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Article

Efficacy of Medicinal Plants on Gastrointestinal Parasites in Small Ruminants in Africa: A Systematic Review and Meta-Analysis Protocol

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Abstract

Gastrointestinal parasitic infections represent a critical challenge to the health and productivity of small ruminants in Africa. The extensive use and misuse of synthetic anthelmintics have accelerated resistance, necessitating sustainable alternatives such as medicinal plants. Despite increasing attention, reported efficacies of these phytotherapeutic interventions remain inconsistent. This study aims to systematically review and quantify the efficacy of medicinal plants used in Africa for controlling gastrointestinal parasites (GIPs) in sheep and goats. Specifically, it seeks to: (i) estimate pooled effect sizes of medicinal plants against GIPs, (ii) identify the most commonly used species and their administration modes, (iii) assess variations in efficacy across plant types, geographic zones, experimental designs, and host species, (iv) evaluate methodological quality and risk of bias of included studies, and (v) identify knowledge gaps and future research priorities. Following PRISMA-P guidelines, this study will perform a systematic search across PubMed, Web of Science, Scopus, ScienceDirect, CAB Abstracts, SpringerLink, Medline, Cochrane, AJOL, and Google Scholar for studies published between 1990 and 2025. Eligible studies will include randomized and non-randomized controlled trials and observational designs assessing the antiparasitic effects of medicinal plants in small ruminants. Data will be synthesized using a random-effects meta-analysis model, and methodological quality will be critically appraised with a standardized tool. This review will generate pooled efficacy estimates, provide evidence-based recommendations, and support the integration of ethnoveterinary medicine into sustainable parasite management strategies in African livestock production.

Keywords

Medicinal plants, Gastrointestinal parasites, Small ruminants, Africa, Anthelmintic efficacy

Article History

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1. Introduction

Small ruminant farming plays a crucial role in sustaining rural livelihoods worldwide, contributing significantly to food security, poverty alleviation, and socio-economic development [1]. In Africa, small ruminants represent over 30% of the total ruminant population and provide essential income, meat, and milk for millions of households [2]. However, productivity in this sector is severely hampered by gastrointestinal parasites (GIPs), particularly gastrointestinal nematodes (GINs), which are recognized as one of the most important health and production constraints in small ruminants [3]. Globally, GIPs are estimated to cause annual economic losses exceeding USD 3 billion due to reduced weight gain, lowered milk production, impaired reproduction, increased morbidity, and mortalities [4]. In sub-Saharan Africa, mortality rates in small ruminants linked to severe parasitic infections have been reported to range from 10-20% in young animals, with significant economic impacts on rural households [5,6]. For instance, prevalence rates of GIPs often exceed 70% in regions such as Ethiopia, Nigeria, and Kenya, compared to lower but still significant burdens in North Africa (30-50%) and other developing regions [7,8]. Such high morbidity and mortality levels underscore the devastating impact of these parasites on livestock productivity and rural economies.

Currently, parasite control relies heavily on synthetic anthelmintics. However, the effectiveness of these drugs is increasingly compromised by the rapid development of anthelmintic resistance. Documented mechanisms of resistance include reduced drug absorption, enhanced efflux through P-glycoproteins, modification of target receptors (e.g., β-tubulin gene mutations against benzimidazoles), and metabolic detoxification of drugs by parasites [9,10]. This resistance not only reduces treatment success but also threatens sustainable livestock production. In addition, while synthetic anthelmintics often improve productivity in the short term, their widespread misuse has raised concerns about drug residues, environmental contamination, and reduced reproductive performance of treated animals [11].

In contrast, medicinal plants offer a promising alternative due to their bioactive compounds with diverse mechanisms of action that differ from those of conventional drugs, thereby reducing the risk of cross-resistance [12,13]. Plant-based therapies have been associated with positive effects on reproductive performance, improved immunity, and overall productivity in small ruminants [14,15]. Their accessibility, affordability, and cultural acceptance further support their potential as sustainable alternatives for GIP control in Africa.

Despite growing evidence of the efficacy of medicinal plants, systematic syntheses of their effects remain limited. Globally, a few reviews have addressed plant-based anthelmintics in livestock [16-18], but these have often been narrative in nature, region-specific, or lacking quantitative synthesis. To our knowledge, no comprehensive systematic review or meta-analysis has specifically focused on the efficacy of medicinal plants against GIPs in small ruminants across Africa. This represents a critical gap, as Africa bears the heaviest burden of parasitic diseases in livestock, yet the majority of traditional knowledge and ethnoveterinary practices originate from this region.

