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Review Article

Traditional Medicine: A Review of Work in India (2012-2017)

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India has a rich heritage in its traditional systems of medicine including Ayurveda, Siddha, and Unani and there has been a lot of research conducted in this area. This paper examines the published contribution of Indian scientists to "Traditional Medicine" research in the last five years (2012-2017). Medline was searched for English language publications with Pubmed as the interface, using two sets of search terms: "Traditional Medicine" AND India and "Traditional Medicines" and India. A filter for last 5 years was applied (2012-2017). Papers were included if at least one author was from India. The search yielded n = 670 papers of which 483 met the inclusion criteria. Of the 483, 63 papers resulted from international collaborations and there was a wide distribution of publications from all across the country. As many as 393/483 (81%) articles were published on plants and the strategy remained evaluation of one or other extract or compound from a plant for efficacy, safety or development of a method. However, there was no commonality of purpose, no thread in the diseases covered, no direction. A number of clinical studies have been reported in conditions ranging from cancer and arthritis to malaria and dengue. As many as 66/483 (13%) of the papers identified were field surveys recording traditional medicine practices – either documenting all the plants (and sometimes insects) used by tribes or recording the treatments used for certain diseases. It is clear from this data that the large part of work that is undertaken under the heading of TM is related to plant pharmacology with no efforts to develop a drug from them. There is indeed very little work done related to "Traditional Medicine".

Keywords: Traditional Medicine; Plant Pharmacology; Ayurveda Biology; Review

Introduction

The World Health Organisation (WHO) defines traditional medicine as "… the sum total of knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health, as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness". On the other hand, herbal medicines "include herbs, herbal materials, herbal preparations and finished herbal products, that contain as active ingredients parts of plants, or other plant materials, or combinations". And further, traditional use of herbal medicines "refers to the long historical use of these medicines. Their use is well established and widely acknowledged to be safe and effective, and may be accepted by national authorities" (WHO Report, 2017). Thus, traditional medicine (TM) includes not only herbal medicines, but also other therapeutic modalities as well as therapeutic procedures.

India has a rich heritage in its traditional systems of medicine including Ayurveda, Siddha, and Unani and there has been a lot of research in this area (Ravishankar and Shukla, 2007; Prasad, 2002).

In a very promising action, in late 2015, the Govt. of India issued a very important notification from the Ministry of Health and Family Welfare, *viz.* G.S.R. 918(E) dated 30th November 2015 in which a "Phytopharmaceutical drug" was officially defined and included under the regulatory ambit. (CDSCO, 2015).

Against this background, this paper examines the published contribution of Indian scientists to

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"Traditional Medicine" research in the last five years (2012-2017).

Methods

Only Medline was searched for English language publications with Pubmed as the interface using two sets of search terms "Traditional Medicine" and India and "Traditional Medicines" and India. A filter for last 5 years was applied (2012-2017). Papers were included if at least one author was from India. The following demographics were recorded:

(i) Year of publication

(ii) Whether national/international

(iii) City and state of first author

(iv) Whether original article or review

Outcomes assessed were

(i) Was the paper evaluation of Efficacy/Safety/ describing a new Methodology or was it a Survey

(ii) If survey, what tribe/ area

(iii) How many plant species described in the survey

(iv) Name of Plant

(v) Part of the plant

(vi) Whether pure compound was used or extract

(vii) Name of compound

(viii) Type of extracts

(ix) Disease condition

(x) Type of activity studied

(xi) Whether animal and if yes what animal

(xii) Whether *in vitro* and if yes, what model

(xiii) Whether clinical

(xiv) Type of method developed if applicable

Results and Discussion

Demographics

The search yielded n = 670 papers of which 483 met the inclusion criteria (at least one author from India) and the yearly distribution of the papers is depicted in Table 1.

Table 1: Year wise distribution of publications

Year	Number of publications
2017	51
2016	82
2015	122
2014	97
2013	90
2012	41

Of the 483, 63 papers resulted from international collaborations. While New Delhi contributed the maximum number of papers, there was a wide distribution of publications across the country [including from places like Belthangdi from Karnataka (n=1) or Silchar in Assam (n=6)]. Table 2 summarises the distribution of papers city-wise of the top 7 cities. It was interesting to note that a metro like Mumbai with a number of internationally acclaimed research centres is last in the list (with only 9 papers), suggesting that very little work is being pursued in TM in this city!

Table 2: Number of Papers City-wise (top 7 cities)

City	Number of Papers
Delhi	33
Kolkata	25
Chennai	25
Bengaluru	20
Lucknow	18
Pune	16
Belagavi	14
Mumbai	9

Tamil Nadu was most prolific among the states with 76 papers (Table 3). The North-Eastern States had as many as 39 papers altogether. This is a very interesting observation as the Government of India has invested highly in these states for research with special programmes (http://www.dbtindia.nic.in/

Table 3: Number of Papers State-wise (only the top 17 states are shown here)

State	No. of papers
Tamil Nadu	76
Karnataka	53
Uttar Pradesh	48
Maharashtra	45
West Bengal	41
Delhi	33
Kerala	24
Jammu and Kashmir	18
North Eastern States	39
Assam	12
Sikkim	1
Arunachal Pradesh	1
Manipur	7
Meghalaya	12
Mizoram	2
Nagaland	1
Tripura	3

twinning-rd-projects-cftp-2017-18/, http://www.fist-dst.org/html-flies/north-east-package.htm, https://www.fundsforngos.org/developing-countries-2/india/call-for-proposal-under-north-east-seed-grant-scheme-promoting-research-activities-in-the-north-east-region/, http://www.mdoner.gov.in/) and it is heartening to note this outcome. Of all the 39 papers, as many as 13 were surveys of the region recording the tribal TM practices. In addition, 20 studied efficacy of the local plants used in TM.

We were able to obtain only 214 full texts of the 483 publications, which were available for free. This remains a limitation to an extent. However, all relevant data was available in the abstracts and this was extracted. Approximately 80% of the papers were original papers (380/483; 79%) and the rest were review articles (103/483; 21%).

Plant Pharmacology

The search terms used for this review included "Traditional Medicine/s" and of the 483 articles shortlisted, as many as 393(81%) articles were on plants and the strategy remained the evaluation of

Table 4: Types of Studies

Type of study	Number	%
Efficacy	269/483	56
Methods	40/483	8
Safety	17/483	3.5
Efficacy, Methods	17/483	3
Efficacy, Safety	22/483	4.5
Safety, Methods	1/483	0.2
Efficacy, Safety, Methods	24/483	5
Policy	12/483	2.5
Surveys	66/483	13
Miscellaneous	14/483	3

one or other extract or compound from a plant for efficacy, safety or development of a method. Over half of the studies (See Table 4) examined only efficacy of one or more plants (upto 662 extracts from 222 plants in one paper) (Panda *et al*., 2016). An additional 40 described methods for identification of active molecules/marker compounds (n=17) or safety studies (n=22) along with efficacy.

