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Review Article

SELF-TREATMENT AMONG ANIMALS BY USING SUCCULENT HERBS TO FIGHT AGAINST PARASITES AND THEIR POSSIBLE USE AS HUMAN MEDICINE

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ABSTRACT: Self-treatment against harmful parasites is found among a wide range of animals, from caterpillars or butterflies to porcupines and different wild animals and up to the African great apes. Many rural people share such knowledge of the animals and use similar herbs among themselves to treat diseases with similar types of symptoms as observed in the ailing animals. Chimpanzees, Bonobo, etc. are genetically very similar to humans, and many self-treatment reports are there among such animals. So, such knowledge of the self-treatment of animals by using plant materials can be considered for the prevention and treatment of many dangerous diseases prevalent among humans. Sixty-four (64) such plants are identified for their anti-parasitic uses and listed in this article. The succulent plant materials effective among these animals have a very high probability of effectiveness for humans also. A new concept of the use of such biomedicines at their succulent condition in bio-encapsulated form can be considered for their widespread therapeutic use. In addition to the Ayurveda and alike medical systems, Homoeopathy as well as in Modern medicine, where therapeutic use of dry parts of the medicinal plants, their extracts, or synthetic analogs of the components are only considered, therapeutic use of the succulent biomedicine may open a new window of therapy of many so-called hard-to-cure diseases caused by various invading parasites. As the succulent plant materials contain a huge number of phytoconstituents and all of them work together to bring the desired health impacts, there is a very low chance of development of resistance against all of them together. These biomedicines can also supply many other additional health benefits to patients without any added effort.

Keywords: Self-medication, African great apes, Wild animals, Succulent biomedicines, Zoopharmacognosy.

INTRODUCTION

Self-medication is a common practice among animals. It is noticed among the various living creatures in their natural environment as well as among the wild animals living *in situ*. The term 'zoo pharmacognosy' is used to describe that subject [1, 2]. Self-selection and use of different parts of plants, insects, soil, etc. are performed by many members of the animal world to prevent or to get relief from the harmful impacts of different parasites, microbes, ingested toxins, and also from many other diseases [2, 4]. Self-medication practice is noticed even in very small living entities up to very large animals. It is found even among the very small insects and caterpillars. Some plant-derived toxins are gathered inside the body through selective feeding by the caterpillars for self-protection when they are infested by parasitic flies [3]. Monarch butterfly (*Danaus plexippus* L. Family: Nymphalidae) lay eggs on a milkweed plant (*Asclepias syriaca* L. Family: Apocynaceae) to defend its offspring as the milkweed affects *Ophryocystis elektroscirrha* Mc. & Myers. (Family: Ophryocystidae), a protozoa, infecting them [6].

Conifer resin is used to line the nests by some wood ants to keep their nest infection-free (do it by anticipating infection), as it is having antibacterial and antifungal activities [5]. Various other small entities like bees, lizards, etc. also have such tendencies [6]. Many known species of birds disturb the ants continuously so that they spray organic acids in their

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nest and the birds' role over it to get it on the feather or body to stay away from many parasites [5].

Among the animals, such self-medication is commonly observed. It is easy to notice that dogs eat rough grasses for physiological reasons like upset stomach, to eat more fiber, in nutritional deficiency, etc. (www.forbes.com/advisor/ca/pet-insurance/pet-care/why-dogs-eat-grass) - that can be considered as a type of self-medication.

Removal of ticks through self-picking by monkeys and dogs, licking of wound areas by animals like dogs or cats to get rid of infections, etc. are some other common practices of animals. Self-medication practice among many wild animals adjusted in domestication is also noticed [7, 8, 9]. But in the wild, animals are accustomed to using specific food or herbs to get relief from various diseases, including parasitic diseases. Perhaps only a very small part of that important subject is brought to light, as it is not easy to get such information from the animals living *in situ*. Some of such information is gathered in this article to shed some light on the possible research on the use of this instinctive knowledge of animals for the benefit of the human race.

The development of self-medication among animal species from caterpillars to chimpanzees is perhaps related to instinct and learning. Many animal species have created their pharmacy from the ingredients available in nature in their surroundings. Gathered experiences of getting aid in digestion, feeling better, preventing diseases, or getting rid of infections of parasites or microbes lead them to think about the re-use of the same materials [6]. So, it is likely that animals come to know many self-medications from their experiences, and at least the higher animals learn these from other members of their species. In the ancient days, perhaps human came to know such knowledge from animals through thorough observation and started their use in their society which is also covered by the subject termed ethnomedicinal practices [10].

