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Can local health traditions and tribal medicines strengthen Ayurveda? Case study 2 – *Trichopus zeylanicus* ssp. *travancoricus* Burkill ex Narayanan

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Abstract

Arogyapacha which has been taxonomically identified as *Trichopus zeylanicus* ssp. *travancoricus* Burkill ex Narayanan, family Trichopodaceae has been traditionally used by the Kani tribe as an antifatigue and stamina boosting herbal drug. Scientific investigations in to the tribal therapeutic claims on this plant has resulted in the discovery of this plant as an adaptogenic, antifatigue, immunoenhancing, cardioprotective, anticancer, antidiabetic, hepatoprotective, antinociceptive and anti-inflammatory herb. Chemical investigations have resulted in the identification of glycolipids, flavonoids, chromones etc. from the aerial parts. The plant, though not mentioned in classical Ayurvedic texts has been tentatively equated as *Varahi*, one of the divine drugs by Ayurvedic scholars. In this article we provide scientific evidence to the therapeutic efficacy of this herb and we strongly feel that *Trichopus zeylanicus* ssp. *travancoricus* merit listing under Ayurvedic drugs and should be included in the Ayurvedic Pharmacopoeia of India. The drug *Jeevani* formulated with *T. zeylanicus* as one of the ingredients has been subjected to toxicological and open clinical studies and is in use since 1996.

Keywords: *Trichopus zeylanicus* ssp. *travancoricus*, Arogyapacha, Ayurvedic identity, Kani tribe, Ethnomedicine, Adaptogenic activity, Antifatigue activity, IPR, Jeevani, Access and benefit sharing model

1. Introduction

In continuation of our earlier communication on *Janakia arayalpathra* (George *et al*., 2016), in this paper we wish to report scientific evidences regarding the therapeutic potential of *Trichopus zeylanicus* ssp. *travancoricus* (Fam. Trichopodaceae), which we feel is a suitable candidate for incorporation in the Ayurvedic Pharmacopoeia of India. Though the therapeutic property of this plant was known to the Kani tribe of Kerala inhabiting in the Agasthya hills of the Western Ghats, its medicinal properties were never known to the outside world until Pushpangadan *et al*. reported about it in 1988.

2. Botanical description of *T. zeylanicus* ssp. *travancoricus* Burkill ex Narayanan

It is a perennial herb, rhizome slender. Leaves ovate-lanceolate, acute or obtuse, apiculate, base deeply cordate, to 12 x 7 cm; 5-7 ribbed, petiole to 5 cm. Flowers fascicled at the base of the petiole. Perianth dark brown, campanulate, lobes lanceolate. Stamens 6, anthers apiculate. Fruit triquetrous, purple-brown; seeds dorsally grooved. It is endemic and is mainly seen in the evergreen and semi-evergreen forests (Sivarajan

et al., 1990; Sasidharan, 2012; Pushpangadan *et al*., 2016). The plant is distributed in the southern Western Ghats of peninsular India at altitudes to an elevation of 1100 m. Locally, it is also known as *Saasthankizhangu* (Sasidharan, 2012; Pushpangadan *et al*.,).

Anilkumar *et al*. (2002) studied the pharmacognostic characteristics of this plant. The study included the macroscopic, microscopic and organoleptic properties of *T. zeylanicus* ssp. *travancoricus*. Various standards for the proper identification and authentication of *T. zeylanicus* ssp. *travancoricus* were established.

3. Ayurvedic identity of *T. zeylanicus*

No information is available in the Ayurvedic texts on the use or identity of this plant species. Sushrutha, while dealing with the various divine drugs along with 'Soma' described a drug 'Varahi' as 'Kandha sambhava' - rhizomatous, 'Ekapatra'- single leaves arising from a stem and 'Bhinnanjana samaprabha' - shining like grey - black stone. The leaves and flowers of this plant shine like grey-black stone. He has also described the plant as one with trailing stem with raised leaves - 'Krishnasarpa swarupena' - like a black cobra with its raised hood. Sushruta ascribed great rejuvenating property to the divine 'Varahi', which is true of 'Arogyapacha'. Sushruta's description of the habitat of this plant as a shade loving herb found on the river banks and natural ponds is also true of 'Arogyapacha'. These facts point out that the divine 'Varahi' described by 'Sushruta' may be 'Arogyapacha' (Pushpangadan *et al*., 1988).