Unfortunately, there were as many plants as the papers! This was similar to the observation in a previous publication (Thatte U, 2009). There was no commonality of purpose, no thread in the diseases covered, no direction. With 311 original articles and 82 reviews, there is still no evidence to change practice.

Although this review is almost a decade after the editorial mentioned earlier, (Thatte U, 2009) there has been no appreciable change in research priorities or parts of plants researched upon. As many as 82/483 (17%) use droots/rhizomes, the stem-bark or even the whole plant, which makes sustainability a challenge.

Extracts or Pure Compounds

Several papers did not adequately describe the material they used in the research (even in the full texts obtained). Of those that had the details (a total of 263/483), 164/263 (62%) used extracts while 65/263 (25%) used pure compounds and 34/263 (13%) used both. The extracts used ranged from aqueous (n=60) to hydroalcoholic – both ethanol and methanol (n=18), ethanol (n=57), methanol (n=58), chloroform

(n=16), petroleum ether (n= 9), acetone (n= 8) and other extracts including hexane, ethyl acetate, n-hexane (n=34) etc. Rather surprisingly two papers used benzene extracts! What about various fractions of extracts used in studies? And, this is where the line has been drawn by Phytopharmaceutical notification).

Over 200 pure compounds derived from plants have been tested in the published papers with curcumin being tested four times over (for as many conditions including immunomodulation (Kumar *et al*., 2015), *in vitro* effect on muscle contractility (Manvizhi *et al*., 2015), amelioration of oxidative stress (Agrawal *et al*., 2015) and effects in ulcerative colitis (Baliga *et al*., 2012) and swertiamerine being studied in three reports from the same group for its anti-inflammatory effects (Saravanan *et al*., 2014a,; Saravanan *et al*., 2014b; Saravanan *et al.*, 2014c). Mangiferrin (both papers describing chromatographic methods to quantify it; Naveen *et al.*, 2017, Kshirsagar *et al.*, 2016), safranal [one a review (Dawalbhakta *et al.*, 2017) describing patents on both therapeutic and cosmetic uses of active compounds of *Crocus sativus* and the other an original paper describing efficacy in rat ischemia reperfusion model (Bharti *et al*., 2012)], chrysin [insulin signaling (Satyanarayana *et al.*, 2015), apoptosis (Laishram *et al.*, 2015)] and cantharidine (cytotoxicity) (Prasad *et al.*, 2013, Verma *et al.*, 2013) have been studied in two studies each. Andrographolide (AG) has been studied for hepato-protection *in vitro* (Mittal *et al.*, 2016) and, from a drug development point of view an important paper (albeit an experimental study in rats) describes the pharmacokinetics of andrographolide (Bera *et al.*, 2014). This study developed and standardized a sensitive LC-MS/MS method for AG and found that the highest concentration of AG was in the kidney (156.12 ng/g) followed by liver, spleen and brain, with an elimination half-life and total exposure (AUC) of 2.45 hours and 278.44 ngh/ml, respectively. Such data is valuable while considering "druggability" of either the pure compound or even the extracts of the plant *Andrographis panniculata*.

All the other papers separately describe as many compounds.

Diseases Studied

What about the diseases that were targeted in the research on TM in India reported in the past five years? The most common condition studied was cancer (n=37), followed closely by diabetes mellitus (n=30). Interestingly, 16 papers looked at various infectious diseases including dengue (n=2) and malaria (n=5). The papers on dengue had one reporting the anti-viral effects of the alcoholic extract of *Cissampelos pareira* using a systematic bioassay-guided screening approach (Sood *et al.,* 2015) and the other describing the effects of *Bruguiera cylindrica* (a mangrove)-synthesized nanoparticles against dengue virus DEN-2 (*in vitro*) and its mosquito vector, *Aedes aegypti* (Murugan *et al.,* 2015).

Interestingly, a field study described the effects of TPMP74 (a coded polyherbal traditional remedy, with each plant's aqueous extract standardized using accepted methods) in malaria prophylaxis. The study was conducted in healthy participants (n=267) recruited from two villages [Tunpar (experimental village) and Kellar (control village)] of Koraput district of Odisha state, India, during the period of high malaria transmission (June to December 2009). The test group was administered 45mL of the decoction twice a week (on an empty stomach) for 14 weeks. During the study period, 14/113 of the experimental group (incidence rate = 12.3%) and 41/154 of the control group (incidence rate = 26.6%; p=0.005) developed malaria (Nagendrappa *et al.,* 2017). Yet another clinical study in malaria (an open label non-comparative design) explored the effects of the paste of fresh leaves of Nyctanthes arbor-tristis in malaria (Godse *et al.,* 2016). This study was exploratory in nature, where 10/20 patients showed both fever and parasite clearance. The remaining ten patients had persistent but decreasing parasitemia. Only 4 patients needed chloroquine as a rescue medication. There was an associated increase in platelet count and normalization of plasma lactic acid, improvement in organ function and good clinical tolerability. The inflammatory cytokines (particularly in TNFá) showed a reduction.

The other three studies were experimental and investigated *Albizia lebbeck (*Kalia *et al.,* 2015), *Berberis aristata* (Chandel *et al.,* 2015) and 8 plants of which the aqueous extract of *Phyllanthus amarus* and chloroform extract of *Murraya koenigii* were found effective (Keluskar *et al.,* 2012) in mice models or *in vitro*. None of these leads appear to have been followed.

Other disease conditions explored included wound healing (n=7), arthritis and inflammation (n=16), asthma (n=4) or diarrhea (n=3) and many varied and disparate conditions including alcohol dependence, anxiety, ageing to male sexual dysfunction and liver disease.

Papers on In vitro and Animal Experimentation

Of all the 483 papers, as many as 155 were experimental studies and used rats (n=98), mice (n=50), guinea pigs (n=4) or hamsters (n=1), a couple using more than one species in the work. Almost as many as the experimental studies, 152/483 described *in vitro* work – largely tests for antioxidant activity (n=41) using mostly chemical assays or cytotoxicity studies (n=31) using a range of cell lines (such as HepG2 cells, MCF-7 (Human mammary gland adenocarcinoma), Caco-2 cell monolayers, H9c2 cells, A172- Glioblastoma, DLD-1- Colorectal adenocarcinoma, PLC/PRF/5- Liver hepatoma, A549-Lung carcinoma, SK-OV-3- Ovarian carcinoma, BxPC-3- Pancreatic adenocarcinoma, DU145- Prostate carcinoma, and Caki-1- Renal carcinoma). There were 7 papers describing *in silico* work – involving the study of *Clitoria ternatea* in neurodegenerative diseases and depression (Margret *et al.,* 2015), the potential ligand target interactions of Chebulagic acid from *Terminalia chebula* with PPARã (Shyni *et al*., 2014), the immunoprotective effects of curcumin in thymocytes apoptosis (Kumar *et al*., 2015), anti-inflammatory effects of swertiamarine from *Enichostemma littorale (*Saravanan *et al*., 2014a; Saravanan *et al*., 2014b) and the fluorescence quenching effects of 5hydroxy3',4',7trimethoxyflavone from *Lippia nodiflora* (Sudha *et al*., 2015) as well as male contraceptive action of piperine (Chinta *et al*., 2015).

