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SCIENTIFIC RATIONALITY, ADOPTION AND PERCEIVED EFFECTIVENESS OF ETHNOMEDICAL PRACTICES ON BITE REMEDIES IN IDUKKI, KERALA

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ABSTRACT

The study was carried out among tribal farmers of Idukki district, Kerala. Forty gramapanchayats were selected for the study. A total of 90 tribal healers cum age-old farmers and 452 tribal farmers were the respondents of this study. The study recorded sixty eight EMPs on bite remedies. The prevalent categories of EMPs expertise were on poisonous bites (48.55%), snake bites (22.05%), scorpion bites (16.17%), spider bites (10.29%), and dog bites (2.94%). Of the sixty eight EMPs, seventeen were assessed for their scientific rationality and adoptions of which sixteen were studied for their perceived effectiveness among tribal farmers. Of the seventeen practices, fourteen were found to be rational, while the rest three were irrational. In this study, the scientific rationale behind fourteen rational EMPs was also explained. Sixteen practices were adopted by 51.32 to 83.18 percent of the respondents. Of the sixteen EMPs studied for effectiveness, all were perceived as effective by the tribal farmers, and this revealed that many EMPs on bite remedies were both rational and effective. This requires more clinical and pharmacological interference to validate and standardize EMPs, which will consecutively pave way for the development of low cost and effective alternative health care system.

Keywords: Ethno medical practices, rationality, adoption, perceived effectiveness

INTRODUCTION

The indigenous systems of medicines continue to serve many inhabitants, particularly in rural and tribal areas to treat various ailments despite the advent of modern medicine (Pullani and Prabha, 2020). Amongthem, envenomation is a significant, dangerous, and often neglected health issue and constitutes an occupational hazard, mainly in agriculture. Some communities typically have inadequate access to the health care systems and poor access to specific treatment, due to insufficient health services and health facilities in rural areas (Felix-Silva *et. al.*, 2017). High mortality and health-related problems are reported due to various bite issues because of transportation delays, poor health issues, and anti-venom administration delays. Anti-venom serum separated from envenomed animals, the effectiveness of which is decreased against lethal acts but has significant side effects, was used for affordable special care (Ramasamy *et al.*, 2018). Ethnomedical practices constitute a medical precedent for bite treatments, showing various phytochemicals compounds for many pharmacological activities of therapeutic concern.

Idukki is the home to nine different ethnic groups living in the interior forest area, having diverse cultures, religious rites, food traditions, and a social life that separate them from each other. These people also have a healthy awareness of indigenous medicine, especially for bite remedies. While some researchers have made efforts to record the ethnomedical practices (EMPs) (e.g., Sudeesh (2012), Ajesh *et al.* (2012), Ajeshand Kumuthakalavalli (2012) and Nair and Viswan (2020)), most of these are fragmented research with a relatively narrow focus on ethnic groups and their knowledge in EMPs. Besides, neither of these findings has pursued to establish the scientific rationale of EMPs. In view of this, the basic objectives of the present research were to gather and record information on EMPs related to bite remedies among tribal farmers of Idukki, in addition, to evaluate the scientific rationale of selected EMPs and determine the level of adoption and perceived effectiveness of selected EMPs.

MATERIALS AND METHODS

In the first phase of the study nine major different tribal groups of the Idukki district were selected and they were Muthuvan, Mannan, Malayaraya, Ullada, Hill Pulayan/ Mala Pulayan, Paliyan, Malavedan and Malapandaram. The local health care system includes EMPs, andthe sampling procedure was designed to cover tribal healers from all major tribal groups. All the eight blocks in the district were purposively selected based on the high percentage and scattered population of the tribal farmers after discussing with officers from the Integrated Tribal Development Project (ITDP), Todupuzha. Ten tribal healers and farmers with the age of more than 60 years and experience of more than 30-40 years from each tribal group were identified through judgment sampling, in consultation with the tribal promoter workers of each village panchayat office, making a total of 90 respondents for elucidating EMPs on bite remedies. The information has been gathered on bite remedies through the participatory informal interview method. Nine focus group discussion sessions were also conducted (one per tribal group) to confirm the authenticity