4. *T. zeylanicus* in ethnomedicine

Among the Kani tribes of Kerala, *T. zeylanicus* ssp. *travancoricus* Burkill ex Narayanan is known as 'Arogyapacha', meaning green health and vitality. The tribals claim that one can live days together without food and still remain energetic and can go on performing even very vigorous physical work or exercise by eating fruits of this plant. They also claim that to remain healthy, agile, young and resistant to various diseases or infections, one should consume the fresh fruits of 'Arogyapacha' regularly (Pushpangadan *et al*., 1988).

5. Biological activity of *T. zeylanicus*

Arogyapacha is credited with adaptogenic, hepatoprotective, immunomodulatory, cardio-protective, antifatigue and a host of other therapeutic properties. Studies carried out in different laboratories in India and abroad have scientifically substantiated the tribal claims on the therapeutic properties of *T. zeylanicus*. A brief summary of the results of the pharmacological studies carried out on *T. zeylanicus* is presented below:

5a. Immunomodulatory activity

Bachhav and Sambathkumar (2016) studied immunomodulatory activity of alkaloid fraction of *T. zeylanicus* using various *in vivo* models. The percentage of neutrophils adhesion to the nylon fibre increased dose dependently in alkaloid fraction of *T. zeylanicus* compared to control group. A dose dependent potentiating of delayed type hypersensitivity reaction induced by sheep red blood cells was also observed from the alkaloid fraction of *T. zeylanicus*. On chronic administration, alkaloid fraction of *T. zeylanicus* (75, 150 and 300 mg/kg. *p.o.*) caused significant ($p<0.001$) increase in haematological parameters like, total white blood cells, red blood cells and haemoglobin. Alkaloid fraction of *T. zeylanicus* also prevented the myelosupression in mice treated with cyclophosphamide (30 mg/kg, *p.o.*).

Pushpangadan *et al*. (1995) found that oral administration of *T. zeylanicus* in mice (0.5 ml of 2% water suspension/mouse) for 7 consecutive days markedly increased the number of thymocytes, splenic lymphocytes, total blood leucocytes and peritoneal macrophages without any effect on haemoglobin content and body weight.

Subramoniam *et al*. (1999) reported that treatment of mice with *T. zeylanicus* leaf resulted in inhibition of antigen-induced degranulation of sensitized peritoneal mast cells. Further, it reduced the ratio of mast cells in the peritoneal exudate cells. Studies in rats using mesenteric mast cells confirmed the above mast cell-stabilizing property of *T. zeylanicus*. This activity was found in the butanol fraction of methanol extract of *T. zeylanicus* leaf. The treatment with this fraction also reduced the number of rat mesenteric mast cells. However, the *in vitro* treatment of the mast cells with the butanol fraction did not inhibit antigen-induced degranulation of the mast cells.

5b. Antitumor activity

Pushpangadan *et al*. (1995) found that treatment of mice with *T. zeylanicus* before and after tumour challenge with Ehrlich Ascitic Carcinoma (EAC) cells (0.5 million / mouse) completely protected 60% of mice from the tumour cell growth and the number of tumour cells were dramatically reduced in the rest of the drug treated mice as compared to untreated tumour challenged mice. In the tumour control mice (untreated mice), full tumour growth was observed in all animals.

5c. Gastrointestinal function test

Pushpangadan *et al*. (1995) studied the gastrointestinal function of *T. zeylanicus* in mice. Mice fasted for 20 h were divided into 3 groups of 10 mice each. Group I and II received 2 different doses of *T. zeylanicus* water suspension. Group III received 0.5 ml of water and served as control. 30 min. after the drug administration, all mice were given 5% suspension of finely ground charcoal in 50% gum acacia. The animals were sacrificed 30 min. after charcoal administration. The distance traversed by charcoal as a percentage of total intestinal length was measured. The result showed that the drug slightly reduced intestinal motility as judged from charcoal movement. At a higher dose (1 ml / mouse) there was about 30% decrease in the movement of charcoal whereas at a lower dose (0.5 ml / mouse) there was a slight decrease.