Papers on Clinical Investigations

Unfortunately, this search revealed only a total of 9 papers describing clinical investigations, two of which have been alluded to earlier (malaria studies) (Nagendrappa *et al*., 2017, Godse *et al*., 2016). A controlled clinical trial to compare the efficacy of two Ayurvedic procedure-based treatments: *Navarakizhi*, (a massage of cooked *navara* rice in a medicated hot bolus), and *pinda sweda,* (a massage made of a different type of rice) given for 7 days in 18 patients of hemiplegia (Guruprasad *et al.*, 2014). Patients who received *navarakizhi* recovered better than those who received *pinda sweda*. In another study, conducted in 116 healthy, non-smoking, non-alcoholic males between the ages of 45 and 60 years received *Amalaki Rasayana* or placebo (for 45 days) starting a day after several pre-procedures (*Koshta Shuddhi*) including *snehana* (oleation), *abhyanga* and *bashpa swedha* (fomentation or sudation), *virechana* (purgation) and *samsarjana* (normalization of diet). Younger individuals (n=51) between 22 and 30 years age group were also included to compare the differences between young and aged. Among other findings, interestingly these authors found a significant increase ($p < 0.05$) in the telomerase activity on the 90th day in the age group of 45-52 years administered *amalaki rasayana* (5.49 ± 0.55) when compared to the respective placebo group (3.92 ± 0.38) (Guruprasad *et al*., 2017).

The effects of *shirodhara* (a procedure described in Ayurveda) were studied in 16 healthy volunteers by measuring mood and stress levels as well EEG patterns. The authors found a significant reduction in stress levels and an improvement in mood, along with a reduction in respiratory rate and heart rate as well as diastolic BP and increase in ?rhythm in EEG (Dhuri *et al*., 2013). Interestingly, a couple of landmark papers have investigated modern correlates of the prakriti concept so greatly emphasised in Ayurveda. One study conducted in a total of 3416 healthy male, non-smoking, non-alcoholic participants between the age group of 20 and 30 found significant correlations of the dominant *prakriti* to place of birth and BMI ($p < 0.01$) (Rotti *et al*., 2014). A genome-wide single nucleotide polymorphism analysis of 262 well-classified male individuals found 52 SNPs ($p \leq 1 \times 10^{-5}$) were significantly different between *Prakritis*, without any confounding effect of stratification, after 10^6 permutations) (Govindaraj *et al*., 2015).

A review paper discussed the role of Traditional Medicines and kidney disease in low- and middle-income countries. Both the harms and benefits of the Indian traditional medicines, with a special focus on Ayurveda, were described in this paper (Stanifer *et al*., 2017), while another review covered the management of adverse drug reactions using Ayurvedic treatment (Jadav *et al*., 2013).

Papers on Safety

There were n = 3 papers describing adverse reactions to traditional medicine practices including acute renal failure, following ingestion of an Ayurvedic medicine containing mercury (Sathe *et al.,* 2013) harmful traditional healing practices in the treatment of lymphatic filariasis (Narahari *et al.,* 2016) and a very disturbing paper on the risk of congenital malformations following the use of TM for sex selection during pregnancy (Neogi *et al.,* 2015).

Papers on Methodology

Among the methods described for measuring biomarkers/active molecules were HPLC (n=20), GCMS (n=9), HPTLC (n=8), LCMS (n=4) and TLC (n=5). Methods to identify plants including bar-coding (see below) and genome wide analysis (GWAS; Lin *et al.,* 2017) have been reported. Bar coding has been described as a method to detect adulteration in plant materials (Urumarudappa *et al.,* 2016) and Vassou *et al* (2016) have DNA barcoded 347 medicinal plants using the *rbcL* marker.

The recent phytopharmaceutical notification GSR 918(E) (CDSCO 2015) a "Phytopharmaceutical drug includes purified and standardised fraction with defined minimum four bio-active or phyto-chemical compounds (qualitatively and quantitatively assessed) of an extract of a medicinal plant or its part, for internal or external use of human beings or animals for diagnosis, treatment, mitigation or prevention of any disease or disorder but does not include administration by parenteral route." None of the publications could lead to a "drug" as they are deficient in many of the data requirements prescribed in this notification.

Surveys

As seen in the Table 4, as many as 66/483 (13%) of the papers identified were field surveys recording traditional medicine practices either documenting all the plants (and sometimes insects) used by tribes or recording the treatments used for certain diseases. Table 5 lists all the areas (and if named, the tribes) that have been studied. Over 5000 (5238) plants have been identified and recorded in addition to 90 toxic plants and 51 insect species in these field surveys.

Description of Therapeutic Areas Covered in Surveys

The management of Diabetes mellitus, lithiasis, sexual and gynaecological disorders, tuberculosis, cancer, dentistry, wound healing, epilepsy, jaundice, and GI disorders using TM in various tribes has been described in 11 surveys. Interestingly, one survey has recorded 41 plants used in treatment of camels in the Shiwalik areas of Kathua (Sharma *et al*., 2015).

Papers Related to General Issues in TM

Apart from the publications related to pharmacological actions of plants, there have been (in the last five years), a few papers that are related to traditional medicine use in the country that bear special mention. For example, a comprehensive survey on usage of AYUSH (acronym for Ayurveda, naturopathy and Yoga, Unani, Siddha, and Homeopathy) in India at the household level throws up surprising figures – less than 30% of Indian households use (Srinivasan *et al*., 2015) the traditional medical systems. There is also a regional pattern in the usage of a particular type of traditional medicine, reflecting the regional aspects of the development of such medical systems. The strong faith in AYUSH is the main reason for its usage; lack of a perceived need for AYUSH and lack of awareness about AYUSH are the main reasons for not using it (Srinivasan *et al*., 2015). Interestingly, a WHO-SAGE survey (Oyebode *et al*., 2016) also revealed that although TM use was highest in India, only 11.7% of people reported that their most frequent source of care during the previous 3 years was TM and only 19.0% reported TM use in the previous 12 months suggesting that TM is not after all so widely used.

