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Review

Prospects for Harnessing the Rich Diversity of Phytochemical Anti-Tick Agents in Africa for the Development of Natural Acaricides

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Abstract

This review aims to highlight the rich biodiversity of plants with acaricidal properties in Africa and the potential for harnessing them for the development of eco-friendly acaricides. Terrestrial plant-derived bioactive substances hold huge potential as cost-effective and eco-friendly insecticides that can serve as a suitable alternative to chemical pesticides. Ticks and tick-borne diseases (TTBDs) constitute a serious challenge to animal and human health globally, necessitating the need for effective control measures. However, the use of chemical acaricides, the mainstay of tick control, is no longer sustainable due to the development of multiple acaricide resistance, economic constraints, and environmental and public health concerns, necessitating the exploration of phytochemical acaricides as a viable option. In Africa, the rich plant biodiversity remains largely underexplored and underutilized for TTBDs control. Our bibliographical review identified 144 plant species from 48 families across 27 African countries that have been assessed in various in vitro assays. These studies report that these plant species possess phytochemicals with acaricidal properties, causing over 50% mortality or repellency on various tick developmental stages. Plant species belonging to the Asteraceae (n = 23), Lamiaceae (n = 17) and Fabaceae (n = 11) from several African countries were reported to possess effective anti-tick properties. Bioactive substances and essential oils, such as the tannins, flavonoids, steroids, terpenoids, camphor, camphene, 1,8-cineole (eucalyptol), alpha-pinene and more were the most frequently isolated compounds, attesting to the rich biodiversity of plants possessing phytochemicals with strong prospects for use in tick control. Despite these encouraging findings, none so far has been translated or formulated into an anti-tick product for commercial use. Therefore, we advocate for robust continental and regional collaborations to coordinate the bioprospecting of anti-tick ethnobotanicals, ultimately leading to the development of cost-effective and eco-friendly natural products for tick control.

Keywords: ticks; phytochemical; acaricide; bioprospecting; Africa

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1. Introduction

The use of ethnobotanicals for livestock tick control is gaining prominence globally due to some challenges associated with most of the currently existing control methods [1,2]. Particularly, the use of chemical acaricides is no longer reliable as a result of resistance

development, costs, and human and environmental bio-safety concerns [2,3]. This is particularly critical in Africa, where cost and inadequate veterinary care preclude the responsible use of chemical acaricide on most occasions. Ticks (Acari: Ixodidae) are ectoparasites of animals and man that cause damage to animal health and products, leading to colossal loss, thereby affecting food security, threatening the socio-economics and livelihood of resource-constrained farmers, and consequently impeding the progress towards the realization of the Sustainable Development Goals (SDGs) 1, 2 and 3 [4–6]. Furthermore, ticks are increasingly incriminated in hosting and modifying the pathogenicity of some organisms, leading to emerging and re-emerging vector-borne diseases with dire veterinary and public health implications [7,8]. Consequently, the scale of impact of ticks and tick-borne diseases on the livestock industry and human health in Africa is enormous and remains a formidable obstacle to profitable livestock production, necessitating the search for alternative, cost-effective and eco-friendly tick control methods. A viable option worth exploring in Africa is the development and commercialization of plant-derived acaricides.

Plants are reputed to secrete bioactive compounds of diverse chemical structures and mechanisms of action that can act against the different developmental stages in the tick's life cycle with deleterious effects resulting in either mortality, reduced fecundity, egg hatchability or repellency [9–13]. Studies conducted on phytochemicals extracted from several plant species in Africa have reported encouraging acaricidal effects with the potential for use as novel products singly or as adjuncts to chemical acaricides [9–13]. It is encouraging that some of the group of compounds, including but not limited to eucalyptol, estragol, trans-anethole, p-cymene, palmitic acid, 10-undecynoic acid, α-Pinene, β-pinene 1,8-cineol, camphor, linalool, terpinene-4-ol, α-terpinol, and β-thujone obtained from plants in Africa, belong to a similar chemical category with products already being used in the development of natural acaricides in other continents [14]. However, a major setback to most of the results derived from the African studies is the insufficient data on the active ingredients and their mechanism of action [6,15]. Therefore, it is imperative to conduct in-depth bio-prospecting studies to identify, isolate and characterize some of the active ingredient(s) with high acaricidal properties. This will require the use of high-throughput technologies to predict pharmacological targets and assist in the determination of the possible mechanisms and interactions between the different phytochemicals of desired acaricidal properties. Undoubtedly, the development and use of such products will assist in overcoming some of the current challenges associated with chemical acaricides, especially in developing countries where costs and insufficient veterinary regulation constitute a bottleneck for effective tick control in livestock [2,16]. Additional impetus for the exploration and development of plant-based acaricides in Africa is the predominant tropical climate that favors the production of diverse plant families. Sustainable and continuous supply of large quantities of plant biomass needed for the extraction of phytochemicals is a critical consideration for most investors in the pharmaceutical industry. Interestingly, Africa was the leading producer of pyrethrum (*Tanacetum cinerariifolium*, Asteraceae) for insecticide production, supplying about 90% of the global requirement in the twentieth century [17]. Similarly, many other plants such as neem (*Azadirachta indica*, Meliaceae) are widely grown in most of Africa, not only for their medicinal properties but for shade, firewood, among others, which makes them readily available and cheap [18]. Taken together, it is obvious that Africa possesses an ample supply of untapped plant resources of medicinal value worth exploring. This review focuses on bioactive plant substances used for the control of hard ticks (Ixodidae) in Africa using a narrative approach. It provides up-to-date information on phytochemical acaricides research conducted in Africa and highlights the prospects for harnessing the diverse bioresource for the development of cost-effective, eco-friendly plant-based acaricides on a commercial scale. We aimed to unravel the range of bioactive

substances with reported acaricidal properties obtained from diverse plant species in Africa and to highlight the prospect for the development and production of plant-based acaricides on the continent for sustainable tick control measures.