TYPES OF SELF MEDICATION

The purpose of self-medication may be of two types–preventive or curative. Both are seen among animals [5].

The self-medication behavior of animals can be categorized into five categories.

i) Sick behavior: The animals are seen as depressed, lethargic, anorexic, less grooming, having pyrexia, showing basking behavior, etc.

ii) Avoidance behavior to reduce the possibility of disease transmission: The animals avoid water, food, etc. contaminated with feces or other materials.

iii) Selection of diet having disease preventive or health maintenance ability and food items eaten in smaller amounts.

iv) Use of substances having the ability to cure health problems: Use of toxic or medicinal items in small amounts having little or no ability to supply nutrition to the body but beneficial to cure health problems.

v) External application of medicinal substances: Use of medicinal substances on the body or affected areas for treatment or control of parasites or other problem-creating factors [11].

AVAILABLE REPORTS OF ANTI-PARASITIC SELF-MEDICATION OF ANIMALS

In the reporting of animal self-medication, clear-cut differences between diseases of microbial, protozoan, or other parasitic origins were not stated and many plant materials are taken by the wild animals as some form of self-medication for one or more such reasons together. It was also found that the reported use for one category proved effective against both types during the study afterward in many cases. Leaves of *Vernonia amygdalina* Del. [Asteraceae] used by Chimpanzees are found effective against malaria, intestinal parasites, and microorganisms infecting the gut [2, 12].

In the reports available regarding self-medication by the use of some plants for anti-parasitic and anti-microbial purposes by the wild animals *in situ*, the plant parts are taken by the animals at their natural succulent state. Such uses are noticed among wild pigs [6, 8, 13]. Asiatic two-horn Rhinoceros [14], Indian bison [7], African elephant [15], porcupine [16], etc. In only one case, it was reported that yak picked the dried larva of the caterpillar of moths to get the medicinal benefits of the fungus *Cordyceps sinensis* [9]. However, most of the studies on anti-parasitic self-medication of higher animals are studied on the African great apes (Gorilla, Chimpanzee, Bonobo) (Table 1).

It is seen that non-nutritional food consumption is almost twice among the chimpanzees in comparison to gorillas living *in situ*. This may be due to the reason that gorillas have more specialized guts and more capability of detoxifying harmful compounds than chimpanzees or humans, so less need to medicate [17]. It is also seen that the suffering due to infections

Table 1. Plants used by the animals for prevention and cure of health problems due to parasites (Micoro-organisms and other uni- or multicellular parasites).

Plant (with family)	Part/s used	Main identified purpose	Used by (animal species)	Reference
Achillea millefolium L. [Asteraceae]	Fresh green plant materials	Kept in the nest, having volatile aromatic oils to repel insects and keeping offspring disease free	European Starling bird (*Sturnus vulgaris* L.)	[32]
Adenopus abyssinicus Hook. F. [Cucurbitaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Aeschynomene cristata Vatke var. *cristata* [Fabaceae]	Root	Reduce protozoal and bacterial load	Porcupine	[16]
Afromomum sanguineum (K. Schum.) K. Schum. [Zingiberaceae]	Fruit, seed	Antimicrobial, antiparasitic and other effects	Gorilla	[2]
Amaranthus spinosus L. [Amaranthaceae]	Root	Anthelmintic	Wild Indian Boar	[4]
Aneilema aequinoctiale (P. Beauv.) G.Don. [Commelinaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Aneilema nyasense C.B. Clarke [Commelinaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Antiaris africana Engl. [Moraceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Agrimonia parviflora Aiton [Rosaceae]	Fresh green plant materials	Kept in the nest, having volatile aromatic oils to repel insects and keeping offspring disease free	European Starling bird (*Sturnus vulgaris* L.)	[32]
Aspilia mossambicensis (Oliv.) Wild. [Asteraceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Aspilia pluriseta Schweinf. ex Engl. [Asteraceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Aspilia rudis Oliv. & Hiern [Asteraceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Balanites aegyptiaca Del. [Zygophyllaceae]	Fruits and leaves	Use to control schistosomiasis	Anubis baboons (*Papio anubis*) and Hamadryas baboons (*Papio hamadryas*)	[33]
Boerhavia diffusa L. [Nyctaginaceae]	Root	Antihelmintic	Wild Indian Boar	[8, 13]
Careya arborea Roxb. [Lecythidaceae]	Leaf, fruit	Expulsion of parasite from the gut	Indian tiger, wild dog, bear civet, jackal	[4, 8]
Celtis adorfi-frederici Engl. [Cannabaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]