An excellent review (Lakshmi *et al.,* 2015), a product of an international collaborative effort has reported the determinants, patterns and incorporation of different traditional systems of medicine in the public health systems in low and middle income countries with a particular focus on India. The main findings of this review are not surprising – that allopathy has been established as the mainstream medical system, along with the legitimation (or in some cases, de-legitimation) of different traditional, complementary and alternative systems of medicine, and finally the establishment of a pluralistic health system. It is expectedly the need to address the disease

Table 5: Survey areas and Tribes (if named)

S. No. Region/Tribe
Assam
Belgaum
Bhopal
Biate tribe of Dima Hasao District, Assam
Central Western Ghats, Karnataka
Chota Nagpur
Eastern Ghats in Tamil Nadu
Gaddi and Gujjar tribes of Kangra and Chamba districts
Gaddi Shepherds in northwestern Himalaya
Gujjar and Bakerwals tribes of Rajouri and Poonch districts of Jammu and Kashmir
Hajong people in Assam
Hausa-Fulani tribes in Sokoto, Northwest Nigeria.
Jaintia tribes Meghalaya
Kakrajhore area, WB
Kalrayan hills of Villupuram district
Kani tribes in Thoduhills of Kerala
Karbis of Assam
Karens of Andaman & Nicobar Islands
Karnataka tribals
Kashmir Himalayas
Kathua district.
Ladakh (western)
Little Nicobar Island
Malayali tribes in Eastern Ghats of Tamil Nadu
Manipur (n=3)
Meghalaya
Murari Devi and surrounding areas of Mandi District in Himachal Pradesh
Nancowry group of Islands of Nicobar

S. No. Region/Tribe
Nelliyampathy hills, Kerala
Nepal
Nicobarese of Car Nicobar
North Tripura district
Odisha
Pachamalai hills
Paddar Valley of Jammu and Kashmir,
Palamalai region of Eastern Ghats
Purulia tribes (n=2)
Radhapuram taluk of Tirunelveli District
Reang tribe of Tripura
Rongmei tribe (Kooki), are inhabitant of the Charoi Chagotlong village, Tupul, Tamenglong district of Manipur
Shankaracharya Hill, Srinagar
Shiwalik areas
Silent valley of Kerala
Similipal Biosphere Reserve, Odisha,
Sub-Himalayan region of Uttarakhand (n=2)
Sursagar, Jodhpur
Tharu community of district Udham Singh Nagar, Uttarakhand
Theni district
Thoppampatti, Dindigul district, Tamilnadu
Tiruvallur district
Tribal population of Madhya Pradesh
Udhampur (n=2)
Udhampur district of Jammu and Kashmir
UP region
Uthapuram, Madurai District, TN
Uttara Kannada district
Wangcho (Wancho) and Nocte tribes of the Tirap District and the Shingpo, Tangsa, Deori and Chakma of the Changlang District

burden borne by the public health system that leads to the inclusion of traditional medicine health providers in the public health workforce. The review also refers to the potential ethical and operational challenges of the administration of a "plural" workforce, even though this type of a pluralistic medical society would offer patients more options.

Mainstreaming traditional medicine has been in the forefront of many discussion fora, and while the paper by Pillai and Sharma (2014) describes 7 models of integration, the many ethical and legal aspects that need to be addressed, while integrating various health care systems are well described by Math *et al*. (2015).

Additional Publications

A few papers that did not show up on the primary search but have been identified through discussions with experts in the field are discussed below.

Clinical Studies

Work on *rasayanas* of Ayurveda has fascinated scientists since long. Similar to another paper on the same medicine (Guruprasad *et al.,* 2017), freshly prepared *Amalki rasayana* given for 45 days to elderly, otherwise healthy, elderly participants maintained/enhanced DNA strand break repair without any adverse effects (Vishwanatha *et al.,* 2016). Shilajit is yet another widely used drug in traditional medicine and is considered to be a *rasayana.* In a randomised, double-blind, placebo-controlled clinical study conducted in healthy individuals between 45 and 55 years age, shilajit at a dose of 250 mg twice a day, increased total and free testosterone and dehydroepiandrosterone (Pandit *et al*., 2016).

Terminalia arjuna has been studied extensively in cardiac conditions and a publication by Maulik *et al.* (2016) reported that a water extract of stem bark of Arjuna (Arjuna extract; 750 mg) given over 12 weeks did **not** improve left ventricular ejection fraction (LVEF) in patients with congestive heart failure in a double-blind, parallel, randomized, placebo-controlled add-on clinical trial although the dame plant has been shown to produce anti-inflammatory actions in patients with coronary artery disease (Kapoor *et al.,* 2015).

Diabetes mellitus is the major target of many traditional medicines, although well-conducted clinical trials are few and far between. In a randomized, controlled study, 93 newly diagnosed patients with Type-2 diabetes mellitus were randomly allocated to receiving a "polyherbal capsule" (500 mg/day, up-titrated weekly to a maximum of 3 g/day) or Metformin 500 mg/day, up-titrated weekly to a maximum of 2 g/day) over 24 weeks. The herbal formulation produced hypoglycemic effects similar to metformin (Awasthi *et al.,* 2015).

Similarly, like diabetes, arthritis is another target disease for traditional medicine therapies and studies have evaluated plants like *Ashwagandha* and agents like *Sidh Makardhwa*) (Kumar *et al.,* 2015) or Ayurvedic formulations (extracts of *Tinospora cordifolia, Zingiber officinale, Emblica officinalis, Boswellia serrata*) (Chopra *et al.,* 2013) with some success. The analgesic activity of *Boswellia serrata* was further confirmed in a human model of pain (Prabhavathi *et al.,* 2014). Other studies have evaluated various therapies like Ayushman-15 (an Ayurvedic polyherbal preparation) in major depression (Kishore *et al.,* 2014), Ayurvedic therapies like *Mauktikyukta Kamdudha* and *Mauktikyukta Praval Panchamruta* in patients receiving cancer chemotherapy to reduce adverse effects (Deshmukh *et al.,* 2014), *Withania somnifera* in infertility (Gupta *et al.,* 2013) and an Ayurvedic regime in cirrhosis (Patel *et al*., 2015). Unani medicines have been tried with some success in *Pityriasis versicolor* (Lone *et al.,* 2012).

Ayurvedic Biology

Under the leadership of Dr MS Valiathan, the program of Ayurvedic Biology was taken up with support from Office of the Principal Scientific Adviser to the Government of India, and the Department of Science and Technology (Valiathan *et al.,* 2016). The main objective of these projects was to apply scientific methods in the study of Ayurvedic concepts, procedures and mechanistic basis of therapeutic effects. The work on the genomics correlates of the prakriti concept has already been alluded to (Govindaraj *et al.,* 2015).