2. Materials and Methods

We conducted a sequential bibliographical search of online databases-Google Scholar, ScienceDirect, PubMed, African Journals online, and Scopus without date restriction for publications in the English language using the search terms: livestock ticks PLUS [phytochemicals, ethnoveterinary plants, bioactive substances, plant acaricides, ethnobotanical anti-ticks, plant tick repellency and acaricidal plants, up to 30 September 2025]. Published literature was screened for appropriate information that included the relevant terms either in the keywords, title, abstract or text. We used the following inclusion and exclusion criteria to screen the title, abstract and the full-text materials: articles on the in vitro or in vivo use of ethnobotanicals for the control of ixodid ticks of domestic livestock in any African country and published in the English language were included. Exclusion criteria include the use of ethnobotanicals on other ecto-parasites such as lice or mites. No date restrictions were applied.

3. Results

Our bibliographic search revealed encouraging reports of the anti-tick efficacy of phytochemicals in several African countries (Figure 1, Table 1). Overall, we identified various studies involving over 144 plant species from 48 families across 27 African countries that have been assessed in various assays. These studies report that the plant species possess phytochemicals with acaricidal properties, causing over 50% mortality or repellency on various tick developmental stages. The studies were conducted on ticks belonging to the genera *Amblyomma*, *Hyalomma*, *Rhipicephalus* and the subgenus *Boophilus*, all reputed as pests of veterinary and public health importance globally. The results showed inconsistencies in the approaches employed in the various studies, such as the sample size, extraction methods, acaricide efficacy evaluation, tick species and developmental stages and animal hosts, resulting in knowledge gaps, which preclude the generalization of the results and their applicability across the continent. Most of the studies used in vitro assays, including the larval packet test, adult/larval immersion tests and their modifications. Similarly, the extraction methods and solvents, as well as the parts of the plants used, differed among the studies. These differences notwithstanding, plant species belonging to the Asteraceae (n = 23), Lamiaceae (n = 17) and Fabaceae (n = 11) from several African countries were the most commonly reported to possess effective anti-tick properties (Figure 1). Bioactive substances and essential oils, such as the tannins, flavonoids, steroids, terpenoids, camphor, camphene, 1,8-cineole (eucalyptol), alpha-pinene, etc., were the most frequently isolated compounds, attesting to the rich biodiversity of plants possessing phytochemicals with strong prospects for use in tick control (Table 1). The mass of data garnered from these studies indicates a progression in the search for alternative tick control methods on the continent. There have been improvements from the initial application of crude extracts based on oral traditions to scientific approaches to validate the efficacy of extracts before field trials. However, we observed that the focus of most of the studies was the short-term benefits of using the bioactive substances in the control of tick infestations in livestock. Most of the studies conclude with the publication of promising results without exploring the long-term potential of translating these findings to commercial product development.