Table 1: Categorization of the documented ethnomedical practices (EMPs) on bite remedies

Sl. No	EMP use categories	Items under each category	Frequency %
1	Poisonous bites	33	48.55
2	Snake bites	15	22.05
3	Scorpion bites	11	16.17
4	Spider bites	7	10.29
5	Dog bites	2	2.94
Total		68	100.00

Table 2: Scientific rationale behind the EMPs on Bite remedies

EMP code	Ethno-medical practices	Rationale/ Phytochemical
EMP-1	Bael (*Aegle marmelos* (L.) Corrêa). Paste prepared by grinding 13 leaves, 3 gm root, and 7 ml curd with a shelf life of 1 hour, applyingthe affected area to cure the poisonous bite.	Leaves contain phytochemicals such as rutacine, sitosterol, meglumine, aegeline, marmeline, fragrine, dictamine, cinnamide,cinnamide, alkaloids, coumarins, steroids, and different derivatives. These phytochemicals detoxify the venom. Curd may increase the shelf life of the formulation
EMP-2	Sage-leaved alangium (*Alangium salviifolium* (L. f.) Wangerin). 120 ml decoction prepared by boiling 30 gm fresh root paste in 600 ml water with a shelf life of 1 day applying on the affected area twice a day to cure dog bite.	Roots contain phytochemicals such as flavonoids, saponins, phenols, and steroids,and it possessesanti-inflammatory and anti-microbial activity
EMP-3	Poison devil (*Alstonia venenata* R.Br). 15 gm stem bark paste mixed with 3 ml coconut milk with a shelf life of 1 day applying on the affected area thrice a day to cure spider bite infection.	A.venerata contains phytochemicals such as terpenoids,tannin,saponins, and alkaloids. These possess anti-inflammatory properties.
EMP-4	Birdwing (*Aristolochia indica*). A decoction prepared by boiling 100 gm shade-dried root in 500 ml water for 30 minutes with a shelf life of 1 day applying on the affected area and taking 10 ml inside twice a day to cure the poisonous bite.	A. indica roots contain phytochemicals such as aristolindiquinone, aristololide, 2-hydroxy-1-methoxy-4Hdibenzo quinoline-4,5-(6H)-dione, cephradione, aristolactumIIa, β-sitosterol-β-D-glucoside aristolactam glycoside I, stigmastenones II and III, methylaristolate, ishwarol, ishwarone, and aristolochene. These possess anti-inflammatory property.
EMP-5	Caraway (*Carum carvi* L.m). Paste prepared by grinding 5 gm leaves mixed with 3 ml coconut oil with a shelf life of 1 day applying twice a day to cure the poisonous bite.	Leaves and stems of C. Carvi contain low volatiles, germacrene D, germacrene, and carvone, which possess anti-inflammatory action.
EMP-6	Vinca/ Periwinkle (*Catharanthus roseus* (L.) G. Don / *Vinca rosea*/ *albelin*). Paste prepared by grinding 13 gm leaves and 7 gm root mixed with few drops of sour gruel with a shelf life of 1 day applying on the affected area to cure the poisonous bite.	C. roseus leaves, and root contains phytochemicals such as caffeoylquinic acids and flavonol glycosides. These possess anti-inflammatory and antioxidant activity.
EMP-7	Clerodendrum (*Clerodendrum infortunatum* L.). 10 gm leaf paste mixed with few drops of milk with a shelf life of 1 hour, taking a day thrice for three days to cure snake bite.	Clerodendrum infortunatum contains flavonoids that promote the wound healing process due to their antioxidant and anti-microbial activities.
EMP-8	White Datura (*Datura alba*). Paste prepared by grinding 10 gm dried seeds and 2 gm tobacco leaf paste with a shelf life of 1 hour applying thrice on the affected area to cure mad dog bites.	Datura alba seed contains tannin, saponins, alkaloids, irredoids, and tobacco, including flavonoids, contributing directly to anti-bacterial and antioxidant activity and scavenging activities established by their hydroxyl group.

Table 2 Continue...