This work was further supported by the results of an epigenetic study based on DNA methylation for differentiating the three *prakrits* (Rotti *et al.,* 2015).

The Ayurveda Biology project also delved into the effects of *Amalki rasayana* [mentioned earlier (Guruprasad *et al.,* 2017, Vishwanatha *et al.,* 2016)]. *Rasayana* fed rats had significantly less DNA damage in neurons and astrocytes in the brain as compared to control rats (Swain *et al.,* 2012). Similarly,Dwivedi *et al*. (2012) showed beneficial effects in a series of studies on the *Drosophila melanogaster,* including suppression of neuro-degeneration in fly models of Huntington's and Alzheimer's diseases without side effects (Dwivedi *et al*., 2013) and suppression of apoptosis in these models (Dwivedi *et al*., 2015).

In addition, the concept of *Panchakarma* was also explored and *basti* (enema) was shown in a clinical trial to produce significant weight reduction as also significant decrease in serum interferon (IFN)-Y and interleukin (IL6), and gradual reduction in IL8 level suggesting that *basti* reduced pro-inflammatory cytokines which are raised in obesity (Thatte *et al.,* 2015). In another study, *Rasasindura* (made of mercury and sulphur) was shown to have the same

structure as non-toxic HgS and toxic chemical forms of mercury were completely absent in the study sample and nano-crystal units of Rasasindura were free of organic molecules (Ramanan *et al*., 2015).

The Way Forward

A few review articles have addressed the issue of research in TM. One review identifies some of the flaws in the conduct of clinical research in TM including small sample sizes, variable or inconsistent results, inadequate research designs, insufficient statistical power, poor controls, and inadequate descriptions of the investigational product. This review further describes the need for evolving research methods that can take into consideration the "holistic" approach in therapy with TM (Telles *et al*., 2014). Some very useful directions for the future have been stated that should be considered by policy makers and academicians alike; including policy making, training of researchers in TM with a combination of conventional research methods and those relevant exclusively to TM, better research budgets and guidelines for writing and reviewing research grant proposals, and research in research methods! Other papers echo similar thoughts and describe the challenges and solutions for clinical research on Ayurveda (Chauhan *et al*., 2015); clinical trials on herbal medicines (Parveen *et al*., 2015); or drug development from herbs (Mandal *et al*., 2012).

If research were to become the focus of the future, there is a need to address the training needs of the researchers! This is well illustrated in a questionnaire-based paper that reports that 75.4% of the respondents of the survey did not receive any structured training on research methodology which included those that had received government funding! The respondents working in research organizations, government organizations, and academic institutions had lower knowledge compared to those who were in private organizations/practice (Narahari *et al.*, 2014).

Conclusions

It is clear from this data that the large part of work that is undertaken carrying the heading of TM is related to plant pharmacology with no efforts to develop a drug from them. There is indeed very little work (especially original) related to "Traditional Medicine" as defined by the WHO. Over 400 publications indicate an expenditure of considerable sums of money on the research, as well as an expenditure of man-hours and energy – but all to what avail? And it is worrisome that there must be at least 10 times similar research that has not been published which would have been funded! There is very little focus on applied research – no effort to develop a drug that could prove useful for the various unmet medical needs that India faces currently (Thatte, 2009).

References

Agrawal N D, Nirala S K, Shukla S and Mathur R (2015) Co-administration of adjuvants along with Moringa oleifera attenuates beryllium-induced oxidative stress and histopathological alterations in rats *Pharm Biol* **53** 1465-1473

Awasthi H, Nath R, Usman K, Mani D, Khattri S, Nischal A, Singh M and Sawlani K K (2015) Effects of a standardized Ayurvedic formulation on diabetes control in newly diagnosed Type-2 diabetics; a randomized active controlled clinical study *Complement Ther Med* **23** 555-561

Baliga M S, Joseph N, Venkataranganna M V, Saxena A, Ponemone V and Fayad R (2012) Curcumin, an active component of turmeric in the prevention and treatment of ulcerative colitis: Preclinical and clinical observations *Food Funct* **3** 1109-1117.

Bera R, Ahmed S K, Sarkar L, Sen T and Karmakar S (2014) Pharmacokinetic analysis and tissue distribution of andrographolide in rat by a validated LC-MS/MS method *Pharm Biol* **52** 321-329

Bharti S, Golechha M, Kumari S, Siddiqui K M and Arya D S (2012) Akt/GSK-3â/eNOS phosphorylation arbitrates safranal-induced myocardial protection against ischemia-reperfusion injury in rats *Eur J Nutr* **51** 719-727

Chauhan A, Semwal D K, Mishra S P and Semwal R B (2015) Ayurvedic research and methodology: Present status and future strategies *Ayu* **36** 364-369

Chandel S, Bagai U, Semwal R B and Semwal D K (2015) Antiplasmodial activity of aqueous extract of *Berberis aristata* roots against *Plasmodium berghei*-infected BALB/c mice *Pharm Biol* **53** 1735-1740

Chinta G, Ramya Chandar Charles M, Klopèiè I, Sollner Dolenc

M, Periyasamy L and Selvaraj Coumar M (2015) *In silico* and *In vitro* Investigation of the Piperine's Male Contraceptive Effect: Docking and Molecular Dynamics Simulation Studies in Androgen-Binding Protein and Androgen Receptor *Planta Med* **81** 804-812

Chopra A, Saluja M, Tillu G, Sarmukkaddam S, Venugopalan A, Narsimulu G, Handa R, Sumantran V, Raut A, Bichile L, Joshi K, Patwardhan B and Ayurvedic medicine offers a good alternative to glucosamine and celecoxib in the treatment of symptomatic knee osteoarthritis: a randomized, double-blind, controlled equivalence drug trial *Rheumatology (Oxford)* **52** 1408-1417

Dawalbhakta M and Telang M (2017) Patents on Therapeutic and Cosmetic Applications of Bioactives of *Crocus Sativus* L. and their Production through Synthetic Biology Methods: *A Review. Recent Pat Biotechnol* **11** 3-19

Deshmukh V, Kulkarni A, Bhargava S, Patil T, Ramdasi V, Gangal S, Godse V, Datar S, Gujar S and Sardeshmukh S (2014) Effectiveness of combinations of Ayurvedic drugs in alleviating drug toxicity and improving quality of life of cancer patients treated with chemotherapy *Support Care Cancer* **22** 3007-3015

Dhuri K D, Bodhe P V and Vaidya A B (2013) Shirodhara: A psycho-physiological profile in healthy volunteers *J Ayurveda Integr Med* **4** 40-44