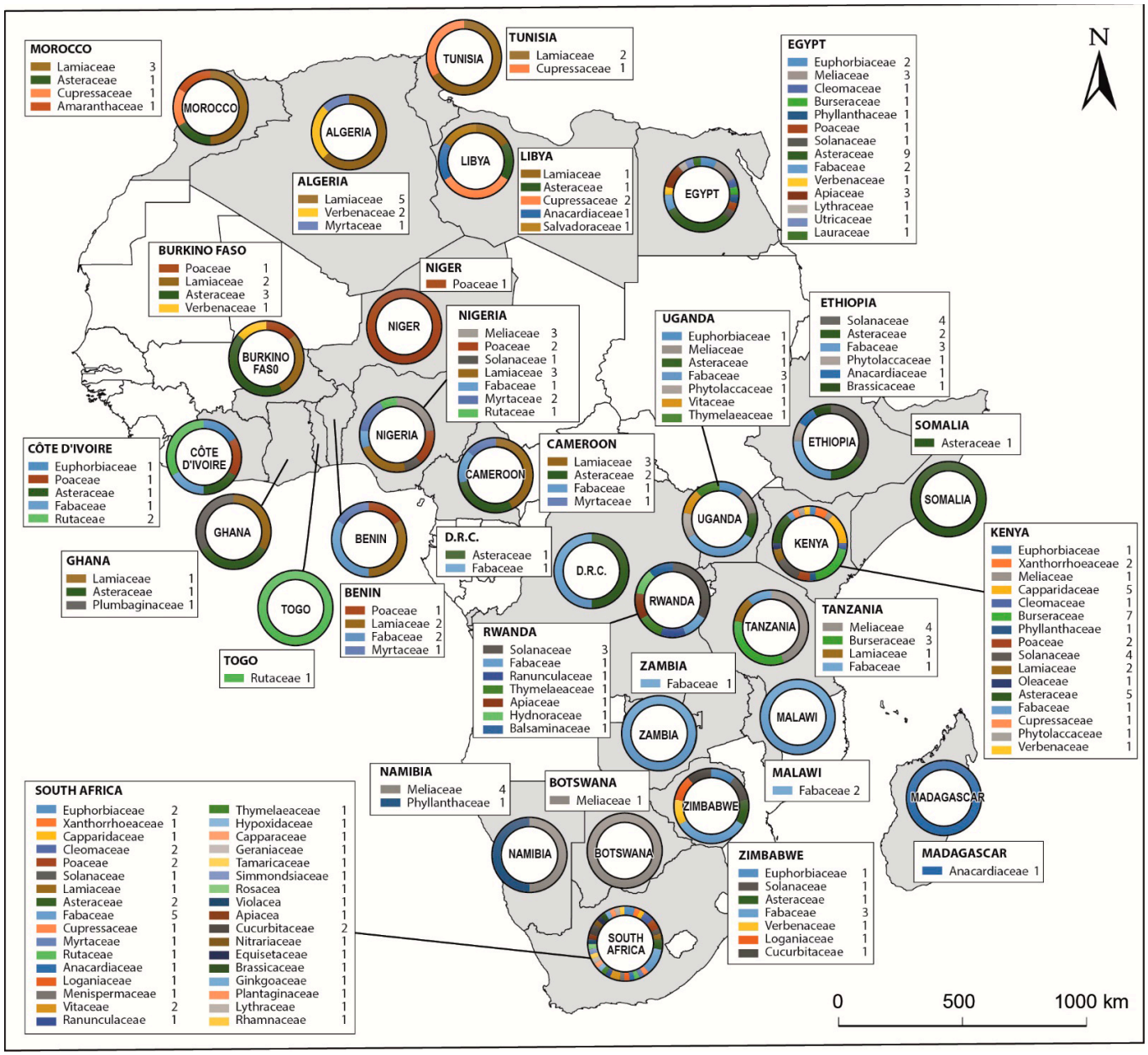


Figure 1. African countries showing plant families with reported phytochemical acaricidal properties.

4. The Use of Ethno-Botanical Acaricide in Africa

The climatic and environmental conditions in Africa favor the survival and proliferation of arthropod vectors, with a negative impact on the predominantly traditionally managed livestock population [5,19,20]. Hence, the use of phytochemicals by local farmers for the control of ectoparasites in man and animals dates back to antiquity [15,21,22]. Traditional practices among local livestock farmers involve the use of whole plants or various plant parts, either fresh or dried, that were formulated into various forms and used for tick control in livestock. They are applied as a spray, wash, or to produce smoke to repel or kill ticks attached to the animals. Common examples include the use of *Azadirachta indica* (neem), *Chrysanthemum* spp., *Nicotiana* spp., *Solanum* spp., *Gynandropsis gynandra*, *Melinis minutiflora*, *Stylosanthese* sp. and *Cassia absus*, among other for to induce tick mortality or repellency [17]. Interestingly, in vivo trials using extracts from some plants such as *Trephosia vogelii*, *Chromolaena odorata*, *Nicotiana tabacum*, *Azadirachta indica*, etc., were effective in reducing tick infestation on livestock. Furthermore, available records of ethnob-

otanical veterinary knowledge and a checklist of traditional tick control practices in Africa strongly indicate the existence of plant-based acaricides from the rich floral biodiversity on the continent [23]. Suffice it to postulate that 'Nature' must have graciously bequeathed the continent with arrays of natural resources to contend with the myriad of challenges posed by TTBDs to profitable livestock production. This can further be buttressed by the number of plants and plant-derived products reputed to possess anti-tick properties reported from across the continent (Table 1). The results from the African studies showed that the acaricidal/repellent activities of these plants were attributed to some bioactive substances and essential oils such as the tannins, flavonoids, steroids, terpenoids, camphor, camphene, 1,8-cineole (eucalyptol), and alpha-pinene [24–26]. Even though the mode of action of most of the phytochemicals in the studies was not fully elucidated, they were reported to induce acaricidal effect against various tick developmental stages with comparative or superior efficacy to commercially available synthetic acaricides [10,27–29]. More studies to isolate and characterize the active ingredients and to determine their mode of action are needed to address this knowledge gap.

Furthermore, climatic factors and soil type are reputed to influence the quality and quantity of bioactive constituents of plants, but the consistent efficacy results obtained from these plant families originating from different ecological zones of Africa suggest that they possess potential for use as effective tick control if properly explored and developed. Therefore, these plant families are potential lead candidates for bioprospecting and subsequent development of natural tick control products. The limitations of these studies notwithstanding, the groundwork has been laid, and these reports constitute an invaluable database for charting a guided bioprospecting agenda for the development of a cost-effective and eco-friendly phytochemical acaricide (Figure 2). More than the terse statement on *Artemisia annua* in the Chinese traditional medicine records, which guided scientists into the isolation of 'qinghaosu' and the subsequent development of artemisinin for the treatment of malaria, the research results on phytochemicals in Africa are clear indications as to the availability of potential natural solutions for tick infestations. Already, a body of databases on ethnobotanical acaricides has been generated from preliminary works, but, in their present state, they are more of academic upshots with little to no benefits to the farmers [17]. Notwithstanding, the efforts are commendable considering the dearth of research funding and resource constraints prevalent on the continent. However, the impetus to progress beyond the current station to the subsequent stages outlined in Figure 2 is required. This will demand a shift in focus from the "research for publication" to "research for product development". Prospectively, a conscientious, organized and systematic in-depth analysis to identify, isolate, characterize and harness the available resource for the development of cost-effective natural products for tick control is necessary. This will entail the involvement of key actors in a coordinated, multi-disciplinary, inter-sectoral and inter-governmental collaboration with the support of local and international funders (Figure 2). It is encouraging to note that similar strategies were adopted in the past with success in Europe, America and China that culminated in the development of quinine, chloroquine and artemisinin; plant derivatives with life-saving impact globally [30–32]. Additionally, plant-based products with therapeutic effects against several human, animal and plant diseases have been developed, commercialized and deployed across the globe [15,17,33]. Currently, natural products are popular, economical and eco-friendly and align with the current drive for Green Technology [33]. This is a testament to the feasibility of tapping into the rich floral diversity in Africa for the development of natural acaricide products. However, beyond establishing the acaricidal properties of these plants, additional data on toxicity, mode of action and characterization of active components are required. Therefore, elaborate studies to elucidate the potential toxicity of plant extracts to

livestock, humans, or beneficial non-target organisms are needed in line with the Ecohealth and Green Technology policies. Such data will be invaluable to regulatory agencies to ascertain product safety before approval for commercialization. But, the state of infrastructure, laboratory equipment, scientific expertise and paucity of funds are critical issues that deserve urgent attention in order to create an enabling environment for standardized bioprospecting research and subsequent product development in Africa [34,35].