EMP-9	Scaber (*Elephantopus scaber*). 10 gm fresh root mixed with 2 gm turmeric rhizome with a shelf life of 1 day applying twice a day to cure the poisonous bite.	Deoxyelephantopin, isodeoxyelephantopin, scabertopin, tricin, luteolin, lupeol acetatelupeol, betulinic acid, epifriedelanol, and ursolic acid were found in the root of the E.scaber, which possess anti-microbial, antioxidant, analgesic, and anti-inflammatory activity. Turmeric comprises curcuminoids, i.e., curcumin and dimethoxy curcumin. These have anti-bacterial, antiviral, antioxidant, and anti-inflammatory properties.
EMP10	Indigo plant (*Indigofera tinctoria* L.). 7 ml leaf extract taken twice and applying 13 gm leaf paste on the affected area with a shelf life of 10 minutes to cure the poisonous bite.	I. tinctoria leaves contain phytochemicals such as alkaloids, deobsurents, retenoids, beta-sitosterol, flavonoids, glycoside-Indirubin, Indican, andIndigotin. These possess anti-inflammatory and antioxidant activity.
EMP-11	Indian lantana (*Lantana indica*). 20 gm leaf paste mixed with 7 ml fresh coconut milk with a shelf life of 1 day applying on the affected area to cure poisonous bite-honey bee, wasp, and lizard.	L. indica contains flavonoidal glycosides, triterpenoids, and tannins that possess anti-microbial and anti-inflammatory properties.
EMP-12	Nerium (*Nerium odorum Aiton/ indicum*). Paste prepared by grinding 5 gm tender leaves, one tulsi leaf, and a pinch of turmeric with a shelf life of 1 day applying twice a day to cure snake bite.	Nerium odorum containsoleandrin and oleandrigenin, known as "cardiac glycosides,"alkaloids, tannin, a flavonoidthatincludesananti-microbial, antiviral, antioxidant, and anti-inflammatory activity. Tulsi and turmeric also possess anti-microbial and anti-inflammatory activity.
EMP-13	Holy basil (*Ocimum sanctum*). Paste prepared by grinding 7 gm fresh flowers, 7 gm fresh root, 5 gm leaves, 1 gm turmeric rhizome, 3 gm Boerhavia diffusa root, and 4 ml Aloe vera extract with a shelf life of 1 day applying a day thrice to cure the poisonous bite.	O. sanctum contains phytochemicals such as eugenol, methyl eugenol, carvacrol, and sesquiterpenehydrocarbon caryophyllene. Fresh leaves and the stem of O. sanctum yielded some phenolic compounds such as cirsilineol, circimaritin, isothymusin, apigenin, rosameric acid, and appreciable quantities of eugenol. These have antioxidant activity. .Two flavonoids, viz., orientin and vicenin. Ursolic acid, apigenin, luteolin, apigenin-7-O-glucuronide, luteolin-7-O glucuronide, orientin, and molludistin have also been found in the leaf. O. sanctum also contains several sesquiterpenes and monoterpenes viz., bornyl acetate,- β- elemene, neral,-α, and- β- pinenes, camphene, campesterol, cholesterol, stigmasterol, and-sitosterol. C. longa contains many rich sources of polyphenolic curcuminoids, i.e., curcumin, demethoxycurcumin, and bisdemethoxycurcumin. B. diffusa contains alkaloids, glycosides, saponins, phytosterols, phenolic compounds, and tannin. A.veracomprises many essential antioxidant vitamins A, C, F, Vitamins B (thiamine), niacin, vitamin B2 (riboflavin), vitamin B12, choline, and folic acid. Other major phytochemicals includes barbaloin, aloe-emodin-9-anthrone, lsobarbaloin, Anthrone-C-glycosides, chromones, campesterol, sitosterol, lupeol, and salicylic acid.These possess anti-inflammatory and antioxidant activity.
EMP-14	Plumbago (*Plumbago rosea/ gocapensis*). Root paste with a shelf life of 1 day applying on the affected area twice a day to cure scorpion bite.	Irrational

Table 2 Continue...

