooking recipes aim at visual appeal and palatability, and other considerations are not their concern.

The Cry 1Ac protein is denatured in the highly acidic mammalian stomach in less than 30 seconds and its fate is the same as that of any other protein without binding sites on mammalian gut lining. The ingredients in the recipe and the cooking process also affect protein integrity. The biology of toxicity of Cry 1Ac and its safety in human consumption are well studied and several plant foods containing *Bt* proteins have been consumed in North America for nearly 15 years without any adverse effects on human health. Studying the effects of *Bt* brinjal cooked in a dozen different ways is a wild and wasteful exercise.

XI. IN CONCLUSION

As is my contention, the Head of the Foundation for Revitalization of Local Health Traditions, Bangalore, stated that “*the brinjal that we eat does not have any medicinal value*” (Indian Express, February 24, 2010).

There are two reasons for this:

- a) the earlier varieties of brinjal, cited in the millennia-old source texts, contained higher concentrations of anti-nutritional and/or toxic chemical constituents, which may have had therapeutic potential, but which imparted unpleasant taste and even affected health. Hence, selection during domestication was aimed at reducing them to improve safety and palatability; and
- b) when we are exposed to small doses of toxic substances, the body system is prepared to tolerate them in higher concentrations and so they become relatively harmless, as per the concept of Hormesis. Present day brinjal varieties do not have appreciable quantities of therapeutically active chemical compounds, and even if some varieties still have them, the body system is already adjusted to make them ineffective. Centuries of cultivation and use as food have made cultivated brinjal unfit for use as medicine, while the wild species of *Solanum* still contain adequate quantities of active principles and so can be used in medicine.

Orthodox Brahmins do not use brinjal in food on anniversary days of death of their family members, just as several other vegetables which are not native to the country are prohibited. Swamy (1978) narrated his grandfather’s irritation on not being able to use even chillies (green or red) on the anniversary of his father’s death, when only black pepper was permitted. Since the Ayurvedic profession was dominated by Brahmins till the turn of the last century, what was prohibited as food would not go into medicine.

Charaka stated that ‘*There is no substance in the world which cannot be used for medicinal purposes. An appropriate substance only needs to be used appropriately, to be effective*’ (Charaka Samhitha, Suthra Sthana, 26.10). Accordingly, any species is a medicinal plant,

provided we find a use for it and a means to use it. It would be in our interest to connect phytochemistry with pharmacological action, to put plants to better medicinal uses. For example, the purple brinjal has anthocyanins in the skin which can be suggested as antioxidants, but charring brinjal skin while cooking would remove this benefit. One can invent a useful formulation putting several species with desired therapeutic benefits, but this makes it only a non-exclusive nutritional supplement and not a medicine, and certainly not a medicine as per the indigenous systems.

Even if the current day medical concoctions use brinjal, it is not on the basis of authentic classical texts of ACSM, but on the whims of latter day specialists, a majority of who have developed an unfortunate habit of claiming to cure all diseases including AIDS, cancer and diabetes. How much of brinjal do they use in medicine and how frequently and which cultivars? If they want non-*Bt* brinjal, the farmers can easily grow the preferred cultivars in the small quantities they need. For this limited use, one need not force all the brinjal farmers and the consumers to continue to suffer with pest infested brinjal, the excessive use of pesticides affecting health and financial losses.

Those who oppose *Bt* brinjal are using the issue of brinjal's nearly non-existent medicinal uses, exploiting the confusing the scientific and vernacular names of brinjal and other species of *Solanum* in classical literature, the consequent misinterpretations, and the general ignorance of the public about ACSM.

Bt brinjal does not pose any threat to the use of non-*Bt* brinjal in medicine if any, as the scope for gene flow from *Bt* brinjal to non-*Bt* brinjal is almost non-existent.

How many of those who are fighting to protect traditional Indian medicine through banning *Bt* brinjal actually go for traditional medicine for themselves and for their families? Of course, we know that they are fighting for their poor cousins who cannot afford modern medicine.

Acknowledgement

I am grateful to a) Dr G Sivaraman, Member, National Siddha Pharmacopeia Committee, Chennai, for kindly sending me material from *Siddha* source texts and other publications, which is additional to MoEF's *Bt* brinjal moratorium documentation, and b) Dr Gurumurthi Natarajan, Agricultural Scientist and Consultant, Chennai, for translating *Siddha* source material from Tamil and for providing additional inputs.

References

Anonymous. 1978a. *The Ayurvedic formulary of India. Part I. Plant drugs*. Ministry of Health and Family Planning, Government of India, New Delhi.

Anonymous. 1978b, 2007. *The Ayurvedic pharmacopoeia of India*. Ministry of Health and Family Welfare, Government of India, New Delhi.

Anonymous. 1989. Formulary of *Siddha* medicines. Indian Medical Practitioners' Cooperative Pharmacy and Stores Ltd., Chennai.