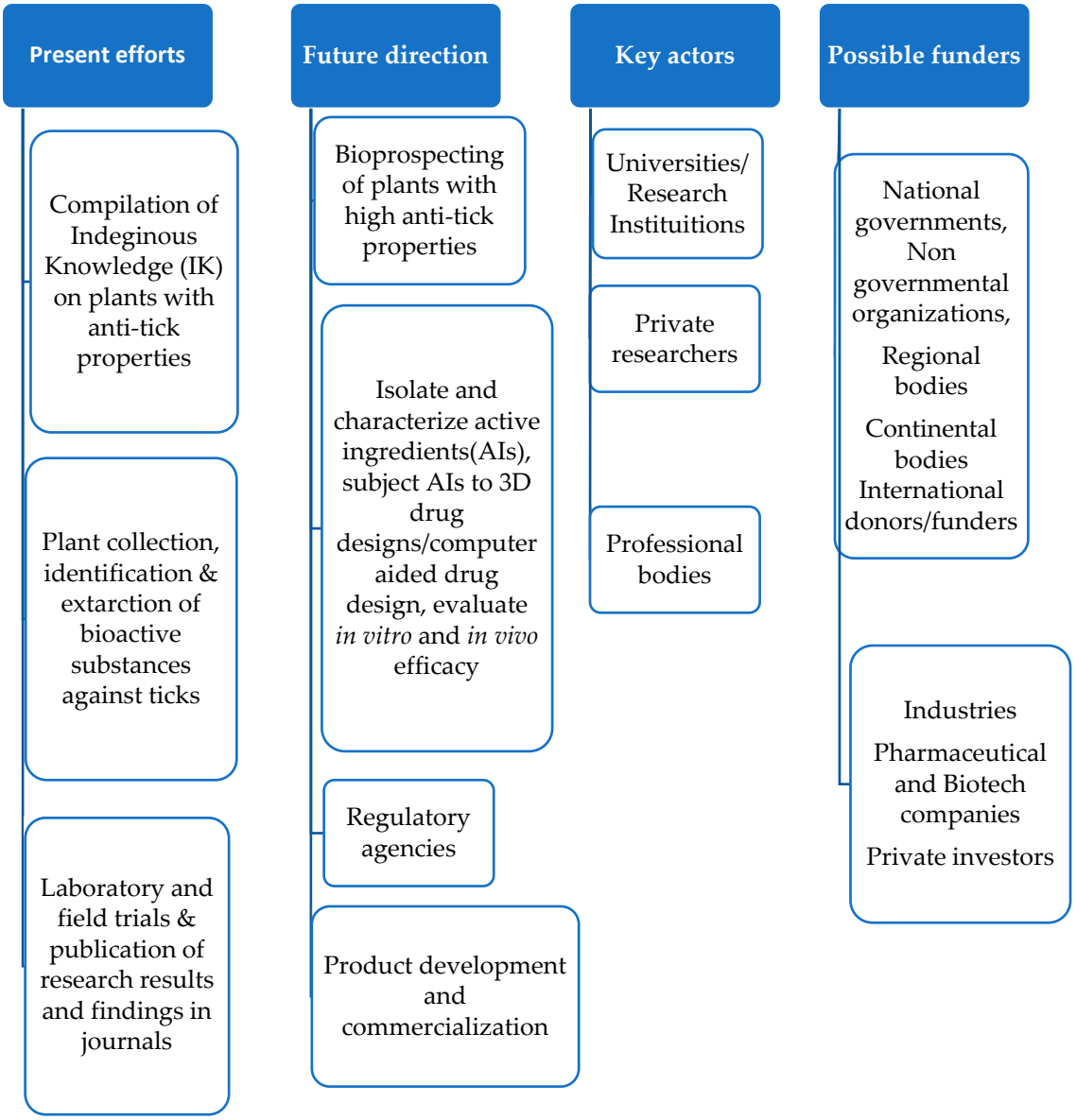


Figure 2. Prospects for a multi-tier approach for the development of plant-based anti-tick products from Africa.

A major limitation with the existing practices for the application of phytochemicals for tick control by local farmers is the lack of standardized procedures for extraction, formulation, dosage, method and duration of application to the animals. Furthermore, there is a paucity of information on storage conditions, stability and shelf-life of these products. This is further complicated by the unconventional practices inherent in the traditional animal husbandry practices prevalent in Africa [36]. Taken together, more studies are needed to address some pertinent issues related to the prevailing livestock

rearing in Africa in conjunction with farmer education to effectively harness the huge plant anti-tick potentials for practical field application.

Table 1. Inventory of plants with acaricidal properties in Africa.