Plant (with family)	Part/s used	Main identified purpose	Used by (animal species)	Reference
Ceriops candolleana Arn. [Rhizophoraceae]	Bark	Remove bladder and UT parasites	Asiatic two horn Rhinoceros	[4, 14]
Citrus spp. [Rutaceae]	Fruit	Rubbing on skin to remove parasites	Capuchin monkeys (*Cebus capucinus*) Spider monkeys (*Ateles geoffroyi*)	[2, 23]
Clematis dioica L. [Ranunculaceae]	Leaves and stems	Use stem, leaf pod and seed after mixing with saliva on fur to reduce irritation of skin and removal of insects.	Capuchin monkeys (*Cebus capucinus*) Spider monkeys (*Ateles geoffroyi*)	[2, 23]
Commelina diffusa Burm. f. [Commelinaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Commelina benghalensis L [Commelinaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Commelina cecilae C.B. Clarke [Commelinaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Conium maculatum L. [Apiaceae]	Leaf	The Hemlok leaf is very toxic but eaten to get rid of tachinid parasitoid (*Thelaira americana*)	Caterpiller (*Platyprepia virginalis*)	[34]
Cordia abyssinica R.Br. ex A.Rich. [Boraginaceae]	Pith	Act as anti-malarial and anti-bacterial medicine	Chimpanzee	[17]
Cordyceps sinensis (Berk.) Sacc. [Cordycipitaceae]	With dried larva of caterpillar of moths of Family Hepialidae	Immunomodulation and preventive to all kind of diseases	Yak	[9, 35]
Cyperaceae sp. [sedges]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Dalbergia latifolia Roxb. [Fabaceae]	Leaf, bark	Eaten to expel parasites of the herbivore prey	Indian tiger, wild dog, bear civet, jackal	[4, 8, 36]
Daucus carota L. [Apiaceae]	Fresh green plant materials	Kept in the nest, having volatile aromatic oils to repel insects and keeping offspring disease free	European Starling bird (*Sturnus vulgaris* L.)	[32]
Dichaetanthera africana (Hook.f.) Jacq.-Fél. [Melastomataceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Eremospatha macrocarpa (Mann & Wendl.) Wendl [Arecaceae]	Bitter piths	Pharmacological activities	Gorilla, Chimpanzee, Bonobo	[2]
Erythrina abyssinica Lam. ex DC. [Fabaceae]	Bark	Having anti-malerial and anti-schistosomal activities	Chimpanzee	[2]

Plant (with family)	Part/s used	Main identified purpose	Used by (animal species)	Reference
Ficus capensis Thunb [Moraceae]	Leaf	Antibacterial	Chimpanzee	[17]
Ficus carica L. [Moraceae]	Leaf, bark	Killing internal parasite, increase milk	Pregnant Lemurs of Madagascar	[4]
Ficus exasperata Vahl [Moraceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Ficus mucuso Welw. ex Ficalho [Moraceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Ficus natalensis Hochst. [Moraceae]	Bark	Act as anti-diarrhoeal, anti-dysenteric	Chimpanzee	[17]
Ficus urceolaris Welw. ex Hiern [Moraceae]	Leaf	Anthelmintic property	Chimpanzee	[17]
Gongronema latifolium Benth. [Apocynaceae]	Bark	Colic, stomach pains connected with intestinal parasite infection	Chimpanzee	[2]
Hibiscus aponeurus Sprague & Hutch [Malvaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Holarrhena antidysentrica Wall. [Apocynaceae]	Bark	Anti-dysentaric activity	Indian Bison	[7]
Hyparrhenia cymbaria (Linn.) Stapf [Poaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Ipomoea involucrata P. Beauv. [Convolvulaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Lagenaria abyssinica (Hook. f.) C. Jeffrey [Cucurbitaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Ligusticum porteri Coult & Rose [Apiaceae]	Root	Chew and rub on skin in irritation and for repelling flies and parasites	Wild Kodiak, Brown bear	[2, 10]
Lippia plicata Baker [Verbenaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Maniophyton fulvum Mull. Arg [Euphorbiaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Melastomastrum capitatum Vahl A. Fern. & R. Fern [Melastomataceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Peponium sp. [Cucurbitaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Piliostigma thonningii (Schum.) Milne-Redh. [Fabaceae]	Leaf	Eaten as active in dysentery, malaria, fever, hookworm, skin diseases etc.	African elephant	[15]