Therefore, this protocol aims to systematically assess and quantify the efficacy of medicinal plants against GIPs in small ruminants in Africa, while also identifying patterns of use, mechanisms of action, and research gaps that can inform sustainable parasite management strategies.

2. Objectives

2.1 General Objectives

To evaluate the pooled efficacy of medicinal plants on GIPs in small ruminants in Africa.

2.2 Specific Objectives

To estimate the pooled effect sizes of medicinal plants against GIPs.

To identify the most commonly used plant species and their modes of administration.

To assess differences in efficacy across plant types, geographical zones, experimental designs, and host species.

To evaluate methodological quality and bias of included studies.

To identify knowledge gaps and research priorities.

3. Materials and Methods

3.1 Information Sources and Search Strategy

A structured literature search will be conducted following the PRISMA 2020 guidelines [19]. Studies published between January 1990 and July 2024 will be searched in multiple scientific databases: PubMed [20], Google Scholar [21], Web of Science [22], Scopus [23], ScienceDirect [24], CAB Abstracts [25], SpringerLink [26], and AJOL (African Journals Online) [27], Cochrane [28], Medline [29]. The search strategy used the following terms as Boolean operators: (“gastrointestinal parasites” OR “helminths”) AND (“medicinal plants” OR “ethnoveterinary”) AND

("goats" OR "sheep") AND ("Africa"). Only peer-reviewed studies written in English or French will be considered. Articles focusing simultaneously on multiple animal species, including but not specific to small ruminants, will be excluded. Reference lists of selected articles will be screened to identify additional eligible studies.

3.2 Eligibility Criteria

3.2.1 Study Inclusion

The inclusion criteria for study eligibility will be as follows: (1) the study must be a full-text article published in English and French, (2) the study must be a cross-sectional study and report the effect of some plants that contained some medicinal effects GIPs (number of parasites species, reduction of Egg parasites count, and Feed Conversion Ratio), and gut health in only small ruminants (sheep and goats), (3) the article which will contained other experimentation in combination with some plants as supplementary diets and must be based on the effect of medicinal plants among small ruminants, (4) All studies that will be conducted during the time frame of the years (January 1990 to July 2025) will be included. We will picked papers from 1990 to 2025 because, after 1990, all of the publications reported cases of various problems in which different plants that not contained medicinal effects will be used (Table 1). These articles will largely medicinally effects and GIPs information pieces. Other publications focused on the reasons for growth performance, hematological and biochemical parameters, carcass and body organs traits by using those plants as an additive in small ruminants' foods. *In vivo* or *in vitro* studies with quantitative outcomes (FEC, PCV, worm burden).

Table 1. Eligibility criteria for study inclusion.

Category	Inclusion Criteria	Exclusion Criteria
Population	Small ruminants (sheep, goats) in Africa	Other animal species or studies conducted outside Africa
Intervention	Use of medicinal plants or plant-based extracts as antiparasitic agents	Synthetic drugs, chemical additives, or other non-plant treatments
Outcomes	Parasite load reduction, growth performance, hematological/biochemical parameters	Studies not reporting on these outcomes
Study Design	Randomized controlled trials, cohort, case-control, and cross-sectional studies	Reviews, opinions, editorials, non-original or incomplete data
Language	English or French	Other languages (if translation not possible)
Publication	Published articles and grey literature with sufficient accessible details	Unpublished data lacking adequate methodological or result information

3.2.2 Study Exclusion

Studies will be excluded if:

- They will be published outside the time frame (January 1990-July 2025) or will be not relevant to the study scope (Table 1).
- They involved species other than small ruminants.

They addressed medicinal plants and GIPs without providing direct evidence on plant effects on small ruminants' growth performance, parasite reduction, gut health, or organ traits.

3.3 Study Records

3.3.1 Data Management and Data Collection Process

The mechanism that managed the records and data throughout the exam will be a software called Rayyan. This is a web-based software that will be manage and controls the items that will be retrieved through the databases.

3.3.2 Selection Process

Two independent reviewers will be evaluating articles for inclusion in the studies based on title and abstract. The full texts will be then retrieved and evaluated for inclusion. A third reviewer will be making the final decision in case of discrepancies.

3.3.3 PICO Framework

PICO stands for Population, referring to the specific group of individuals under study, Intervention, describing the treatment or exposure being investigated, Comparison, indicating the control or alternative intervention used for evaluation, and Outcome, representing the measurable effects or endpoints of interest.