Family	Plant Species	Plant Part(s) Used	Active Ingredient(s)	Tick Species Investigated	References
1. Astereceae	*Psiadia punctulata*	Whole plant	NA	*R. appendiculatus*, *R. evertsii*, *R. decoloratus*, *A. variegatum*	[37]
	Tagetes minuta	Aerial parts	Essential oils such as cis-ocimene, dihydrotagetone, piperitonone, trans-tagetone, β-ocimene, 2-methyl-2-butenyl	*R. appendiculatus* *H. rufipes*	[38,39]
	Tithonia diversifolia	Aerial parts	α-pipene, β-pipene, isocaryophyllene, nerolidol	*R. appendiculatus*	[39]
	Francoeuria crispa	Aerial part	Essential oils	*H. dromedarii*	[40]
	Solanecio manii		NA	*R. appendiculatus*	[39]
	Ageratum houstonianum	flowers	Essential oils	*R. lunulatus*	[41]
	Chromolaena odorata	Aerial parts	Essential oil (bicyclogermacrene)	*R. lunulatus*	[42]
	Artemisia herba-alba	Fruits/Aerial part	Essential oils, alcohol extracts	*H. dromedarii*	[40,43]
	Artemisia herba-alba	Aerial part	Essential oils such as oxygenated monoterpenes, camphor, cis-thujone, monoterpene hydrocarbons	*H. eagyptium*	[9]
	Artemisia monosperma	Aerial part	Essential oils	*H. dromedarii*, *A. persicus*	[40]
	Artemisia herba-alba	Leaves	Piperitone, ethylcinnamate, camphor, hexadecanoic acid	*I. ricinus*	[44,45]
	Artemisia judaica	Leaves, flowers, fruit, seed	Terpenoids, steroids, flavonoids, phenylpropanoids, benzenoids	*H. longicornis*	[46]
	Calendula officinalis	flowers	α-cardinol, carvone	*I. ricinus*	[44]
	Conyza dioscoridis	leaves	α-cardinol, hexadecanoic acid	*I. ricinus*	[44]
	Matricaria recutita	flower	NA	*I. ricinus*	[44]

Table 1. *Cont.*

Family	Plant Species	Plant Part(s) Used	Active Ingredient(s)	Tick Species Investigated	References
1. Astereceae	*Silybum marianum*	Aerial part	Essential oils	*B. annulatus*	[40]
	Vernonia amygdalina	Fresh leaf	Saponin, tannin, flavonoids	*B. decoloratus*, *R. pulchellus*	[27,47]
	Vernonia amygdalina	Fresh leaf	Saponin, tannin, alkaloids	*R. appendiculatus*	[11]
	Kleinia sp.	Leaf/tuber	Aqueous extract plus surfactants	*R. decoloratus*	[48]
	Ageratum conizoides	NA	Essential oils	*A. variegatum*	[49]
	Laggera aurita	NA	Essential oils	*A. variegatum*	[49]
	Leggera oloptera	aerial parts	tannins, coumarins, alkaloids, flavonoids, terpenes and sterols.	*R. microplus*	[50]
	Tithonia diversifolia	leaves	NA	*R. microplus*	[51]
	Chromolaena odorata	Fresh leaves	NA	*R. microplus*	[52]
2. Fabaceae	*Senna didymobotrya*	Aerial parts	NA	*R. appendiculatus*	[39]
	Senna italica	Root, leaves, fruits	alkaloids, cardiac glycosides, flavonoids, phenols, saponins, steroids, tannins, and terpenoids	*R. microplus*, *H. marginatum*	[28,53]
	Tephrosia vogelii	Leaf, root, pod, seed	Tannins, alkaloids, terpenoids, flavonoids, catechol, polyterpenes, sterol, leuco-anthocyanes, saponosides, rotenone	*R. lunulatus*, *R. appendiculatus*, *R. sanguineus*, *R. microplus*	[11,29,54–62]
	Calpurina aurea	Leaves, flowers	alkaloids, cardiac glycosides, flavonoids, phenols, saponins, steroids, tannins, and terpenoids	*R. turanicus*	[28,63,64]
	Acacia nilotica	seeds	phenols, flavonoids	*H. dromedarii*	[26]
	Ceratonia siliqua	pods	NA	*H. dromedarii*	[26]
	Neorautanenia mitis	root	Neoraudiol	*R. appendiculatus*	[65,66]
	Calpurina aurea	Fresh leaves	Saponin, tannins, flavonoids, glycosides, alkaloids	*B. decoloratus*, *R. pulchellus*, *A. variegatum*	[27,67]
	Cassia didymobotrya	Whole plant	NA	*R. appendiculatus*	[68]
	Cassia abbreviata	leaves	NA	*R. decoloratus*	[48]

Table 1. *Cont.*

Family	Plant Species	Plant Part(s) Used	Active Ingredient(s)	Tick Species Investigated	References
2. Fabaceae	*Bobgunnia madagascariensis*	pods		*A. variegatum*	[57]
3. Lamiaceae	*Ocimum suave*	leaves	NA	*R. appendiculatus*, *A. variegatum*	[69,70]
	Ocimum basilicum	Leaves	Phenol, flavonoid, tannin, estragole, linalool	*H. dromedarii*, *H. scupense*	[71]
	Ocimun grastissimum	Leaves	EO such as thymol, gamma terpinene, anthocyanin, tannins, coumarins, alkaloids, flavonoids, terpenes and sterols.	*R. microplus*, *A. variegatum*	[25,49,50,72]
	Ocimum urticaefolium		Eugenol, 1-8-cineole	*R. microplus*	[29,72]
	Ocimum americanum	Hexane, ethanol	Tannin, alkaloids, coumarins		[50]
	Clerodendrum glabrum	leaves		*R. appendiculatus*	[73]
	Hoslundia opposita	leaves	Ursolic acid	*A. variegatum*	[39]
	Hyptis suaveolens	leaves	Tannin, flavonoid, anthocyanins	*R. sanguineus*, *A. variegatum*, *R. microplus*	[25,29,74]
	Hoslundia opposita	leaves	Ursolic acid	*A. variegatum*	[75]
	Menthe suaveolen subsp. *timija*	Aerial parts	Oxygenated monoterpene, pulegone, methanone	*H. aegypticum*	[9]
	Satureja calamintha	Aerial parts	Menthone, Oxygenated monoterpene, pulegone, menthol	*H. aegypticum*	[9]
	Lavandula pendunculata subsp. *atlantica*	Aerial parts	Alpha-pinene, camphene, camphor, 1.10-di-epi-cubenol, Oxygenated monoterpene, monoterpene hydrocarbona	*H. aegypticum*	[9]
	Origanum majorana	leaves	4-terpineol, cis-Thujan 4-ol, delta-terpinene, linalool	*H. scupense*, *I. ricinus*	[45,76]
	Rosmarius officinalis	NA	Camphor, eucalyptol, camphene, 1,8-cineole, 1-camphor, alpha-pinene	*R. sanguineus*, *H. dromedarii*	[24,77]
	Lavandula stoechas	NA	Alpha-thujone, camphor, camphene	*R. sanguineus*	[77]