Plant (with family)	Part/s used	Main identified purpose	Used by (animal species)	Reference
Piper marginatum Jacq. [Piperaceae]	leaves and stems	Use stem, leaf pod and seed after mixing with saliva on fur to reduce irritation of skin and removal of insects	Capuchin monkeys (*Cebus capucinus*) Spider monkeys (*Ateles geoffroyi*)	[2, 23]
Polycephalium capitatum (Baill.) Keay [Icacinaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Punica granatum L. [Lythraceae]	Root	Expel tapeworm	Pig	[4, 8]
Rubia cordifolia L. [Rubiaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Sloanea teniflora (Sessé & Moc. ex DC.) Standl. [Elaeocarpuseae]	leaves and stems	Use stem, leaf pod and seed after mixing with saliva on fur to reduce irritation of skin and removal of insects.	Capuchin Monkeys (*Cebus capucinus*) Spider monkeys (*Ateles geoffroyi*)	[2, 23]
Tamarindus indica L. [Fabaceae]	Leaf	Endo-parasite killing property, increase milk	Pregnant Lemurs of Madagascar	[4]
Terminalia kaiseriana F. Hoffm. [Combretaceae]	Root	Active against diarrhea of parasitic and other reasons	Wild pig (*Phacochoerus africanus*)	[15]
Thomandersia laurifolia T. Anders. ex Baill. [Thomandersiaceae]	Young leaf	Act on parasite infestation and fever.	Gorilla	[2]
Trattinnickia aspera (Standl.) Swart [Burseraceae]	Freshly scraped bark	Vigorous rubbing on the fur in irritation and for repelling flies and parasites	White-nosed coatis (*Nasua narica*)	[2]
Trema orientale (L) Blume. [Cannabaceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Tristemma coronatum Benth. [Melastomataceae]	Whole leaf	Expulsion of parasite from the gut	Gorilla, Chimpanzee, Bonobo	[2]
Vernonia amygdalina Del. [Asteraceae]	Bitter piths	Malaria, Dysentery, intestinal parasitism, stomach disorders, antimicrobial effects	Gorilla, Chimpanzee, Bonobo	[2, 12, 23
Vernonia colorata (Willde.) Drake [Asteraceae]	Bitter piths	Anti-plasmodial	Gorilla, Chimpanzee, Bonobo	[2, 37]
Vernonia hochstetteri Schi-Bip. [Asteraceae]	Bitter piths	Antiparasitic, antimicrobial	Gorilla, Chimpanzee, Bonobo	[2, 38]
Vernonia kirungae R. E. Fr. [Asteraceae]	Bitter piths	Antiparasitic	Gorilla, Chimpanzee, Bonobo	[2]

like *Oesophagostomum stephanostomum* (Strongylidae) that form nodules in the intestine is not so severe among the chimpanzees living *in situ* in comparison to the animals living *ex-situ* (in Zoo etc.). The reasons are assumed as the practice of self-medication of the animals living in their natural environment [11, 18]. Eating plant parts with medicinal effects as well as eating whole rough leaves as such for mechanical activity on the parasites (for the increase in gut motility and forced expulsion of excreta along with intestinal parasites) is assumed as the main reasons for such self-medications [11, 18]. But the second part of that analysis is questionable, as the succulent rough leaves are eaten slowly as such by animals like chimpanzees have not only the property of bulk roughness but also many other medicinal activities proved in some other research (for example: plants like *Aspilia mossambicensis* (Oliv.) Wild. have other proven activities like anti-malarial, anti-microbial, etc., though the rough nature of the leaves is only considered beneficial in some research). Both of the effects perhaps work together [18].

Different animals use succulent parts of many herbs to prevent or cure parasitic infestations as well as many parasitic diseases. Some of such uses are almost copied by rural people living nearby. This area is perhaps not properly explored but some such evidence is already identified. One such report is the use of the root of the plant *Aeschynomene cristata* Vatke var. *cristata* [Fabaceae] to cure dysentery (of both protozoan and bacterial origin) by some tribal people was started in a part of Africa after observing such use by porcupines living in the nearby forest [16].

A total of sixty-four (64) such plants are identified through a literature survey. Details of the plant species with Family, part of the plants used, and species of the animal that use them as a part of their self-medication are displayed along with the individual reference of the information in tabular form (Table 1).