5d. Antioxidant and DNA protecting properties

T. zeylanicus extract was administered orally to aged BALB/c mice at doses of 50 and 250 mg/

kg body weight for 15 days. Groups of young mice and aged mice (more than 15 months old) were taken as controls. The extract increased antioxidant status in liver mitochondria of aged mice compared with the aged control. Higher levels of GSH, increased activity of SOD and CAT, and decreased level of MDA in the treated groups compared with the controls were evident. The extract also possessed significant 2,2-diphenyl-l-picrylhydrazil (DPPH), 2, 2'-azinobis (3-ethylbenzothiazolin-6-sulphonic acid) (ABTS) radical scavenging activities and ferric reducing antioxidant power (FRAP) and lipid peroxidation inhibiting activity (Cherian *et al*., 2009).

Tharakan *et al*. (2005) showed that *T. zeylanicus* significantly scavenged free radicals, reduced lipid peroxidation and inhibited lipoxygenase activity. It also exhibited iron-chelating activity and inhibited reactive oxygen species induced DNA damage.

5e. Antifatigue activity

Tharakan *et al*. (2006) conducted a study to investigate the effectiveness of *T. zeylanicus* whole plant powder on fatigue in young Sprague-Dawley rats and aged normal and long-living mutant Ames dwarf mice by using swim test. *T. zeylanicus* (250 and 500 mg/kg) treated young Sprague-Dawley rats resisted fatigue at a significant level ($p<0.005$) compared with controls by an extended swim time in the forced swim test. Oral *T. zeylanicus* (500 mg/kg) treatment for 2 weeks significantly increased the mobility time in the aged mutant ($p<0.05$) and normal mice ($p<0.01$) and significantly increased the swim time in the forced swim test in the aged normal mice ($p<0.05$).

Pushpangdan *et al*., (1995) carried out the swimming endurance test with details as under. Animals were divided into 5 groups of 10 animals each. Groups I and II were given 0.2 ml of 10% Tween 80 and water respectively and served as control. Groups III, IV and V were given a single dose (200 mg/kg b.w.) of water, methanol and acetone extracts respectively in 0.2 ml water or 10% Tween 80. After 1h all mice were put to swimming in plastic buckets filled with water (26^0C) and were allowed to swim till exhausted and drowned which was taken as the end point. Swimming time for each animal was recorded. The water extract of *T. zeylanicus* was found to have no significant effect on the swimming performance of mice at a dose of 200 mg/kg., whereas at this dose methanol and acetone extract showed 54 and 40% increase respectively in the swimming performance as compared to control. This shows that the agent which induces the anti-fatigue effect is not extractable in water.

Singh *et al*. (2000) studied adrenocortico-sterone alterations in male albino mice treated with *T. zeylanicus*. The levels of corticosterone were estimated by the HPLC method in the adrenal glands of stressed (5h constant swimming) male albino mice treated with *T. zeylanicus* and compared with non-treated stressed and normal controls. The treatments increased the corticosterone levels in all the groups. The physical endurance (increased survival time) of swimming mice also increased in all the treated groups.

5f. Cardioprotective activity

The cardioprotective effect of *T. zeylanicus* leaves against isoproterenol induced myocardial ischemia was studied by Velavan *et al*. (2009).

Wistar rats were pretreated with *T. zeylanicus* leaves (500 mg/kg b.w.) for 28 days and then intoxicated with isoproterenol (20 mg/100 g, *i.p.* for 2 consecutive days). In isoproterenol treated group, shrinkage of cardiac markers in plasma and elevated lipid peroxidation were accompanied by decreased content of reduced glutathione in heart and plasma. The prior administration of *T. zeylanicus* significantly (p<0.001) prevented the isoproterenol induced alterations and restored the cardiac markers. These findings indicate the cardioprotective activity of *T. zeylanicus* during isoproterenol-induced myocardial ischemia.