Table 1. *Cont.*

Family	Plant Species	Plant Part(s) Used	Active Ingredient(s)	Tick Species Investigated	References
3. Lamiaceae	*Origanum floribundum*	NA	Oregano, carvacrol, p-cymene, gamma-terpinene	*R. sanguineus*	[77]
	Thymus capitatus	Leaves	Carvacrol, p-cymene, delta-pinene, gamma-terpinene	*R. sanguineus*	[77]
4. Solanaceae	*Solanum incanum*	Whole plant/ fruit juice in water	Solasonine, nitrosamines, solamargine	*R. appendiculatus*, *R. everstsi*, *R. decoloratus*, *Hyalomma* spp./ *A. hebraum*	[78,79]
	Nicotiana tabacum	Fresh leaves, root methanol extract	Tannin, phenolic compounds, steroids, flavonoids, phlobotannins, alkaloids	*R. appendiculatus*, *R. everstsi*, *R. decoloratus*, *H. marginatum rufipes*, *R. sanguineus*, *R. pulchellus*	[37,66,80–82]
	Capsicum annuum	fruits		*H. dromedarii*	[26]
	Solanum dasyphyllum	Fruits, leaf, stem	NA	*R. appendiculatus*	[66]
5. Meliaceae	*Azadirachta indica*	Whole plant, leaves, fruits, root bark	Tannins, alkaloids, phlobatannins, anthraquinons, saponins, cardiaglycosides, terpenoids	*R. microplus*, *H. dromedarii*, *H. antolicum*, *A. variegatum*, *B. decoloratus*, *R. appendiculatus*, *A. hebreaum*, *H. truncatum*	[11,51,83–88]
	Turraea abyssinica	Root bark	NA	*R. appendiculatus*	[89]
	Melia volkensii	Ripe fruit	NA	*R. appendiculatus*	[89]
	Melia azedarach	Ripe fruit	Azadirachtin, triterpenoids, steroids, alkaloids and tannins.	*H. dromedarii*	[43]
6. Burseraceae	*Commiphora swynnertonii*	Gum, resin	Linaloolacetete, terpenes	*R. appendiculatus*, *A. variegatum*	[89–91]
	Commiphora erythraea	Oil	NA	NA	[92,93]
	Commiphora myrrh	Gum, resin, oil	NA	NA	[92]
	Commiphora molmol	myrrh	NA	*A. persicus*	[94]

Table 1. *Cont.*

Family	Plant Species	Plant Part(s) Used	Active Ingredient(s)	Tick Species Investigated	References
7. Poaceae	*Melinis minutiflora*	Whole plant	NA	*R. appendiculatus*, *R. microplus*	[95]
	Sorghum bicolor	Whole plant	NA	*B. annulatus*	[96]
	Cymbopogon citratus	leaves	Essential oils, saponin, tannin, flavonoids	*A. variegatum*, *H. longicornis*, *R. microplus*	[25,51,97,98]
	Cymbopogon giganteus	leaves	Essential oils	*A. variegatum*	[49]
8. Myrtaceae	*Eucalyptus globoidea*			*H.m.rufipes*	[81]
	Eucalyptus camaldulensis	Red gum	p-cymene, spathulenol, farnesol	*R. sanguineus*	[77]
	Eucalyptus saligna	Aerial parts	Essential oils (alpha-pinene)	*R. lunulatus*	[42]
	Eucalyptus globulus	Leaves, blue gum	Eucalyptol, mentol, menthone, 1,8-cineole, alpha pinene, viridiflorol,	*B. annulatus*, *A. variegatum*	[12,25,77]
	Syzgium aromaticum	Flower buds	Essential oils	*R.microplus*	[97]
9. Euphorbiaceae	*Ricinus communis*	Leaves, seeds	saponin, tannin, flavonoids, glycosides, phlobatanin	*Ixodes ricinus*, *R. appendiculatus*, *B. decoloratus*, *R. pulchellus*, *R. microplus*	[27,44,51]
	Euphorbia aegyptiaca	Aerial part	Essential oil	*H. dromedarii*	[40]
	Euphorbia hirta	Whole plant	NA	*R. appendiculatus*	[68]
	Euphorbia abovalifolia	latex	NA	*Ixodidae*	[47]
	Croton macrostachyus	leaves	tannin, flavonoids, glycosides, phlobatanin	*B. decoloratus*, *R. pulchellus*	[27]
	Monadenium lurgadae	leaves		*B. decoloratus*	[48]
10. Verbenaceae	*Lantana camara*	Aerial parts, leaves	NA	*Ixodes ricinus*, *R. appendiculatus*	[39,44]
	Lappia javanica	leaves	Apigenin, luteolin, diosmetin, isothymusin, eupatorin, genkwanin, salvigenin, xanthine	*R. evertsi*, *appendiculatus*, *Hyalomma and Amblyomma* spp.	[99]
11. Capparidaceae	*Cleome gynandra*	leaves	NA	*R. turanicus*	[63,100]
	Thylachium africanum	Aerial parts	NA	*R. appendiculatus*	[69]
	Gynandropsis gynandra	Whole plant	Essential oils	*R. appendiculatus*, *A. variegatum*	[100–102]