USE OF THE KNOWLEDGE OF ANIMAL SELF-MEDICATION FOR BENEFIT OF THE MANKIND

It is assumed that the herbs used in self-medication by great apes like chimpanzees have a strong probability to be equally medicinally effective for humans also, as the chimpanzee, bonobo, and human have 98.7 percent genetic similarity [19]. It is also observed that there are strong similarities in the plants they use for the treatment of similar problems in many parts of rural Africa where they live nearby [20]. But all such uses are limited among the tribal or forest living communities, and in some cases, among some rural people residing in the surrounding areas. There are many similar or related types of use of such knowledge found among the people living in some other parts of the world also.

In some cases, people of some small part of a country use such knowledge for their health benefits, but the application of such knowledge is perhaps not felt as important by the researchers for their widespread use, which may be due to the reason that these are not considered as any potential subject leading to drug development and marketing [21, 22]. However, it is a potential area for the identification and widespread use of some very important medicines.

Use of the dry powder of caterpillar moths (Family: Hepialidae) with *Cordyceps sinensis* for various health benefits is in practice among some native people living in Sikkim of the Himalayan region after getting the knowledge from the yak [9], but efforts for widespread use of such knowledge is lacking.

It is time to consider the widespread use of such knowledge for the benefit of mankind.

Many incomplete reports of self-medication by the animals are also found. Use of plants like *Ligusticum porteri* Coult. & Rose [Apiaceae] (insect repellent), *Azadirachta indica* A. Juss., [Meliaceae] (insecticide), *Caesalpinia pulcherrima* (L.) Sw. [Fabaceae] (in Malarial fever) etc. are some examples [23].

LIMITATION OF CONTEMPORARY RESEARCH: FAILURE TO ANALYSE THE EFFICACY OF SUCCULENT BIOMEDICINES

The animals (even the species close to humans) are generally accustomed to using all self-selected biomedicines in their naturally available form - at their succulent state, principally collecting from living plants. As they are adapted to getting their energy from alike food materials, so availability of the medicinally active phytoconstituents and micronutrients by digestion of these raw herbal medicines is not at all a problem to them [24, 25].

Human beings also eat many such biomedicines in their succulent form without knowing them as some medicines (as most of the edible succulent fruits, spices, and vegetables as salads, etc.). Many other phytomedicines can be eaten at their succulent state by the human at their medicinal doses for various important health benefits. Many of our known spices, uncommon fruits, vegetables, etc. fall under this category [24, 25].

Table 2. Required conceptual shifting of study for validation of medicines for development of succulent biomedicines [21].

Presently practiced pattern followed for development of modern medicines from herbal source:
Diluent extraction/ chemical extraction from dry plant parts, other sources → active ingredient isolation → structural analogue manufacturing → safety and efficacy study → proceeding towards the development of marketable medicines.
↓ Shifting
A new pattern may be followed for Succulent bio-medicines:
Succulent biomedicines → *in vivo* and/or in-patient study for validation of efficacy → dose and safety study → chemical composition analysis (if not already known) → proceeding towards the development of marketable medicines by bio-encapsulation.

Table 3. Production and transport of proposed succulent biomedicines [22].

Identification of the effective plants to get succulent biomedicines for the intended purpose/es
↓
Validation of reported activities of the medicinal plant/ plant parts by *in vivo* models or directly on patients
↓
Standardization of dose and measurement of toxicity level, mainly on models or by using animals
↓
Preparation of database about the main phyto-constituents present in plant parts and preparation of a standard chart of it from the available resources for each effective plant medicines
↓
Standardization of packaging related parameters like bio-preservatives, bio- encapsulation, spoilage indicator, etc. for each medicine
↓
Planning for production of the medicines at a large scale
↓
Cultivation of plants in their near-natural environment and soil
↓
Collection of succulent pant parts/fruits/dry seeds, etc.
↓
Quality testing and calculation of quantity per dose by measuring main constituents available in each lot/ batch of raw materials by comparing with standard chart and then mixing of raw materials of different sources as per the requirement
↓
Preparation of pulp-paste or extraction of juice of succulent plant parts or fruits/ preparation of powder of dry seeds, etc.
↓
Concentration or dilution of the pressure extracts (juice)/ mixing of a few biomedicines together/ making block or capsule of powders prepared from the dry biomedicines/ addition of the bio-vehicle/s with the medicines, etc. (as per requirement)
↓
Addition of bio-preservative/ bio-coating in/on the biomedicines (as per requirement)
↓
Encapsulation of the medicine (pulp/juice/powder etc.) inside digestible/ harmless biological capsular materials for oral use
↓
Addition of spoilage indicator/s on the packets of the biomedicines (as Vaccine Vial Monitor chemicals)
↓
Transportation through the cold chain (at different temperatures at different stages) up to the patient level
↓
Intake of the biomedicines at encapsulated condition or after removal of covering and bringing the temperature of the medicines near to 25°C just before use by use of warm water, etc.