Dwivedi V, Anandan E M, Mony R S, Muraleedharan T S, Valiathan M S, Mutsuddi M and Lakhotia S C (2012) *In vivo* Effects of Traditional Ayurvedic Formulations in Drosophila melanogaster Model Relate with Therapeutic Applications *PLoS ONE* **7** e37113

Dwivedi V, Tripathi B K, Mutsuddi M and Lakhotia S C (2013) Ayurvedic Amalaki Rasayana and Rasa-Sindoor suppress neurodegeneration in fly models of Huntington's and Alzheimer's diseases *Curr Sci* **105** 1711-1723

Dwivedi V, Tiwary S and Lakhotia S C (2015) Suppression of induced but not developmental apoptosis in Drosophila by Ayurvedic Amalaki Rasayana and Rasa-Sindoor *J Biosci* **40** 281-297

Godse C S, Tathed P S, Talwalkar S S, Vaidya R A, Amonkar A J, Vaidya A B and Vaidya A D (2016) Antiparasitic and disease-modifying activity of Nyctanthes arbor-tristis Linn. in malaria: An exploratory clinical study *J Ayurveda Integr Med* **7** 238-248

Govindaraj P, Nizamuddin S, Sharath A, Jyothi V, Rotti H, Raval R, Nayak J, Bhat B K, Prasanna B V, Shintre P, Sule M, Joshi K S, Dedge A P, Bharadwaj R, Gangadharan G G, Nair S, Gopinath P M, Patwardhan B, Kondaiah P, Satyamoorthy K, Valiathan M V and Thangaraj K (2015) Genome-wide analysis correlates Ayurveda *Prakriti Sci Rep* **5** 15786

Gupta A, Mahdi A A, Shukla K K, Ahmad M K, Bansal N, Sankhwar P and Sankhwar S N (2013) Efficacy of Withania somnifera on seminal plasma metabolites of infertile males: A proton NMR study at 800 MHz *J Ethnopharmacol* **149** 208-214

Guruprasad Aggithaya M, Narahari S R, Vijaya S, Sushma K V, Kumar N P and Prajeesh P (2014) Navarakizhi and pinda sweda as muscle-nourishing Ayurveda procedures in hemiplegia: Double-blind randomized comparative pilot clinical trial *J Altern Complement Med* **20** 57-64

Guruprasad K P, Dash S, Shivakumar M B, Shetty P R, Raghu K S, Shamprasad B R, Udupi V, Acharya R V, Vidya P B, Nayak J, Mana A E, Moni R, Sankaran M T and Satyamoorthy K (2017) Influence of *Amalaki Rasayana* on telomerase activity and telomere length in human blood mononuclear cells *J Ayurveda Integr Med* **8** 105-112

Jadav H R, Ghetiya H, Prashanth B, Galib, Patgiri B J and Prajapati P K (2013) Ayurvedic management of adverse drug reactions with *Shvitrahara Varti Ayu* **34** 189-192

Kapoor D, Trikha D, Vijayvergiya R, Parashar K K, Kaul D and Dhawan V (2015) Short-Term Adjuvant Therapy with Terminalia arjuna Attenuates Ongoing Inflammation and Immune Imbalance in Patients with Stable Coronary Artery Disease: *In vitro* and *In vivo Evidence J Cardiovasc Transl Res* **8** 173-186

Kalia S, Walter N S and Bagai U (2015) Antimalarial efficacy of *Albizia lebbeck* (Leguminosae) against *Plasmodium falciparum in vitro&P. bergheiin vivo Indian J Med Res* **142** Suppl: S101-S107

Keluskar P and Ingle S (2012) Ethnopharmacology guided screening of traditional Indian herbs for selective inhibition of Plasmodium specific lactate dehydrogenase *J Ethnopharmacol* **144** 201-207

Kishore R K, Abhishekh H A, Udupa K, Thirthalli J, Lavekar G S, Gangadhar B N, Raju T R and Sathyaprabha T N (2014) Evaluation of the influence of ayurvedic formulation (Ayushman-15) on psychopathology, heart rate variability and stress hormonal level in major depression (Vishada) *Asian J Psychiatr* **12** 100-107

Kshirsagar P R, Gaikwad N B, Panda S, Hegde H V and Pai S R (2016) Reverse Phase-ultra Flow Liquid Chromatography-diode Array Detector Quantification of Anticancerous and Antidiabetic Drug Mangiferin from 11 Species of Swertia from India *Pharmacogn Mag* **12**(Suppl 1) S32-S36

Kumar A, Sasmal D, Jadav S S and Sharma N (2015) Mechanism of immunoprotective effects of curcumin in DLM-induced

thymic apoptosis and altered immune function: an *in silico* and *in vitro* study *Immunopharmacol Immunotoxicol* **37** 488-498

Kumar G, Srivastava A, Sharma S K, Rao T D and Gupta Y K (2015) Efficacy & safety evaluation of Ayurvedic treatment (Ashwagandha powder & Sidh Makardhwaj) in rheumatoid arthritis patients: a pilot prospective study *Indian J Med Res* **141** 100-106

Laishram S, Moirangthem D S, Borah J C, Pal B C, Suman P, Gupta S K, Kalita M C and Talukdar N C (2015) Chrysin rich *Scutellaria discolor* Colebr. induces cervical cancer cell death *via* the induction of cell cycle arrest and caspase-dependent apoptosis *Life Sci* **143** 105-113

Lakshmi J K, Nambiar D, Narayan V, Sathyanarayana T N, Porter J and Sheikh K (2015) Cultural consonance, constructions of science and co-existence: a review of the integration of traditional, complementary and alternative medicine in low- and middle-income countries *Health Policy Plan* **30** 1067-1077

Lone A H, Ahmad T, Anwar M and Sofi G (2012) Clinical efficacy and safety of a pharmacopial polyherbal Unani formulation in pityriasis versicolor: a comparative randomized single-blind study *J Altern Complement Med* **18** 978-982

Lin Y, Min J, Lai R, Wu Z, Chen Y, Yu L, Cheng C, Jin Y, Tian Q, Liu Q, Liu W, Zhang C, Lin L, Zhang D, Thu M, Zhang Z, Liu S, Zhong C,Fang X, Wang J, Yang H, Varshney RK, Yin Y and Lai Z (2017) Genome-wide sequencing of longan (Dimocarpus longan Lour.) provides insights into molecular basis of its polyphenol-rich characteristics *Gigascience* **6** 1-14

Manvizhi S, Kumar A, Shanthi F M and Ernest K (2015) Inhibitory effect of curcumin on the contractility of isolated caprine detrusor muscle *Indian J Pharm Sci* **77** 222-226