Table 1. *Cont.*

Family	Plant Species	Plant Part(s) Used	Active Ingredient(s)	Tick Species Investigated	References
11. Capparidaceae	*Boscia angustifolia*	Aerial parts	NA	*B. decoloratus* *Amblyomma* spp.	[103]
	Boscia mossambicensis	Aerial parts	NA	*B. decoloratus* *Amblyomma* spp.	[103]
	Cadaba farinnosa	Aerial parts	NA	*B. decoloratus* *Amblyomma* spp.	[103]
	Maerua edulis	Leaves, root, tuber	NA	*R. decoloratus*	[48]
12. Cupressaceae	*Junipeus procera*		NA	*R. appendiculatus*	[39]
	Juniperus thurifera	Aerial parts	Sabinene, monoterpene hydrocarbon, oxygenated monoterpene, limonene	*H. aegyptiacum*	[9]
	Juniperus communis	Leaves, berries	Alpha-pinene, delta-3-carene, beta-phellandrene	*H. scupense*	[76]
	Juniperus phoenicea		Alpha-pinene, beta-myrcene, beta-phellandrene. Alpha-terpinyl-acetate, germacrene	*I. ricinus*	[45,104]
	Cupressus sempervirens	leaves	Essential oils (Eicosapentaenoic acid, 10,12-Docosadiynedioic acid, 10-Undecynoic acid, Palmitic and flavonoids, tannins, and carbohydrates	*R. annulatus*	[13]
13. Rutaceae	*Haplophyllum tuberculatum*	Aerial parts	Essential oils	*H. dromedarii*, *A. persicus*	[40]
	Citrus limon	Fruit peels	Essential oils	*A. variegatum*	[25]
	Clausena anisata	Leaves	Estragol, c-cymene, alpha-pinene, transanethole, anisaldehyde	*A. variegtum*, *R. decoloratus*, *R. microplus*	[10]
	Zanthoxylum zanthoxyloides	Stem bark	NA	*R. microplus*	[61]
	Zanthoxylum rubescens	leaves	NA	*R. microplus*	[61]
14. Apiaceae	*Ammi majus*	seed	NA	*Ixodes ricinus*	[44]
	Ammi visnaga	seed	NA	*Ixodes ricinus*	[44]
	Foeniculum vulgare	seed	NA	*Ixodes ricinus*	[44]
	Apium graveolens	seed	NA	*H. dromedarii*	[26]

Table 1. *Cont.*

Family	Plant Species	Plant Part(s) Used	Active Ingredient(s)	Tick Species Investigated	References
14. Apiaceae	*Carum carvi*	seed	Phenol, flavonoids, tannins	*H. dromedarii*	[26]
	Peucedannum angolense	leaves	NA	*R. appendiculatus*	[66]
15. Anacardiaceae	*Pistacia atlantica*		Terpinene-4-ol, alpha pinene, beta-myrcene	*I. ricinus*	[104]
16. Cleomaceae	*Cleome droserifolia*	Leaves, flowers, fruit, seed	NA	*H. longicornis*	[46]
17. Xanthorrhoeceae	*Aloe secundiflora*	Whole plant	NA	*R. evertsi*, *R. decolratus*, *Amblyomma* spp.	[105]
18. Phytolaccaceae	*Phytolacca dodecandra*	leaves	Saponin, steroids, flavonoids, terpenoids	*R. appendiculatus*	[11,106]
19. Phylanthaceace	*Phyllanthus emblica*	seed	NA	*H. dromedarii*	[26]
	Margaritaria discoidea	latex	NA	*R. appendiculatus*, *A. variegatum*	[107]
20. Thymelaeaceae	*Gnidia deserticola*	Whole plant	NA	*R. turanicus*	[63]
21. Vitaceae	*Cissus quadrangularis*	stem	NA	*R. turanicus*	[63]
	Cissus adenocucaulis	Whole plant	NA	*R. appendiculatus*	[68]
22. Cucurbitaceae	*Cucurbita pepo*	Seed/peel	Phenol, flavonoids	*H. dromedarii*	[26]
23. Loganiaceae	*Strychnos madagascariensis*	leaves	NA	*R. appendiculatus*	[73]
	Strychnos spinosa	Seeds/inner soft pod	Secoiridoids, kingiside, flavonoid	*R. appendiculatus*, *R. decoloratus*, *R. evertsi*, *A. hebreum*	[79]
24. Zygophyllaceae	*Peganum harmala*	Aerial parts	Essential oils	*B annulatus*	[40]
	Balanites aegyptiaca	seeds	NA	*A variegatum*	[25]
25. Ranunculaceae	*Climatis villosa*	roots	NA	*R. turanicus*	[63,100]
	Ranunculus multifidus	fruits	NA	*R. appendiculatus*	[66]
26. Brassicaceae	*Eruca sativa*	Seeds	NA	*H dromedarii*	[26]
	Lepidium sativum	seeds	NA	*Ixodidae*	[47]
27. Lythraceae	*Lawsonia inermis*	leaves	NA	*Ixodes ricinus*	[44]
	Punica granatum	Peel	NA	*H. dromedarii*	[26]