5g. Antidiabetic activity

Rajan *et al*. (2015) reported the antidiabetic activity of the ethanolic extract of *T. zeylanicus* in streptozotocin induced diabetic rats by oral administration of extract 400 mg/kg b.w. for 15 days. The effect was compared with the standard drug Glibenclamide at oral dose of 0.5 mg/kg. Determination of blood glucose level was done by GOD-POD kit method. The result shows the ethanolic extract of *T. zeylanicus* leaves significantly lowered the blood glucose of hyperglycemic rats. From the toxicity study it was observed that ethanolic extract of *T. zeylanicus* was nontoxic up to 5 g/kg body weight and phytochemical study showed the presence of phytosterols, flavonoids and glycosides. It is concluded that *T. zeylanicus* leaf extract has significant antidiabetic activity, which lowered the fasting blood glucose level in Streptozotocin induced diabetic rats.

5h. Adaptogenic activity

Rishikesh *et al*. (2012) reported the anxiolytic activity of saponin fraction of *T. zeylanicus* by elevated plus maze method and light-dark test. The antidepressant activities were assayed by tail suspension test and force swimming test on mice. The various doses (75, 150 and 300 mg/kg, *i.p.*) have shown significant (p<0.001) increase in percentage of entries in open arm and time spent in open arm. Similarly, it has also shown increased time spent in light box and decreased time in dark box significantly (p<0.001). In antidepressant study, various doses (75, 150 and 300 mg/kg, *i.p.*) of saponin fraction of *T. zeylanicus* have shown significant (p<0.001) increase in immobility time in forced swimming and tail suspension method. The study confirmed that saponin fraction of *T. zeylanicus* at a dosage of 75, 150 and 300 mg/kg has shown promising anxiolytic and antidepressant activities.

Sharma *et al*. (1989) found that *T. zeylanicus* at a dose of 100 mg/kg b.w. possess potent anti-stress properties as tested in rats and mice using variety of stress models.

Singh *et al*. (2001, 2005) reported the adaptogenic activity of a glyco-peptido-lipid fraction from the alcoholic extract of *T. zeylanicus*. The glyco-peptido-lipid fraction exhibited significant anti-stress activity in dose dependent manner in all the parameters studied, against the different stresses used to induce non-specific stress. *Ashwagandha,* the commercial extract of *Withania somnifera* roots was used as control. A preliminary acute toxicity study in mice showed a good margin of safety, as the LD_{50} value was more than 3000 mg/kg b. w. *p.o.* with no signs of abnormalities. The results suggest that oral administration of glyco-peptido-lipid fraction is capable of increasing the capacity to tolerate non-specific stress in experimental animals, as evident from restoration of the large number of parameters studied during different

types of stress. In view of its adaptogenic activity glyco-peptido-lipid fraction may build up non-specific resistance against diverse types of stress, recovery after illness and environmental changes, in both humans and in animals.

The alcoholic extract of seeds of *T. zeylanicus* showed potent adaptogenic or anti-stress properties against a variety of stresses in both rats and mice. The extract increased the swimming performance of normal and adrenalectomized mice, significantly prevented a variety of stress and chemical induced ulcerations in rats and also prevented milk-induced leucocytosis in mice. The extract further reduced the gastric secretary clume, pH and acid output in pylorusligated rat stomach. The study indicated that *T. zeylanicus* seeds induce a state of nonspecific increased resistance against a variety of stress induced biological changes in animals (Sharma *et al*., 1989).

The alcohol extract of *T. zeylanicus* leaf (100 mg/kg) decreased plasma glucose levels (1h after the administration) and increased the swimming performance of mice, which was maximum at 100 mg/kg. At a dose of 100 mg/kg, the extract decreased plasma glucose levels and increased the levels of free fatty acids (FFA) without significant changes in the levels of pyruvic acid (PA) and lactic acid (LA) in the resting mice. In contrast, after exercise for 90 min, glucose level was found to be higher whereas the levels of FFA, LA and PA were found to decrease compared to control (Evans *et al*., 2001).