EMP-15	Ashoka tree (*Saraca asoca / indica*).Paste prepared by grinding an equal quantity of stem bark, flower, and fruit with a shelf life of 1 day applying on the affected area twice or thrice a day cure scorpion sting.	The presence of flavanol in Saraca asoka exhibits anti-microbial and anti-inflammatory activity.
EMP-16	Wild Lucas (*Trichodesma indicum*). The formulation was prepared by grinding 10 gm fresh root and one curry leaf with a shelf life of 1 day, applying twice a day to cure the poisonous bite.	Irrational
EMP-17	Vetiver (*Vetiveria zizanioides* (L.). Nash)Paste prepared by grinding root and sandalwood of 5 gm, each with a shelf life of 1 day is applying a day thrice to cure spider bites poison.	Irrational

Table 3: Practice wise rationality, adoption, and perceived effectiveness of the selected EMPs on bite remedies

S.N.:	EMP CODE.	Rationality score (n=52)	Adoption		MPEI (n=452)
			Number (n=452)	Percentage	
1	EMP-1	3.25 R	376	83.18	2.475 E
2	EMP-2	2.67 R	346	76.54	2.197 E
3	EMP-3	2.75 R	304	67.25	2.213 E
4	EMP-4	3.4 R	356	78.76	2.28 E
5	EMP-5	2.8 R	332	73.45	2.21 E
6	EMP-6	3.45 R	343	75.88	2.203 E
7	EMP-7	3 R	284	62.83	2.595 E
8	EMP-8	2.7 R	274	60.61	2.132 E
9	EMP-9	2.65 R	293	64.82	2.38 E
10	EMP-10	3.15 R	330	73	2.544 E
11	EMP-11	2.65 R	325	71.9	2.48 E
12	EMP-12	3.58 R	311	68.8	2.32 E
13	EMP-13	3.1 R	300	66.37	2.627 E
14	EMP-14	2.75 IR	195	43.14	-
15	EMP-15	2.96 R	232	51.32	2.084 E
16	EMP-16	2.3 IR	273	60.39	2.090 E
17	EMP-17	2.5 IR	290	64.15	2.573 E

and refine the information gathered, in which a total of 111 healers and farmers have participated. A total of sixty-eight items of EMPs on bite remedies were documented through this method.

In the second phase, after excluding the tribal group and block specific EMPs, a rationality analysis on the remaining 17 EMPs was performed. Rationality refers to the degree to which EMPs can be explained or supported with scientific explanations or have been established based on long term experiences. On the contrary, irrationality refers to the degree to which EMPs cannot be explained or supported with scientific reasons or not supported by long term experience. The collection of 17 EMPs chosen was administered using a four-point continuum to experts who were asked to judge the rationality or otherwise. The response categories were rational based on scientific evidence, rational based on experience, irrational based on experience, and irrational based on scientific evidence with a score of 4, 3, 2, and 1 respectively (Somasundaram, 1995; Husain, 2011). The respondents had been drawn from among the Agadathanthra (Toxicology) scientists of various Ayurveda and Siddha medical colleges from Kerala and Tamil Nadu. A total of 64 experts belongs to Agadathanthra were approached, and 52 responded by returning the filled out questionnaires, mean score was calculated for each EMPs, and those with a mean score of 2.5 and above were identified as rational and those below 2.5 were considered as irrational.

With experts' guidance, the underlying principles of the rational EMPs were also articulated during collecting data on rationality using open-ended questions. For validating the EMPs, 43 experts from Dravyaguna (Ayurvedic Pharmacology) department were contacted.

In the third phase, the extent of adoption and perceived effectiveness of the EMPs among tribal farmers were assessed using a structured interview schedule. Two or more villages in each of the eight blocks viz., Adimali, Devikulam, Nedumkandam, Elamdesam, Idukki, Kattappana, Todupuzha and Azhutha were selected. Thus, a total of forty village panchayats spread over the blocks were selected. The following formula published by National Education Association was used to determine the sample size (Krejcie and Morgan, 1970).

Where: {s = required sample size, X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.8416) (1.96 X1.96 = 3.8416), N = the population size, P = the population proportion (assumed to be 0.50 since this would provide the maximum sample size), d = the degree of accuracy expressed as a proportion (0.05)}.