Margret A A, Begum T N, Parthasarathy S and Suvaithenamudhan S (2015) A Strategy to Employ *Clitoria ternatea* as a Prospective Brain Drug Confronting Monoamine Oxidase (MAO) Against Neurodegenerative Diseases and Depression *Nat Prod Bioprospect* **5** 293-306

Mandal V, Gopal V and Mandal S C (2012) An inside to the better understanding of the ethnobotanical route to drug discovery - the need of the hour *Nat Prod Commun* **7** 1551-1554

Math S B, Moirangthem S, Kumar N C and Nirmala M C (2015) Ethical and legal issues in cross-system practice in India: Past, present and future *Natl Med J India* **28** 295-299

Maulik S K, Wilson V, Seth S, Bhargava B, Dua P, Ramakrishnan S and Katiyar C K (2016) Clinical efficacy of water extract of stem bark of Terminalia *arjuna* (Roxb. Ex DC.) Wight & Arn. in patients of chronic heart failure: a double-blind, randomized controlled trial *Phytomedicine* **23** 1211-1219

Mittal S P, Khole S, Jagadish N, Ghosh D, Gadgil V, Sinkar V and Ghaskadbi S S (2016) Andrographolide protects liver cells from H2O2 induced cell death by upregulation of Nrf-2/HO-1 mediated *via* adenosine A2a receptor signalling *Biochim Biophys Acta* **1860**(11 Pt A): 2377-2390

Murugan K, Dinesh D, Paulpandi M, Althbyani A D, Subramaniam J, Madhiyazhagan P, Wang L, Suresh U, Kumar P M, Mohan J, Rajaganesh R, Wei H, Kalimuthu K, Parajulee M N, Mehlhorn H and Benelli G (2015) Nanoparticles in the fight against mosquito-borne diseases: bioactivity of *Bruguiera cylindrica*-synthesized nanoparticles against dengue virus DEN-2 (*In vitro*) and its mosquito vector *Aedes aegypti* (Diptera: Culicidae) *Parasitol Res* **114** 4349-4361

Nagendrappa P B, Annamalai P, Naik M, Mahajan V, Mathur A, Ghosh S, Gay F and Venkatasubramanian P (2017) A prospective comparative field study to evaluate the efficacy of a traditional plant-based malaria prophylaxis *J Intercult Ethnopharmacol* **6** 36-41

Narahari S R, Aggithaya M G, Thamban C, Muralidharan K and Kanjarpane A B (2014) How knowledgeable are investigators studying therapies of traditional medicines? *Ayu* **35** 243-251

Narahari S R, Manjula K, Bose K S, Aggithaya M G, Swamy G K and Ryan T J (2016) Harmful traditional healing practices in the treatment of lymphatic filariasis *Indian J Dermatol Venereol Leprol* **82** 565-567

Naveen P, Lingaraju H B and Prasad K S (2017) Rapid development and validation of improved reversed-phase high-performance liquid chromatography method for the quantification of Mangiferin, a polyphenol xanthone glycoside in Mangifera *indica Pharmacognosy Res* **9** 215-219

Neogi S B, Negandhi P H, Sandhu N, Gupta R K, Ganguli A, Zodpey S, Singh A, Singh A and Gupta R (2015) Indigenous Medicine Use for Sex Selection During Pregnancy and Risk of Congenital Malformations: A Population-Based Case-Control Study in Haryana, India *Drug Saf* **38** 789-797

Oyebode O, Kandala O B, Chilton P J and Lilford R J (2016) Use of traditional medicine in middle income countries: a WHOSAGE study *Health Policy Plan* **31** 984-991

Panda S K, Mohanta Y K, Padhi L, Park Y H, Mohanta T K and Bae H (2016) Large Scale Screening of Ethnomedicinal Plants for Identification of Potential Antibacterial Compounds *Molecules* **21** 293

Pandit S, Biswas S, Jana U, De R K, Mukhopadhyay S C and Biswas T K (2016) Clinical evaluation of purified Shilajit on testosterone levels in healthy volunteers *Andrologia* **48** 570-575

Parveen A, Parveen B, Parveen R and Ahmad S (2015) Challenges and guidelines for clinical trial of herbal drugs *J Pharm Bioallied Sci* **7** 329-333

Patel M V, Patel K B, Gupta S, Michalsen A, Stapelfeldt E and Kessler C S (2015) A Complex Multiherbal Regimen Based on Ayurveda Medicine for the Management of Hepatic Cirrhosis Complicated by Ascites: Nonrandomized, Uncontrolled, Single Group, Open-Label Observational Clinical Study *Evid Based Complement Alternat Med* **2015** 613182

Phytopharmaceutical medicine. available at http://www.cdsco.nic.in/writereaddata/GSR%20918-E-dated-30-11-2015.pdf (last accessed 3rd Aug 2017)

Pillai G K and Sharma P (2014) Finding a sustainable prototype for integrative medicine *J Ayurveda Integr Med* **5** 134-138

Prabhavathi K, Chandra U S, Soanker R and Rani P U (2014) A randomized, double blind, placebo controlled, cross over study to evaluate the analgesic activity of Boswellia serrata in healthy volunteers using mechanical pain model *Indian J Pharmacol* **46** 475-479

Prasad L V In: Indian System of Medicine and Homoeopathy Traditional Medicine in Asia. Ed. Chaudhury Ranjit Roy, Rafei Uton Muchatar. New Delhi: WHO- Regional Office for South East Asia; 2002. pp. 283-286

Prasad S B and Verma A K (2013) Cantharidin-mediated ultrastructural and biochemical changes in mitochondria lead to apoptosis and necrosis in murine Dalton's lymphoma *Microsc Microanal* **19** 1377-1394

Ramanan N, Lahiri D, Rajput P, Varma P C, Arun A, Muraleedharan T S, Pandey K K, Maiti N, Jha S N and Sharma S M (2015) Investigating structural aspects to understand the putative/claimed non-toxicity of the Hg-based Ayurvedic drug Rasasindura using XAFS *J Synchrotron Radiat* **22** 1233-1241

Ravishankar B and Shukla V J (2007) Indian Systems of Medicine: A Brief Profile *Afr J Tradit Complement Altern Med* **4** 319-337

Rotti H, Raval R, Anchan S, Bellampalli R, Bhale S, Bharadwaj R, Bhat B K, Dedge A P, Dhumal V R, Gangadharan G G, Girijakumari T K, Gopinath P M, Govindaraj P, Halder S, Joshi K S, Kabekkodu S P, Kamath A, Kondaiah P, Kukreja H, Kumar K L, Nair S, Nair S N, Nayak J, Prasanna B V, Rashmishree M, Sharanprasad K, Thangaraj K, Patwardhan B, Satyamoorthy K and Valiathan M V (2014) Determinants of *prakriti*, the human constitution types of Indian traditional medicine and its correlation with contemporary science *J Ayurveda Integr Med* **5** 167-75