5i. Hepatoprotective activity

Pushpangadan *et al*. (1995) found that alcoholic extracts of seed, leaf and rhizome of *T. zeylanicus* showed potent hepatoprotective activity in different models tested.

Subramoniam *et al*. (1998) evaluated the antihepatotoxic and choleretic activities of *T. zeylanicus* extract in rats. The plant leaf suspension (1000 mg/kg, wet weight) as well as its methanol extract (100 mg/kg) showed a remarkable hepatoprotective activity against paracetamol induced hepatotoxicity. The effect of the methanol extract was found to be concentration dependent. The methanol extract (100 mg/kg) also exhibited choleretic activity in anesthetized normal rats.

5j. Aphrodisiac property

Subramoniam *et al*. (1997) reported aphrodisiac property of *T. zeylanicus* extract in male mice. Administration of *T. zeylanicus* leaf (ethanol extract) to male mice stimulated their sexual behaviour as evidenced by an increase in number of mounts and mating performance. This activity of the ethanol extract was concentration dependent and destroyed by heat treatment at 100°C for 15 min. Although oral administration of a single dose (200 mg/kg) was effective, daily administration of the extract for 6 days was found to be more effective. The pups fathered by the drug treated mice were found to be normal with reference to foetal growth, litter size and sex ratio. The water as well as *n*-hexane extracts of the plant leaf were inactive. The study revealed for the first time the aphrodisiac activity of *T. zeylanicus*.

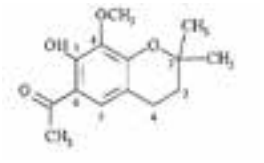
5k. Antinociceptive and anti-inflammatory activity

Kumar *et al*. (2012) reported antinociceptive and anti-inflammatory activity of alkaloid fraction of *T. zeylanicus*. The alkaloid fraction of *T. zeylanicus* (AFTZ) obtained from methanolic

extract upto the dose of 2000 mg /kg b.w. *p.o.* did not show any mortality or toxicity. Diclofenac sodium (20 mg /kg *p.o*.) and Pentazocine (10 mg/kg *i.p.*) was used as reference standard for antinociceptive and anti-inflammatory activity. The AFTZ at a dose of 75, 150 and 300 mg/ kg *p.o.* in acetic acid induced writhing and in hot plate analgesic method showed significant (p<0.001) dose dependent inhibition of writhing and elevated mean basal reaction time in hot plate method respectively. In carrageenan induced rat paw edema and cotton pellet induced granuloma method the AFTZ at a dose of 75, 150 and 300 mg/kg *p.o* showed significant (p<0.001) decrease in paw edema volume and weight of granulomatous tissue respectively. AFTZ showed antinociception in acetic acid induced writhing method may be by inhibiting peripheral pain receptor present on cell lining of peritoneal cavity. In hot plate method, the activity of AFTZ may be by involvement of opioid receptor. The carrageenan induced inflammation, AFTZ possibly act by inhibiting release and /or action of histamine, serotonin, kinin and prostaglandin like substances. The decrease in weight of granuloma of tissue may be due to both, the ability of AFTZ reducing the number of fibroblast and synthesis of collagen and mucopolysaccharide.

6. Chemistry of *T. zeylanicus*

Studies have found that seeds and leaf extracts are rich in saponins. Chemical investigations showed that the leaf contains flavonoid glycosides, glycolipids and some other non-steroidal compounds. Detailed chemical investigation of aerial parts resulted in the isolation and characterization of five compounds namely, 6-acetyl-7-hydroxy, 8-methoxy-2,2-dimethyl-3,4-dihydro-1H-1-benzopyran(**1**), β-sitosterol (**2**), Triacontanol (**3**), apigenin-8-C-glucoside (vitexin) (**4**) and apigenin-6,8-di-C-glucoside (Vicenin-2) (**5**) (Chacko *et al*., 2002).