Anonymous. 2009a. *National consultations on Bt brinjal: a primer on concerns, issues and prospects*. Centre for Environment Education, Ahmedabad. Pp. 20.

Anonymous. 2009b. Multilingual multiscrypt plant name database. Univ. Melbourne. http://www.plantnames.unimelb.edu.au/new/Sorting/Solanum_eggplants.html. (accessed May 28, 2011).

Anonymous. 2009c. Website of Chakrapani Ayurveda Clinic and Research Centre, Jaipur. www.ayu.in. (accessed on June 6, 2011).

Anonymous. 2010. *National Consultations on Bt brinjal: report*. Centre for Environment Education, Ahmedabad. Pp.101.

Anonymous. 2011. Website of the Indian Siddha Medical Graduates Association, Chennai. <http://www.ismga.net/1/post/2010/11/-allergic-rhinitis.html>. (accessed on June 20, 2011).

Ayensu, S.E. 1986. World medicinal plant resources. In: *Conservation for productive agriculture*. (Eds.) Chopra, V.L. and Khoshoo, T.N. ICAR, New Delhi. Pp. 11-49.

Babu, C.R. and Hepper, F.N. 1979. Taxonomy and nomenclature of *Solanum khasianum* and some of its relatives. *Kew Bull.*, **34**:407-411.

Bhat, S. and Kameswara Rao, C. 1993a. *Ayurveda Parichaya* (Introduction to *Ayurveda*, in *Kannada*). Directorate of Indian Systems of Medicine and Homoeopathy, Government of Karnataka, Bangalore. pp. 53.

Bhat, S. and Kameswara Rao, C. 1993b. *Siddha Vaidya Parichaya* (Introduction to the *Siddha* system, in *Kannada*). Directorate of Indian Systems of Medicine and Homoeopathy, Government of Karnataka, Bangalore. pp. 17.

Bhat, S. and Kameswara Rao, C. 1993c. *Unani Vaidya Parichaya* (Introduction to the *Unani* system, in *Kannada*). Directorate of Indian Systems of Medicine and Homoeopathy, Government of Karnataka, Bangalore. Pp. 22.

Boericke, W. 1991. *Pocket manual of Homoeopathic Materia Medica*. Augmented and revised edition. B Jain Publishers (Pvt.) Ltd., New Delhi. (reprinted ed.).

Chadha, Y.R. (Ed.). 1972. *Wealth of India: dictionary of Indian raw materials and industrial products*. Vol. IX. CSIR, New Delhi. Pp. 381-390.

Corning, P.A. 1998. *The synergism hypothesis*. J. Social and Evolutionary Systems 21. Available at <http://www.complexsystems.org/publications/synhypo.html>. (accessed on June 7, 2011).

Fathima, T. 1994. *Glossary of medicinal plants in Unani system of medicine*. M.Sc., dissertation, Bangalore University.

Friedman, M., Henika, P.R. and Mackey, B.E. 1996. Feeding of potato, tomato and eggplant alkaloids affects food consumption and body and liver weights in mice. *J. Nutrition*, 126:989-999. <http://jn.nutrition.org/content/126/4/989.full.pdf> (accessed on June 8, 2011).

Guimarães P.R., Galvão, A.M.P., Batista, C.M. 2000. Eggplant (*Solanum melongena*) infusion has a modest and transitory effect on hypercholesterolemic subjects. *Braz. J. Med. Biol. Res.*, **33**:1027-1036.

Jagga Rao, Y., Narasimha Rao, Y., Seetharamayya, Y. and Krishna Murthy, Y. 1933. *Vastugunadeepika* (in *Telugu*). 6th ed. Shree Rama Printing Press, Rajahmundry.

Kameswara Rao, C. 2000. *Database of medicinal plants*. Karnataka State Council of science and technology and Department of Forests and Ecology, Government of Karnataka, Bangalore. (pp 458).

Kameswara Rao, C. 2002. Database of medicinal plants. Website at www.medicinalplants-kr.org . (accessed on June 11, 2011).

Kameswara Rao, C. 2010. *Moratorium on Bt Brinjal: A Review of the order of the Minister of Environment and Forests, Government of India*. FBAE, Bangalore. (pp 75). Electronic copy available at http://www.whymbiotech.com/resources/tps/Moratorium_on_Bt_Brinjal.pdf (accessed June 11, 2011).

Kameswara Rao, C. and Sangeeta, W. 1993. Alternate sweeteners. *Vatika*, No. 4, winter, 1993.

Murugesu Mudaliar, K.S.M. 1988. *Gunapadam (Siddha Materia Medica, vegetable section, in Tamil)*. Directorate of Indian medicine and Homoeopathy, Chennai.