Thus a total of 452 tribal farmers have been selected through a proportionate random sampling technique.

In this study, adoption was operationalized as whether an individual respondent had ever practiced the selected EMPs. For this purpose, the collection of selected EMPs was extensively described to the tribal farmers, discussing whether the EMP in question had ever been followed in the past. If the answer was "Yes," a score of one was assigned, and zero was given if the answer was "No." The scores allocated to a specific EMP by all respondents were summed up, and an adoption index was established to determine the degree of adoption.

Perceived effectiveness of the EMPs, i.e., the degree of the relative usefulness of the EMP as perceived by the farmers in resolving the health issues in bite remedies, was measured using the Perceived Effectiveness Index (PEI) methodology developed by Sundaramari (2001) and Sakeer Husain (2011). A mean perceived effectiveness index (MPEI) of 3 was assumed to be the most effective, and most ineffective was found to be an MPEI of 1. An average effective EMP would get an MPEI of 2.0. Hence, EMP with MPEI of greater than 2 was considered effective, as per farmers' perception and others as less effective. EMPs on bite remedies adopted by more than 50 percent of farmers were alone selected for assessing their perceived effectiveness.

RESULTS AND DISCUSSION

As part of this study, a total of 68 EMPs was identified and category wise description of the same is given in Table 1.Of the use categories, the category of poisonous bites or stings from bees, wasps, hornets, yellow jackets and fire ants (48.55%) ranked first followed by snake bites (22.05%), scorpion bite (16.17%), spider bites (10.29%) and dog bites (2.94%).

Scientific rationale behind the EMPs on Bite remedies

After deleting tribal group and block specific ethno-medical practices, 17 EMPs were selected for further analysis. Rationality analysis showed that out of the seventeen practices selected for further study fourteen practices were rated as rational by the scientists, and the rest three practices were irrational. Hence, the rationale outlined by the scientists for the rational practices has been presented in Table 2. It can be seen from the data presented, majority of the EMPs have strong scientific bases.

It could be deduced from Table 2 that almost all the plants used in the rational EMPs were found to contain various phytochemicals such as alkaloids, flavonoids, steroids, terpenoids, glycosides, saponins, tannins, phenols, phytosterols, etc. in different combination as indicated against each medical practices in the above table. These phytochemicals are indicated to possess anti-inflammatory, antioxidant, and anti-microbial activities, which would cure wounds and other sufferings caused by various bites and these phytochemicals, have the ability to neutralize the lethal effect of poisonous bites. Further, alkaloids acts as an antidote (Enenebeaku *et al.* (2018), Kulatunga and Arawwawala (2019) and Wufem *et al.* (2007). The way in which these phytochemicals detoxify the venoms in the human body has been explained in the succeeding paragraph as "Process of Detoxification".

Process of detoxification

The efficacy of EMPs against various envenomation may be associated with the presence of various phytochemicals present in it, while, symptomatic relief may be due to the anti-inflammatory, antimicrobial and antioxidant effects. The possible mechanism of envenomation includes anti-inflammatory action due to the presence of β-sitosterol and some flavonoids. Another possible mechanism may involve complexation of constituents with venom and subsequent prohibition to act as receptors. Further, may involve quick antagonism or metabolism of catecholamine released as a results of interaction of venom with receptors. The intensity of envenomation effect also be reduced by non-specific stimulation of the immune system that would result in neutralization or phagocytosis of the peptides of venom. Phospholipase enzymes play significant role in the cascade which leads to pain and inflammatory responses. The inhibition of these enzymes may relieve effects of envenomation (Nasim *et al.,* 2013). The above EMPs (Table 2) contain various types of flavonoids, steroids, triterpenoids, alkaloids, tannins and coumarins. Complete activity of a practice cannot be attributed to a single constituent: instead, complete activity of a practice is due to the synergistic effect of various constituents on various target structures (enzymes and receptors). Usually phytochemicals are multifunctional as they perform more than one biochemical or pharmacological action simultaneously (Nasim *et al.*, 2013). The synergistic effect of chemical constituents in a plant extract can successfully neutralize multi-toxicity or pathogenesis inducing factors altogether (Nisha *et. al*., 2018).