However, there are problems in the validation of reported activities of such raw, succulent herbal biomedicines, as almost all of our analytical systems are developed for laboratory-synthesized medicines [26].

Presently, either the dry part of the medicinal plants (in Ayurveda and similar systems) or the alcoholic extracts of such dry parts (as Homoeopathic medicines) are used as some medicines. In Modern medicine, the active principles are identified from the diluents extracted section of the dry parts of the medicinal plants to synthesize them artificially in the laboratory (synthesis of structural analogs) and then to market them commercially, if proven to be effective and non-toxic [27, 28, 29]. Many of the effective principles available in the succulent state of these biomedicines are not accessible in Ayurveda or Homoeopathy and also are not identified in the contemporary drug discovery research of Modern medicine. Also, for not giving any importance to the cumulative effects of all available phytoconstituents of a medicinal plant part present only at their succulent state, the present concept of validation of the efficacy of ethnomedicines is facing the criticism of performing only partial study [27, 30].

It is argued that the parts of the medicinal plants used for human treatment by the rural people, used in alternative medicines, or having the ability to be effective in human treatment should also be studied for their efficacy in their nature-gifted state (at their succulent stage) as they contain the complete set of phytoconstituents in that state only [24, 25].

There were perhaps problems like all-season unavailability of all the succulent biomedicines and the chance of spoilage of the stored biomedicines at their succulent forms in the ancient days of human civilization. Easy preservation and use of the dry parts of the medicinal plants throughout the year having at least partial efficacy was perhaps the main force behind the practice of the use of dry parts of the plants in all the systems of medicine. Later, all the studies are pointed only towards validation or use of dry parts of the medicinal plants perhaps due to that reason [28, 31].

The knowledge of the use of anti-parasitic succulent biomedicines used as a part of self-medication among animals may be used as some effective medicines for both humans and animals.

SUCCULENT BIOMEDICINE CAPSULE–A NOVEL FORM OF HERBAL MEDICATION

Like commonly eaten succulent fruits, parts of various medicinal plants can be used for therapeutic purposes in their succulent state. The so-called toxic plants may be some good medicines at some lower doses [26].

Many of the succulent plant parts are generally used in some medicines either by different animals (like bitter piths of *Vernonia amygdalina* by the great apes) or by the ethnic and rural people or already listed in the ancient texts of older medicine systems. All of these may be used as effective biomedicines to prevent and cure many dangerous or hard-to-cure diseases, as considered in Modern medicine.

Some plants are selected to prevent, cure, and reduce the severity of many diseases, such as viral diseases like Covid 19 [21], to control Type 2 diabetes [22], cancers [26], etc. The immune modulation by different anti-oxidation and other activities along with disease-specific effects can reduce the chance of expression of many other diseases without any extra medication that can be performed by using such succulent biomedicines [25]. Some pieces of literature are available with a basic layout plan for the production of such succulent biomedicines in capsular form [21, 22]. However, a flow chart for the required shifting of contemporary research concepts for the preparation of these biomedicines is displayed (Table 2) and another flow chart displaying the main points of production and use of the biomedicines is also added (Table 3).

CONCLUSION

In the era of the development of resistance of parasites to different synthetic anti-parasitic drugs, the use of nature-derived succulent biomedicines with cumulative effects of a huge number of active phytoconstituents together (with different types of the mechanism of activities individually) to perform the desired effect may be very fruitful thinking. A thorough study of self-medication of animals (*in situ*) may enrich the present knowledge status further and can provide new insight into dealing with the infections of invading parasites. The use of effective medicinal plant parts in their succulent, encapsulated form may be a new tool to combat many so-called hard-to-cure diseases.

REFERENCES

[1] Glander KE. Nonhuman primate self-medication with wild plant foods. In: NL Etkin (ed.), Eating on the wild side: the pharmacologic, ecologic, and social implications of using noncultigens. Tuscon: University of Arizona Press. 1994; 239-256.