Nadkarni, A.K. 1954. Dr KM Nadkarni's *Indian materia medica*. 3rd ed. Popular Prakashan, Bombay.

Nair, R.V. and Vasudevan, R. (date of publication untraceable). *Common medicinal plants: a concise dictionary*. Arya Vaidya Pharmacy (Coimbatore) Ltd., Coimbatore. Pp. 108-109.

Oliver-Bever, B.E.P. 1986. *Medicinal plant of tropical West Africa*. Cambridge University Press, Cambridge.

Praca, J.M., Andréa Thomaz, A. and Caramelli, B. 2004. Eggplant (*Solanum melongena*) extract does not alter serum lipid levels. *Arq. Bras. Cardiol.*, **82**:273-276.

Ramalingayya, M. 1968. *Vaidya Yoga Ratnavali* (Formulary of Ayurvedic medicines). Indian Medical Practitioners' Cooperative Pharmacy and Stores Ltd., Chennai. (Translated from the Telugu original, whose date of publication is unknown, into English and Tamil).

Ray, P. and Gupta, H.N. *Charaka Samhitha, a scientific synopsis*. INSA, New Delhi.

Ray, P., Gupta, H.N. and Roy, M. 1980. *Sushruta Samhitha, a scientific synopsis*. INSA, New Delhi.

Ribeiro Jorge, P.A., Neyra, L.C., Osaki, R.M., Almeida, E. and Bragagnolo, N. 1998. Efeito da berinjela sobre os lípidos plasmáticos, a peroxidação lipídica e a reversão da disfunção endotelial na hipercolesterolemia experimental. *Arq. Bras. Cardiol.*, **70**: 87-91.

Sivarajan, V.V. and Balachandran, I. 1994. *Ayurvedic drugs and their sources*. Oxford & IBH, New Delhi.

Swamy, B.G.L. 1978. *Namma hotteyalli diakshina America* (South America in our stomach) (in Kannada). *Prasaranga*, Bangalore University, Bangalore.

Vaidya, B. 1982. *Some controversial drugs in Indian medicine*. Chaukambika, Varanasi.

Personal note:

I apologize for this personal note, which I felt necessary to indicate my professional experience on the issues discussed in this article.

1. At the Department of Botany, Bangalore University, my lab worked on Indian medicinal plants from 1987 to 2002, with financial support from the Department of Forests and Ecology, Government of Karnataka and the SynPhar Laboratories, Edmonton, Canada. The work involved four successful Ph.D., candidates. A 458 page volume, 'Database of Medicinal Plants', constituting our team's work on medicinal plant databases and experimental work on selected medicinal plants, was jointly published by the Karnataka State Council for Science and Technology and the Department of Forests and Ecology, Government of Karnataka (Kameswara Rao, 2000) and was distributed free of cost. When the hard copies were exhausted, the contents of this volume and additionally profiles and photographs of 90 species of Indian medicinal plants were placed in the public domain on the website 'Database of Medicinal plants' accessible at www.medicinalplants-kr.org (Kameswara Rao, 2002). We have also published introductory books on *Ayurveda*, *Siddha* and *Unani* in *Kannada* (Sathyanarayana Bhat and Kameswara Rao, 1993a,b,c) and on a few other issues. My services to the cause of indigenous medicine were noted, by the Open International University for Alternative Medicine, Colombo (established by the authority of the Sri Lankan Parliament), which awarded a D.Sc. (*h.c.*) in 1997 and by the Lama Gangchen World Peace Foundation, Beijing (affiliated to the UN) which awarded a Certificate of Merit in 2001.
2. My Ph.D., thesis was in areas of cytology and immunological characterization of seed proteins for comparative systematics (taxonomy). I have taught plant taxonomy at the

Departments of Botany of the Andhra and Bangalore Universities for over 37 years. I have produced computer based plant identification packages at the British Museum (Natural History), London, and the Royal Botanic Gardens, Kew, the international hubs of plant taxonomy, while on a Commonwealth Academic Staff Fellowship and a Royal Society and Nuffield Foundation Bursary, over a period of two years. My research students worked on some phytochemical aspects with bearing on taxonomy and medicinal plants. I was the President of the Indian Association for Angiosperm Taxonomy for 1999, and a member of the Programme Advisory Committee of Botanical Survey of India and Zoological Survey of India (2001-04), and a Member of the Multi-disciplinary Expert Committee, Botanical Garden of the Indian Republic (2005-06), both under the Ministry of Environment and Forests, Government of India. I am a member of the Indian Subcontinent Plant Specialist Group, under the Species Survival Commission of the International Union for Conservation of Nature and Natural Resources (IUCN), Gland (Switzerland), since 1996 and compiled from IUCN publications, the 'Red List of Threatened Vascular Plant Species in India' published by the Botanical Survey of India, Ministry of Environment and Forests, Government of India (2003).

June 29, 2011