Many EMPs were found to possess different phytochemicals (acids, alkaloids, steroids, enzymes, peptides, pigments, glycoproteins and glycosides, phenols, tannin, terpenoids, quinonoid and other compounds) which are effective against envenomation (Gomes *et al.*, 2010) by neutralizing different enzymes and toxins (procoagulent enzymes, haemorragins, cytolytic or necrotic toxins, phospholipases A_2, B, C, D, hydrolyses, phosphatases, proteases, esperases, acetylcholine esterases, transaminase, hyaluronidase, phosphodiesterases, nucleotidases, ATPase and nucleosidases) in venoms (Rita *et al.*, 2011). Enzyme inhibiting and protein binding characteristics had been associated with chemically active compounds of flavonoids, polyphenols, and terpenoids and so on; the phytochemicals additionally inhibit PLA_2 activities of venom (Selvanayagam *et al.*, 1996). Phenolics, specifically polyphenols like a few tannins bind proteins, acting upon components of venom without delay and disabling them to act on receptors. They may also act by competitive blocking of the receptors (Lans *et al.*, 2001).

Practice wise rationality, adoption, and perceived effectiveness of the selected EMPs on bite remedies

There were 17 EMPs selected in bite remedies for in-depth study. The rationality and adoption of each of these EMPs by farmers are presented in Table 3.

It is evident from the above Table 3 that 82.35 percent of the practices were judged as rational by the scientists, and 17.64 percent practices were judged as irrational. Further seven of the seventeen EMPs have got rationality score of more than three (1, 4, 6, 10, 12 and 13). Of them, regarding adoption, the results showed that all the practices except one were adopted by more than 50.00 percent of the respondents. Of them, four EMPs were (1, 2, 4, and 6) adopted by more than 75 percent of respondents and all are rational. Fifty to seventy-five percent of respondents adopted twelve EMPs (3, 5, 7, 8, 9, 10, 11, 12, 13, 15, 16, and 17) of which ten (3, 5, 7, 8, 9, 10, 11, 12, 13 and 15) were rational, and the other two (16 and 17) were irrational. There is one EMP (14) adopted by only 43.14 percent of the respondents, which was irrational.

The following EMPs, which were perceived as effective by the tribal farmers, had a rationality score of more than 3. The EMP1 had a rationality score of 3.25 and 83.18 percent of adoption with an MPEI of 2.475. *Aegle marmelos (L.) Corrêa* is widely available in the area, and they protected this plant due to various reasons. They believe that *A. marmelos* acts as a sink for chemical pollutants due to its capacity of absorbing poisonous gases and harmful components from the atmosphere to make them neutral (Jhajhria and Kumar, 2016). They also cultivate this plant widely because the plant is considered a "Fragrant" species, whose flowers and volatile vapors neutralize the terrible smell of petrified organic matter and save human life from bacterial infection by making them inert (Agarwal, 1997). While considering the EMP1, the leaf extract of *A. mermelos* contains antioxidant phytochemicals such as flavonoids, alkaloids, sterols, tannin, phlobotannin, and flavonoid glycosides, and theseexhibit free radical scavenging activity (Raja Durai and Prince, 2005). The leaves also contain lupeol and skinnianine (Geetha and Varalakshmi, 2001) to possess anti-inflammatory, analgesic, antipyretic, and antiallergic activities (Arul *et al.*, 2005). The plant has anti-bacterial activity due to cumin aldehyde and eugenol (Duke, 1992). Due to its above phytochemical activities, *A. marmelos* is widely used as an antidote against poisonous bites (Bhrmavarchas, 2003). Curd peptides help to reduce hypertension by inhibiting angiotensin converting enzyme (ACE) (Dabarera *et al*, 2015). Hence, the high percentage of adoption of the practice is understandable.