[2] Huffman MA. Current evidence for self-medication in primates: A multidisciplinary perspective. Yearbook of physical anthropology. 1997; 40: 171-200. Wiley-Liss, Inc.

[3] Piel A, Stewart F. What Chimpanzees know about giving medicine. https://www.sapiens.org/biology/chimpanzees-self-medication-wound/, 2022; downloaded on 12.06.2023.

[4] Huffman MA, Wrangham RW. The diversity of medicinal plant use by chimpanzees in the wild. In: Wrangham, RW, McGrew WC, deWaal FB, Heltne PG (eds.), Chimpanzee Cultures, Harvard University Press, Cambridge, MA. 1994; 129-148.

[5] Hawley J. Meet the animals that self-medicate. https://www.discovermagazine.com/planet-earth/meet-the-animals-that-self-medicate. 2021; downloaded on 05.06.2023.

[6] Shurkin J. News feature: animals that self-medicate. Proceedings of the National Academy of Sciences. 2014; 111(49): 17339-17341, www.pnas.org/cgi/doi/10.1073/pnas.1419966111.

[7] Ogilvie GH. Bison eating bark. J Bombay Nat Hist Soc. 1929; 33: 706-707. Cited by: Huffman MA. (2003) Animal self medication and ethnomedicine: exploration and exploitation of the medicinal properties of plants. Proc Nutri Soc. 2003; 62: 371-381, DOI: 10.1079/PNS2003257.

[8] Janzen DH. Complication in interpreting the chemical defense of tree against tropical arboreal plant eating vertebrates. In: The ecology of arboreal folivores. 1978; 73-84. Washinghton DC, Smithsonian Institute Press. Cited by: Huffman MA. Animal self medication and ethnomedicine: exploration and exploitation of the medicinal properties of plants. Proc Nutri Soc. 2003; 62: 371-381, DOI: 10.1079/PNS2003257.

[9] Maity D. A study on ethnomedicinal uses of Yartshagumba, *Cordyceps sinensis* (Berk.) Sacc. (Cordycipitaceae) by the tribal communities of North Sikkim and its conservation. Explor Anim Med Res. 2013; 3(2): 95-101.

[10] Huffman MA, Vitazkova SK. Primates, plants, and parasites: the evolution of animal self-medication and ethnomedicine. In: Encyclopedia of life support systems (EOLSS), developed under the auspices of the UNESCO, 2006; Eolss Publishers, Oxford, UK, https://www.eolss.net/sample-chapters/c03/E6-79-19.pdf.

[11] Huffman MA. Primate self-medication, passive prevention and active treatment - a brief review. Intern J Multidiscipline Stud. 2016; 3(2): 1-10.

[12] Evbuomwan L, Chukwuka EP, Obazenu EI, Ilevbare L. Antibacterial activity of *Vernonia amygdalina* leaf extracts against multidrug resistant bacterial isolates. J Appl Sci Environ Manage 2018; 22(1): 17-21, https://dx.doi.org/10.4314/jasem.v22i1.4.

[13] Dharmkumarsinhji RS. Indian wild boar (*Sus scrofacristatus* Wagner) feeding on *Boerhavia diffusa* Linn. J Bombay Nat Hist Soc. 1960; 57: 654-655. Cited by: Huffman MA. Animal self medication and ethnomedicine: exploration and exploitation of the medicinal properties of plants. Proc Nutri Soc. 2003; 62: 371-381, DOI: 10.1079/PNS2003257.

[14] Hubback TB. (1939) Two horned Asiatic rhinocerous (*Dicerorhinus sumatrensis*) J Bombay Nat Hist Soc. 1939; 40: 594-617. Cited by: Huffman MA. Animal self medication and ethnomedicine: exploration and exploitation of the medicinal properties of plants. Proc Nutri Soc. 2003; 62: 371-381, DOI:10.1079/PNS2003257.

[15] Huffman MA. (2021) Folklore, animal self-medication, and phytotherapy-something old, something new, something borrowed, some things true. Planta Med. 2021; DOI 10.1055/a-1586-1665.

[16] Huffman MA. (2001) Self-medicative behavior in the African great apes: An evolutionary perspective into the origins of human traditional medicine. BioScience. 2001; 51(8): 651-661.

[17] Viegas J. Chimpanzees self medicate with food. 2011; https://www.nbcnews.com/id/wbna45484594.