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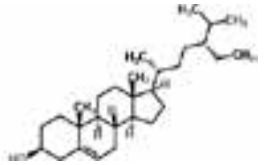

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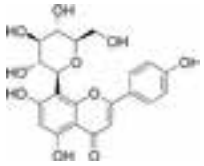

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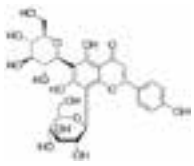

(5)

7. Propagation of *T. zeylanicus*

It can be propagated both by seeds as well as by vegetative means. Fresh seeds take 6-7 months to germinate and only 10% germination is obtained. Rhizomes of 3 cm length wrapped in moist gunny sack or placed in cow dung are used for planting. Sprouting takes 3-5 days. Sprouting is poor when planted directly (Pushpangadan *et al*., 2016).

Rapid micropropagation of *T. zeylanicus* was achieved by culturing shoot tips (0.3-0.5 cm) of 2-month-old axenic seedlings on woody plant medium (WPM). Among the cytokinins tested, only 6-benzylaminopurine (BAP) induced callus-free multiple shoot bud formation, with a maximum of 8.5±0.4 buds per explant being obtained with 2.0 mg/L BAP after 8 weeks of culture. Shoot tips containing proliferated buds were divided and sub-cultured on medium containing 0.2 mg/L BAP to produce 12.0±1.0

shoots per explant in 6 weeks. Excision of buds after culture initiation, with subculture of the debudded basal tissue in 2 successive passages yielded 20.0±1.0 and 13.5±0.5 buds per explant respectively. Each bud cultured in turn for 4 weeks on WPM with 1.0 mg/L BAP formed 3.8±0.4 secondary buds which were repeatedly re-cultured to increase bud production. Altogether this method enabled an estimated harvest of 7848 buds from a single shoot tip in 28 months. Shoots (3-5 cm) developed from bud cultures were rooted in half-strength WPM medium with 0.5 mg/L each of 1-naphthaleneacetic acid (NAA) and indole-3-butyric acid (IBA), and 90-100% of the rooted plants were established in the field after hardening. Micropropagated plants were grown to maturity free of defects in growth, morphological, flowering and seed set characteristics (Krishnan *et al*., 1995).

Martin *et al*. (2011) reported high frequency *in vitro* propagation of *T. zeylanicus* spp. *travancoricus* using branch–petiole explants. Callus obtained from the branch-petiole explants cultured on Murashige and Skoog (MS) medium with 4.5 µM 2,4-dichlorophenoxyacetic acid upon subculture to medium with different concentrations of 6-benzyladenine (BA) either alone or in combination with an auxin favoured shoot morphogenesis. Medium with 13.3 µM BA alone facilitated high frequency shoot bud (mean of 93.2) formation. Medium with lower concentrations of BA (4.4, 6.6 and 8.8 lM) alone or in combination with lower concentration of α-naphthaleneacetic acid (NAA) or indole-3-butyric acid (IBA) favoured better shoot growth than 13.3 µM BA containing medium, but with reduced number of shoot buds. Subsequent cultures on medium with lower concentrations of BA and also on MS basal media facilitated shoot formation as well as growth of shoots. The shoot regeneration potential showed no decline up to 5 years. Culture of the in vitro-derived whole branch–leaf explants on MS basal medium developed shoots directly from the node. On medium with 19.6 µM IBA, the whole branch–leaf explants induced nodular callus from the node, which developed shoots later. Subsequent cultures on medium with BA exhibited high frequency shoot formation. The transfer of shoots after 10–15 days culture on half-strength MS medium containing 2.7 µM NAA to half-strength basal medium induced a mean of 11.3 roots. Field survival of plantlets relied on the soil mix: a 1:4 ratio of sand and red-soil exhibited the highest plantlets survival (86.6%). RAPD profile of the source plant and plants regenerated from calli after 4 years showed no polymorphism. The established plantlets with morpho-floral features similar to that of the source plants flowered normally and set fruits.