EMP 4 was adopted by 78.76 percent of the respondents with a rationality score of 3.40, and the MPEI was 2.280. The roots of *Aristolochia indica* contain aristolindiquinone, aristololide, 2-hydroxy-1-methoxy 4- H dibenzo quinolone-4,5-(6H)- dione, cephradione, aristolactum II a, β-sitosterol, β-D-glucoside aristolactam glycoside I, stigma stenone II and III, methylaristolate, ishwarol, iswarone, and aristolochene (Rakesh *et al.,* 2010). Due to the above phytochemical constituents' presence, *A. indica* possesses anti-venom, lethal toxicity, edema – forming, haemorrhagic, defibrinogenating, procoagulant, fibrinolytic, phospholipase, and anti-inflammatory activities (Meenatchisundaram *et al.*, 2009; Bhattacharjee and Bhattacharyya, 2013). These might have been the reason for the anti-venom effect of the formulation and higher adoption and MPEI of the above practice.

EMP6 was adopted by 75.88 percent of the respondents with a rationality score of 3.45 and MPEI of 2.203. The primary ingredient of the practice is *Catharanthus roseus*

(L.). It contains many volatile and phenolic compounds, including caffeoylquinic acid and flavanol glycosides, which are known to possess antioxidant activity (Salah *et al.*, 1995). Besides antioxidant activity, these compounds exhibit antiallergic, anti-inflammatory, and anti-microbial effects (Garg *et al.,* 2012). Hence the high percentage of adoption and MPEI is reasonable.

EMP 10 was adopted by 73.00 percent of the respondents with a rationality score of 3.15, and MPEI was found to be 2.544. The main ingredient of the formulation is *Indigofera tinctoria*. It contains alkaloids, deobsurents, retinoids, beta-sitosterol, and flavonoids (Kumar *et. al*., 2020). The plant possesses anti-inflammatory (Amala, 1982), antioxidant, and anti-bacterial properties due to alkaloids, saponins, phenols, and flavonoids in it (Swaminathan, 2018). This may be the reason to cure the poisonous bite.

While considering the EMP 12, it scored the highest rationality score (3.58), and this practice was found to have an MPEI of 2.320. But this practice has been adopted by only 68.80 percent of the respondents. The main ingredients of the practice are *Nerium odorum, Ocimum sanctum and Curcuma longa*. *Ocimum sanctum* leaves possess good inhibition of coagulant activity and it effectively antagonizes the fibrinolytic activity of venom. Further it inhibits the enzyme activity of phospholipase A_2 enzyme present in the venom, which has the ability to cause lysis of RBC's. These effects might have been due to the triterpenoids present in the plant (Kuriakose *et al.*, 2012). *Curcuma longa* root contains ar-turmerone, which may act as an enzymatic inhibitor in the case of venom enzymes with proteolytic and hemorrhagic activities or it may possess a direct antitoxin action or chemical inactivation (Ferreira *et al.,* 1992). Respondents considered *N. odorum* as a poisonous plant and many of its compounds may exhibit toxicity when consumed in high dosage. It contains cardiac glycosides such as oleandrin and oleandrigenin, which do not have a narrow therapeutic index and can be toxic when ingested; still, the plant's topical administration is safe (Sivagnanam *et al.*, 2012). Due to these reasons, a skilled practitioner's advice is necessary for the administration of this formulation. That may be the reason for less adoption of this EMP.