[18] Krief S, Jamart A , Mahé S, Leendertz FH, Mätz-Rensing K *et al.* Clinical and pathologic manifestation of oesophagostomosis in African great apes: does self-medication in wild apes influence disease progression? J Medical Primatology. 2008; 37(4): 188-195, https://doi.org/10.1111/j.1600-0684.2008.00285.x.

[19] Gibbons A. Bonobos join Chimps as closest human relatives. 2012; https://www.science.org/content/article/bonobos-join-chimps-closest-human-relatives, downloaded on 12.07.23.

[20] Cousins D, Huffman MA. Medicinal properties in the diet of gorillas: an ethno-pharmacological evaluation. African Study Monographs. 2002; 23(2): 65-89.

[21] Pattanayak S. Anti-COVID-19 biomedicines - a layout proposal for production, storage and transportation. The Open COVID J. 2021; 1: 166-88, DOI: 10.2174/2666958702101010166.

[22] Pattanayak S. Prevention and control of diabetes by intake of succulent biomedicines and following of designed lifestyle: A ready plan for execution. Internati J Scientific Res Updates. 2022; 03(02): 81-103, https://doi.org/10.53430/ijsru.2022.3.2.0047.

[23] Jain CP, Dashora A, Garg R, Kataria U, Vashistha B. Animal self-medication through natural sources. Natural Product Radiance. 2008; 7(1): 49-53.

[24] Pattanayak S. Healthcare system using succulent parts of plants, Volume 2: Steps for production and marketing of some selected healthcare products. 2019; ISBN: 978-93-5391- 625-1.

[25] Pattanayak S. Succulent biomedicines - an effective way of getting protection against diseases through immunomodulation. Explor Anim Med Res. 2020; 10(2): 112-123.

[26] Pattanayak S. Anti-cancer plants and their therapeutic use as succulent biomedicine capsules. Explor Anim Med Res. 2023; 13(Ethnomed. Spl.): 01-50, DOI: 10.52635/eamr/13(S)01-50.

[27] Pattanayak S. Healthcare system using succulent parts of plants, Volume I: For infectious diseases. 2019; ISBN: 978-93-5346-842-2.

[28] Pattanayak S. Plants in healthcare: past, present and future. Explor Anim Med Res. 2021; 11(2): 140-144, DOI: 10.52635/eamr11.2.140-144.

[29] Pattanayak S. Research targeting business profits: impacts on health and environment. Explor Anim Med Res. 2022; 12 (1): 1-7, DOI: 10.52635/eamr/ 12.1.1-7.

[30] Pattanayak S, Mandal TK, Bandyopadhyay SK. Validation and therapeutic use of succulent plant parts - opening of a new horizon of alternative medicine. Explor Anim Med Res. 2016; 6(1): 8-14.

[31] Pattanayak S. Alternative to antibiotics from herbal origin - outline of a comprehensive research project. Current Pharmacogenomics Personalized Medic. 2018; 16: 9-62, DOI: 10.2174/1875692116666180419154033.

[32] Clark L, Mason JR. Use of nest material as insecticidal and anti-pathogenic agents by the European Starling. Oecologia. 1985; 67(2): 169-176, DOI: 10.1007/BF00384280.

[33] Costa-Neto EM. Zoopharmacognosy, the self-medication behavior of animals. Interfaces Científicas - Saúde e Ambiente, Aracaju. 2012; 1(1): 61-72.

[34] Karban R, English-Loeb G. Tachinid parasitoids affect host plant choice by caterpillars to increase caterpillar survival. Ecology. 1997; 78(2): 603-611, https://doi.org/10.1890/0012-9658.

[35] Choda U. Medicinal value of *Cordyceps sinensis*. Transl Biomed 2017; 8(4): 132.

[36] Huffman MA. Animal self medication and ethnomedicine: exploration and exploitation of the medicinal properties of plants. Proc Nutri Soc. 2003; 62: 371-381, DOI: 10.1079/PNS2003257.

[37] Chukwujekwu JC, Lategan CA, Smith PJ, Van Heerden FR, Van Staden J. Antiplasmodial and cytotoxic activity of isolated sesquiterpene lactones from the acetone leaf extract of *Vernonia colorata*. South African J Botany. 2009; 75(1): 176-179, https://doi.org/10.1016/j.sajb.2008.10.001.

[38] Ndungu JM. Phytochemical screening and antimicrobial assay of *Vernonia hochstetteri*. Project submitted in the Jomo kenyatta university of agriculture and technology, Kenya. Downloaded on 11.11.2023.

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