8. Patents filed/obtained on products containing *T. zeylanicus*

Three patents have been obtained based on the study conducted on *T. zeylanicus*. Indian patent number IN183071 dated September, 1999 was awarded for the Patent application entitled "A process for the isolation of a glycolipid fraction from *Trichopus zeylanicus* possessing adaptogenic activity". Indian patent number IN187975 dated August 2002 was awarded for the patent application entitled "A process for preparation of novel immunoenhancing, antifatigue, antistress and hepatoprotective herbal drug". The third patent was granted for a multi-drug combination containing *Trichopus zeylanicus* leaf and *Janakia arayalpathra*

root, entitled "A process for preparation of a novel herbal medicinal composition for cancer treatment from *Janakia arayalpathra* root and *Trichopus zeylanicus* leaf", IN193609 dated 22. 09. 2006.

9. Development of "Jeevani" and technology transfer

Based on Ayurvedic pharmacology and modern scientific validation, a new polyherbal Ayurvedic drug in a granular form, named 'Jeevani' was developed. The term 'Jeevani' means 'elixir of life'. The ingredients of 'Jeevani' are *Trichopus zeylanicus* ssp. *travancoricus* Burkill. ex Narayanan, *Evolvulus alsinoides* (Linn.) L., *Withania somnifera* (L.) Dunal. and *Piper longum* L. Clinical trial of 'Jeevani' was conducted on more than hundred subjects with different backgrounds - 70 % non-healthy and 30 % healthy persons. Apart from modern drug efficacy tests, the results were evaluated on the basis of Ayurvedic pharmacology also. It is classified under health promoting ('Swastahita') group of drugs. Subsequently, technical knowhow for production of the drug 'Jeevani' was transferred to a reputed Ayurvedic drug manufacturing company for a period of 7 years for a license fee of Rs.10 lakhs and 2% annual royalty on ex-factory sales price.

10. Development of Access and Benefit Sharing (ABS) model

Based on the technology transfer of 'Jeevani', TBGRI has decided to part with 50% of the licence fee and royalty received from the manufacturing company to the Kani tribe who provided the lead for the development of the drug. Kani tribe registered a Trust called 'Kerala Kani Samudaya Kshema Trust' with the guidance from TBGRI and 50% of the benefits received by the technology transfer and royalty were remitted to the Trusts account. Later, in consultation with TBGRI, the Executive Committee of the Trust decided to felicitate the three Kani tribesmen who divulged the information about Arogyapacha. Accordingly, they were felicitated by the trust and Rs. 20,000/- each was awarded to Sri. C Mallan Kani and Sri A Kuttimathan Kani and Rs. 10,000/- to R Eachan Kani (total Rs. 50,000/-). This amount has been taken from the first year interest of the Rs. 5 Lakhs remitted to the trust account. They also decided to keep Rs. 5 Lakhs as the permanent asset of the trust in the bank and only the interest accrued will be utilized for the welfare activities of the Kani tribe.

Pre-benefit sharing effect: Pre-benefit sharing mechanism was implemented by the appointment of two informants Sri. Mallan Kani and Kutti Mathan Kani of Choanampara tribal settlement, Kottoor, Thiruvanathapuram district, Kerala as consultants in the Division of Ethnomedicine and Ethnopharamacology at Tropical Botanic Garden and Research Institute for a period of 7 years from 1993 to 1999. They were paid a total remuneration of Rs. 5,04,000/- (@ Rs.3,000/- month for 2 persons for 7 years). This is one of the novelties of ABS Kani model of benefit sharing.

Post-benefit sharing effect: Some significant outcome arising out of the benefit sharing model were:

- Rs.2,500/- each is maintained as a fixed deposit in the name of two Kani girls aged

8 and 10 whose mother was killed by a wild elephant in 2002.