The EMP 13 was found to have the highest MPEI value (2.627) but adopted by only 66.37 percent of the respondents with a rationality score of 3.10. The tribal farmers of the Idukki district have been widely using this medicinal plant for the management of various disease conditions. It is one of the finest and cheap sources of medicine as an antidote against poisonous bite due to its triterpenoid presence (Kuriakose *et al.,* 2012). Leaves of *Ocimum sanctum* yield 71.30 percent eugenol, 3.20 percent carvacrol, and 2.04 percent methyl eugenol, and 1.70 percent caryophyllene, which might have a potent effect against poisonous bite (Senthamarai and Pooja, 2019). Above all, *O. sanctum* extract has a significant ability to scavenge highly reactive free radicals due to its flavonoid (orientin and vicenin) and phenolic compounds viz., cirsilineol, cirsimaitin, isothymusin, apigenin, rosmarinic acid and appreciable quantities of eugenol (Nair *et. al*., 1982) and (Kelm*et. al*., 2000). *O. sanctum* fixed oil showed good anti-bacterial activity due to the presence of higher content of linolenic acid in it (Sing *et. al*., 2005). It also exhibits analgesic, antipyretic, and anti-inflammatory effect due to the presence of fixed oil and linolenic acid (Sing *et al*., 1997). It also shows anticoagulant activity due to the fixed oil (Singh *et al*., 2001). *Curcuma longa* contains a protein turmerin. This protein inhibits the enzymatic activity and neutralizes the pharmacological properties, such as cytotoxicity, oedema and myotoxicity of multitoxic phospholipase A_2 of venom (Chethan kumar and Srinivas, 2008). *Boerhavia diffusa* contains alkaloids,rotenoids, phenolic glycoside and methyl flavone which possess anti-inflammatory, immunomodulatory and antiproliferative properties (Nandi and Ghosh, 2016). *Aloe vera* had a dose dependent inhibitory effect on reactive oxygen metabolite production and it inhibit the production of prostaglandin E2 (Langmead *et al*., 2004). Further it is effective in wound healing (Leitner *et al*., 1989). Due to the above fact, the practice scored high MEPI among the tribal farmers. Even though the plant part used for the practice is its fresh, flowers, root and leaves, the frequent use may lead to destroy the whole plants. That may be the reason for the low adoption of the practice.

It can be observed from Table 3 that EMP 16 and EMP 17 were found to be irrational by the scientists, but the farmers had perceived these practices effective as an antidote. In EMP16, the main ingredient is *Trichodesma indicum*. It contains flavonoids, phenols, tannin, terpenoids, and steroids, and these are considered as significant source of natural antioxidants (Anusha *et al*., 2014) and is one of the anti-inflammatory agent too (Perianayagam*et. al*., 2006). Other than this, another ingredient in this practice is the leaves of *Murraya koenigii*. It contains alkaloids, flavonoids, and sterols, which exhibit analgesic and anti-inflammatory action. Above all, *M. koenigi* leaves have antioxidant (koenimbine, koenigine, mahanimbine) and anti-microbial (Gurjunene, Murrayanol) activities (*Gahlawat et. al.,*2014). Combining these two plants and their phytochemicals might have made the formulation more potential as anti-venom.

In EMP 17, there are two ingredients, *Vetiveria zizanioides,*and *Santalum album*. V. zizanoids contains Kushimol, the main active ingredient, which exhibits promising anti-microbial activity (Dos Santos *et al.,* 2014). Significant sandalwood phytoconstituents are α and β-santalols, bergamotols, and several of their stereoisomers, which would possess antiseptic, anti-inflammatory, anti-bacterial and antioxidant properties (Kumar *et al.,* 2015). Combining these plants and their phytochemicals might have made the formulation more effective against poisonous bites as anti-venom.

Out of the sixteen EMPs selected for assessing the perceived effectiveness, EMPs 16 and 17 were found as irrational but both were perceived as effective while the rest (87.50%) were rational and effective. Of these, high MPEI values were obtained by EMP 13 and 17. In addition EMP 1, 10 and 13 had relatively high rationality scores and MPEI scores implying that these practices were very good and effective. In nutshell, it could be concluded that the majority of EMPs on bite remedies (87.50%) were rational and effective.

CONCLUSION

The present study documented 68 EMPs on bite remedies. In rationality study, majority of the EMPs were judged as rational by experts. Similarly, majority of the EMPs were perceived as effective by the tribal farmers. The phytochemical constituents in EMPs provided significant inhibitory effects against various poisonous bites which reveals the potential use of these EMPs in the development of new poisonous bite therapies. Thus EMPs with significant source of bioactive compounds may lead to new antivenomous practice developments. Further these EMPs may be standardized for the possibility of blending with Ayurveda and Siddha systems of medicine. The traditional healers and tribal farmers are to be motivated to spread and adopt this precious knowledge to future generation for promoting sustainable health care system. At the same time, extension personnel may encourage the tribal farmers to continue the use of the rational EMPs and motivate to discontinue or recommend further verification for the irrational EMPs.

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