Table 1. *Cont.*

Family	Plant Species	Plant Part(s) Used	Active Ingredient(s)	Tick Species Investigated	References
28. Menispermaceae	*Antizoma angustifolia*	roots	NA	*R. turanicus*	[63]
29. Hypoxidaceae	*Hypoxis rigidula*	bulbs	NA	*R. turanicus*	[63]
30. Capparaceae	*Maerua angolensis*	Leaves	NA	*R. turanicus*	[63,64]
	Maerua edulis	Leaves, tuber	NA	*Ixodidae*	[48,108,109]
31. Geraniaceae	*Mansonia angustifolia*	Whole plant	NA	*R. turanicus*	[63,64]
32. Tamaricaceae	*Reaumuria hirtella*	Aerial parts	Essential oils	*H. dromedarii*	[40]
33. Simmondsiaceae	*Simmondsia chinesis*	Aerial parts	NA	*B. annulatus*	[96]
34. Rosaceae	*Mespilus germanica*	leaves	Phenols, flavonoids, tannins	*H. dromedarii*	[26]
35. Violaceae	*Viola alpine*	Flowers	Phenols, flavonoids, anthocyanins	*H. dromedarii*	[26]
36. Oleaceae	*Olea europaea* subsp. *cuspidata*	Whole plant		*R. appendiculatus*, *R. decoloratus*, *R. evertsi*, and *Amblyomma* spp.	[37]
37. Nitrariaceae	*Peganum harmala*	seeds	Phenols, flavonoids, tannins	*H. dromedarii*	[26]
38. Equisetaceae	*Equisetum arvense*	Leaves	NA	*H. dromedarii*	[26]
39. Ginkgoaceae	*Ginkgo biloba*	leaves	NA	*H. dromedarii*	[26]
40. Plantaginaceae	*Plantago psyllium*	seeds	NA	*H. dromedarii*	[26]
41. Rhamnaceae	*Ziziphus spinachristi*	leaves	NA	*H. dromedarii*	[26]
42. Utricaceae	*Forsskaolea tenacissima*	Leaves, flowers, seeds	NA	*H. longicornis*	[46]
43. Hydnoraceae	*Hydnora johannis*	Whole plant	NA	*R. appendiculatus*	[66]
44. Balsaminaceae	*Impatiens stuhmannii*	leaves	NA	*R. appendiculatus*	[66]
45. Plumbaginaceae	*Plumbago zeylanica*	root	Plumbagin, beta sitosterol, stigmasterol	*A. variegatum*	[75]
46. Amaranthaceae	*Dysphania ambrosioides*	Aerial parts	Delta-3-carene, p-cymene, 1.4-epoxy-p-menth-2-ene, monoterpene hydrocarbon, oxygenated monoterpenes	*H. aegyptium*	[9]

Table 1. *Cont.*

Family	Plant Species	Plant Part(s) Used	Active Ingredient(s)	Tick Species Investigated	References
47. Lauraceae	*Laurus nobilis*	leaves	1.8-cineole, alpha-terpinyl, sabinene	*H. scupense*	[110]
48. Salvadoraceae	*Salvadora persica*		Hexenal, eucalyptol, beta-pinene	*I. ricinus*	[104]

NA = not available.

5. Prospects for the Development of Phytochemical Acaricide in Africa

Plants have and are serving beneficial purposes to man, as a source of nutrients and medicaments, among others. The current global human population explosion necessitates an urgent need for increased food production, especially that of good-quality animal protein [5,17]. This can be achieved with improved livestock production systems that ensure animal health and welfare for maximum productivity. However, in Africa, TTBDs remain a major constraint to livestock production due to the prevalent traditional production system practiced in most of the continent [5]. Conventional tick control measures are failing, and there is a need for an integrated approach that will ensure success without compromising human and environmental safety [3,16,111]. Plant-based pharmaceuticals are possible options worth exploring for tick control in Africa, considering the rich floral biodiversity on the continent [17,18]. Available data indicated that more than 144 plant species belonging to 48 plant families in Africa possess potent acaricidal properties against the various developmental stages of soft and hard ticks. These reports emanated from studies conducted in 27 countries from different regions of Africa. Indeed, phytochemicals obtained from plants of the Asteraceae, Lamiaeceae and Fabaceae were the most frequently reported to possess potent acaricidal properties. This is encouraging, because plants from these families were foremost in the manufacture of natural veterinary products already in commercial use globally [33]. Furthermore, bioactive substances and essential oils associated with the acaricidal activities of the plants studied in Africa constitute essential components of some synthetic acaricides. Thus, the prospect for the development of commercial pphytochemicalacaricides from African plants is high. At the moment, an attractive incentive to investors will be a comprehensive bioprospecting data with convincing evidence of potency, safety and cost-effectiveness that will provide justification for a profitable return on investments. This is key, and will constitute an essential first step towards the exploration of the vast floral biodiversity potentials in Africa for the development of novel and potent bioactive acaricides. However, huge investments are required to carry through with such a project [18,112]. This will require partnership and collaboration between key stakeholders in public and private sectors at local, regional or international levels to pool and match resources and expertise that will holistically upscale the bioprospecting research on the continent to provide sufficient quantitative and qualitative data that will attract investors and accomplish this noble objective [6,15,17]. Additionally, an elaborate business model with convincing success indices will be required to convince potential investors [113]. Thus, it is pertinent for professional associations and consortia working on various aspects of TTBDs control in Africa, with the full support of governments, to prioritize the development and commercialization of phytochemical acaricides. This will improve livestock production and boost the socio-economic status of livestock farmers and, ultimately, assist in achieving the SDGs 1–3.

6. Conclusions

There has been renewed interest in the use of plant extracts to control ticks and counter the intractable threat posed to livestock production by TTBDs in Africa. Several published data attest to the efficacy of phytochemicals against various tick developmental stages in in vitro studies, suggesting their potential for the development of natural acaricides. Therefore, optimizing the results of these studies for the development of cost-effective and sustainable tick control measures deserves priority attention. We propose the need for future research to prioritize isolating active compounds, elucidating their mechanisms of action, and optimizing formulations that will engender sustainable and effective tick management strategies [2]. This is feasible but requires a combined and coordinated multi-tier approach involving professionals from different backgrounds, similar to the 'Project 523' that resulted in the discovery of artemisinin, an effective anti-malaria therapy [31]. For the academic community in Africa to become relevant, the prevailing "research for publication" mentality should be changed to "transitional research for product development" for solving problems. Therefore, translating phytochemical research findings into acaricidal products in Africa is key. This is feasible, but should be pursued through multidisciplinary, regional and multi-sectoral collaborations with possible assistance from international bodies and governments.

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