- A Community Centre with necessary infrastructure facilities was constructed at Chonampara Kani settlement.
- A Jeep was purchased for transportation of people and marketing of goods and Non Wood Forest Produce.
- Kerala Kani Samudaya Kshema Trust (KKSKT) has given employment to two Kani tribesmen as Driver of the Jeep and Helper and both of them are paid salary every month.
- Telephone facilities have been provided to the office of the Trust.
- Established rain water harvesting system.
- A Distillation Still for production of essential oil has been installed at the Tribal Community Centre.

Conclusion of Kani model / Pushpangadan model / TBGRI model of access and benefit sharing

- Implemented Article 8(j) and Article 15.7 of CBD
- Recognized and rewarded IPR of Kani tribe
- Protected traditional knowledge of Kani tribe
- Extended short term benefits to the informants
- Extended long term benefit to the Kani community

Kani Access and Benefit Sharing (KABS) model offered several lessons to be learnt at various levels. It also signifies the growing interplay between the collective rights, and the monopolistic rights of the WTO regime. The KABS model demonstrates that the traditional communities can be empowered to preserve/ protect their traditional knowledge and at the same time enable them to avail their rights while sharing their resource and knowledge in the market regime of the modern world.

*Outcome and lessons learnt***:** The sharing of benefits with Kanis and formation of the Kerala Kani Samudaya Kshema Trust fund have started showing positive impacts in the sense that the tribal community is now becoming conscious about the values of and rights over their knowledge system and associated biological resources. These developments also have helped in bringing the Kani families to a single organizational framework, so that the benefits accrued from the trust fund could be utilized for the economic well being and social development in the Kani tribal hamlets. The Kani tribe is now a proud and dignified community. The trust has a concrete building of fully furnished four rooms (about 2000 sq.ft.) with fully furnished office room, conference hall, library cum reading room and a store room. The Kani community regularly meets at the Community Hall, discuss their problems and take decisions for the welfare of the community. For the first time in the history of the Kani tribe, they feel confident and dignified. They have initiated various welfare programmes for the benefit of their community. Looking back, it is unbelievable to see the kind of transformation of this otherwise timid, nomadic forest dwelling tribe who used to be scared of outsiders and foresters now standing up with dignity and claiming their rights and privileges. There are now many Kani boys and girls who have completed high school and University graduation for which the trust played a positive role. The trust acquired a vehicle for transportation of men and materials from the tribal hamlets to the towns outside the

forest area and two Kanis are employed for the smooth running of the vehicle. The trust was able to persuade the local authorities to build a motorable road of over 10 km inside the forest to the tribal village (Pushpangadan and Pradeep, 2008).

The TBGRI Model perhaps is a unique experiment and first of its kind in India, wherein the benefits accrued from the development of a product based on an ethnobotanical lead were shared with the holders of the traditional knowledge. Considering the significant outcome of this model in community empowerment and income generation and poverty eradication of a tribal community, Pushpangadan was awarded with the UN-Equator Initiative Prize (under individual category) at the World Summit on sustainable development held in Johannesburg in August, 2002. Now with the CBD-Bonn and WIPO guidelines and our national legislation on biodiversity in position, the TBGRI Kani case study could be taken as an ideal model of equitable benefit sharing involving genetic resources and associated traditional knowledge (Pushpangadan and Pradeep, 2008). After the expiry of the license period of 7 years JNTBGRI has extended the license for production of Jeevani for a further period for 3 years. Since the patent period is over, the technology for production of *Jeevani* is now in public domain.

11. Conclusion

Arogyapacha, in spite of its proven therapeutic efficacy, is not listed in the Ayurvedic Pharmacopoeia of India. *T. zeylanicus* ssp. *travancoricus* has to be evaluated based on the principles of Ayurvedic Pharmacology. Ayurveda, being a dynamic and ever expanding Indian System of Medicine has to expand its arsenals by including new resources to its armoury to meet the challenges raised by new and emerging diseases.

The evidences provided in this article strongly support the tribal claims on the therapeutic efficacy of this plant drug. AYUSH and the Ayurvedic scholars should take necessary steps to incorporate and integrate this very important medicinal herb into the official list of Ayurvedic medicinal plants.

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