Rotti H, Mallya S, Kabekkodu S P, Chakrabarty S, Bhale S, Bharadwaj R, Bhat B K, Dedge A P, Dhumal V R, Gangadharan G G, Gopinath P M, Govindaraj P, Joshi K S, Kondaiah P, Nair S, Venugopalan Nair S N, Nayak J, Prasanna B V, Shintre P, Sule M, Thangaraj K, Patwardhan B, Valiathan M S and Satyamoorthy K (2015) DNA methylation analysis of phenotype specific stratified Indian population *Journal of Translational Medicine* **13** 15

Saravanan S, Pandikumar P, Prakash Babu N, Hairul Islam V I, Thirugnanasambantham K, Gabriel Paulraj M, Balakrishna K and Ignacimuthu S (2014a) *In vivo* and *in vitro* immunomodulatory potential of swertiamarin isolated from Enicostema axillare (Lam.) A. Raynal that acts as an anti-inflammatory agent *Inflammation* **37** 1374-1388

Saravanan S, Islam V I, Babu N P, Pandikumar P, Thirugnanasambantham K, Chellappandian M, Raj C S, Paulraj M G and Ignacimuthu S (2014b) Swertiamarin attenuates inflammation mediators *via* modulating NF-êB/I êB and JAK2/STAT3 transcription factors in adjuvant induced arthritis *Eur J Pharm Sci* **56** 70-86

Saravanan S, Islam VI, Thirugnanasambantham K, Pazhanivel N, Raghuraman N, Paulraj M G and Ignacimuthu S (2014c) Swertiamarin ameliorates inflammation and osteoclastogenesis intermediates in IL-1β induced rat fibroblast-like synoviocytes *Inflamm Res* **63** 451-462

Satyanarayana K, Sravanthi K, Shaker I A, Ponnulakshmi R and Selvaraj J (2015) Role of chrysin on expression of insulin signaling molecules *J Ayurveda Integr Med* **6** 248-258

Sathe K, Ali U and Ohri A (2013) Acute renal failure secondary to ingestion of ayurvedic medicine containing mercury *Indian J Nephrol* **23** 301-3

Sharma R and Manhas R K (2015) Ethnoveterinary plants for the treatment of camels in Shiwalik regions of Kathua district of Jammu & Kashmir, India *J Ethnopharmacol* **169** 170-175

Shyni G L, Kavitha S, Indu S, Arya A D, Anusree S S, Vineetha V P, Vandana S, Sundaresan A and Raghu K G (2014) Chebulagic acid from Terminalia chebula enhances insulin mediated glucose uptake in 3T3-L1 adipocytes via PPARã signaling pathway *Biofactors* **40** 646-657

Sood R, Raut R, Tyagi P, Pareek P K, Barman T K, Singhal S, Shirumalla R K, Kanoje V, Subbarayan R, Rajerethinam R, Sharma N, Kanaujia A, Shukla G, Gupta Y K, Katiyar C K, Bhatnagar P K, Upadhyay D J, Swaminathan S and

Khanna N (2015) Cissampelos pareira Linn: Natural Source of Potent Antiviral Activity against All Four Dengue Virus Serotypes *PLoS Negl Trop Dis* **9** e0004255

Srinivasan R and Sugumar V R (2015) Spread of Traditional Medicines in India: Results of National Sample Survey Organization's Perception Survey on Use of AYUSH *J Evid Based Complementary Altern Med* **4** pii: 2156587215607673

Stanifer J W, Kilonzo, K, Wang, D, Su, G, Mao, W, Zhang, L, Zhang, L, Nayak-Rao S and Miranda J J (2017) Traditional Medicines and Kidney Disease in Low- and Middle-Income Countries: Opportunities and Challenges, *Semin Nephrol* **37** 245-259

Sudha A and Srinivasan P (2015) *In vitro*, fluorescence-quenching and computational studies on the interaction between lipoxygenase and 5-hydroxy-3',4',7-trimethoxyflavone from *Lippia nodiflora* L. *J Recept Signal Transduct Res* **35** 569-577

Swain U, Sindhu K K, Boda U, Pothani S, Giridharan N V, Raghunath M and Rao K S (2012) Studies on the molecular correlates of genomic stability in rat brain cells following *Amalaki rasayana* therapy *Mech Ageing Dev* **133** 112-117

Traditional Medicine: Definitions (WHO) available at http://www.who.int/medicines/areas/traditional/definitions/en/ last accessed 3rd Aug 2017

Telles S, Pathak S, Singh N and Balkrishna A (2014) Research on traditional medicine: What has been done, the difficulties, and possible solutions *Evid Based Complement Alternat Med* Published online 2014 Jun 12. doi: 10.1155/2014/495635

Thatte U (2009) Still in search of a herbal medicine *Indian J Pharmacol* **41** 1-3

Thatte U, Chiplunkar S, Bhalerao S, Kulkarni A, Ghungralkar R, Panchal F, Vetale S, Teli P, Kumbhar D and Munshi R (2015) Immunological & metabolic responses to a therapeutic course of Basti in obesity *Indian J Med Res* **142** 53-62

Urumarudappa S K, Gogna N, Newmaster S G, Venkatarangaiah K, Subramanyam R, Saroja S G, Gudasalamani R, Dorai K and Ramanan U S (2016) DNA barcoding and NMR spectroscopy-based assessment of species adulteration in the raw herbal trade of *Saraca asoca* (Roxb.) Willd, an important medicinal plant *Int J Legal Med* **130** 1457-1470

Vassou S L, Nithaniyal S, Raju B and Parani M (2016) Creation of reference DNA barcode library and authentication of medicinal plant raw drugs used in Ayurvedic medicine *BMC Complement Altern Med* **16** Suppl 1 186

Valiathan M S (2016) Ayurvedic biology *Current Science* **110** 2043-2044

Verma A K and Prasad S B (2013) Antitumor effect of blister beetles: An ethno-medicinal practice in Karbi community and its experimental evaluation against a murine malignant tumor model *J Ethnopharmacol* 30 **148** 869-879

Vishwanatha U, Guruprasad K P, Gopinath P M, Acharya R V, Prasanna B V, Nayak J, Ganesh R, Rao J, Shree R, Anchan S, Raghu K S, Joshi M B, Paladhi P, Varier P M, Muraleedharan K, Muraleedharan T S and Satyamoorthy K (2016) Effect of *Amalaki rasayana* on DNA damage and repair in randomized aged human individuals *J Ethnopharmacol* **191** 387-397.