3.3.3.1 Type of Participants

Small ruminants (sheep and goats) from different geographical regions. Any study including both species based on medicinal effect and GIPs (revealed the effect of plants on growth performance) will be included.

3.3.3.2 Type of Intervention

Interventions deemed eligible for inclusion in this study must be related to the effect of plants on GIPs and must have the objective of assessing their effects of these plants on growth performance, hematological and biochemical parameters, carcass and body organs traits of small ruminants. Treatment with medicinal plant extracts

3.3.3.3 Types of Comparison

Geographical comparison: to compare the plants effects throughout the continents from which the nations in this study are recruited. Also, synthetic anthelmintics or untreated controls.

3.3.3.4 Types of Outcomes

The primary outcomes will focus on parasitological indicators, specifically parasite load reduction, fecal egg count reduction, and hematological improvements. Secondary outcomes will include growth performance, hematological and biochemical parameters, as well as carcass and body organ traits. These secondary outcomes will be measured only after the experimental phase, since they are influenced by multiple extrinsic factors in addition to the tested interventions.

3.4 Data Extraction

3.4.1 Procedure for Study Selection

The titles and/or abstracts of studies will be retrieved using the search strategy and those from additional sources will be independently reviewed by two review authors to identify studies that potentially meet the inclusion criteria described above. The full text of these potentially eligible studies will be retrieved and will be evaluated independently by two members of the review team. Any disagreement between them about the eligibility of particular studies will be resolved by discussion with a third reviewer. A standardized, pre-piloted form will be used to extract data from included studies to assess study quality and evidence synthesis. Information extracted included: country of origin, original sample (strains of animals examined), target sample (number of small ruminants (sheep and goats) positive for the test performed), description of the intervention, study design, animal species involved, specimen, farms method used for analysis, results obtained, and information to assess the risk of bias. Missing data will be requested from the study authors.

3.4.2 Methods for Data Selection

Two reviewers independently will extract data from each article. We will first be trying to extract numerical data from tables, text, or figures (Table 2). If these are not reported, we will extract data from graphs using digital software. In case data will not be reported or will be unclear, we will be attempting to contact authors by e-mail (max. 2 attempts). In case an outcome (initial and finished values of plants used) is measured at multiple time points, data from the time point where efficacy is highest will be included (Table 2).

Table 2. Data extraction variables.

Category	Parameters to Extract
Study Identification	Author(s), Year, Country
Study Characteristics	Design, Sample size, Species
Intervention Details	Plant species, Part used, Preparation method, Dose, Duration
Outcome Measures	Parasite species targeted, Parasite load, Clinical signs, Growth parameters
Methodology	Diagnostic techniques (e.g., fecal egg count, PCR)
Results	Effect size (mean difference, odds ratio), Confidence intervals
Risk of Bias Assessment	Randomization, blinding, attrition rates

3.5 Quality Assessment (Risk of Bias)

The included publications will be systematically evaluated for risk of bias, methodological quality, and relevance. Three complementary tools will be employed to ensure robustness and validity of the assessment: the SYRCLE risk of bias tool [30], the CAMARADES checklist [31], and the Joanna Briggs Institute (JBI) critical appraisal checklist for

prevalence studies [32]. The rationale for using multiple instruments lies in the nature of the included studies: while SYRCLE is specifically designed for preclinical animal research, CAMARADES provides additional criteria relevant to experimental rigor, and the JBI checklist strengthens the evaluation of prevalence and epidemiological aspects. Together, these tools allow for a comprehensive appraisal of methodological quality and minimize the risk of overlooking study biases. Each study will be assessed independently by two reviewers, and discrepancies will be resolved by a third reviewer. A quality score >70% will be considered indicative of high-quality evidence.

For SYRCLE's tool, the following domains will be evaluated: (1) Will be the allocation sequence generated and applied appropriately? (2) Will be groups comparable at baseline or adjusted for confounders? (3) Will be allocation adequately concealed? (4) Will be animals randomly housed? (5) Will be caregivers/investigators blinded to group allocation? (6) Will be animals randomly selected for outcome assessment? (7) Will be the outcome assessor blinded?

The CAMARADES checklist addressed additional criteria including: (1) peer-reviewed publication, (2) presence of a control group, (3) random allocation of treatment, (4) blinded induction of medicinal plants or parasites, (5) blinded outcome assessment, (6) reporting of estimated values and statistical methods, (7) clarity of animal model (age, infected or healthy status), (8) sample size calculation, (9) compliance with animal welfare regulations, and (10) statement of potential conflicts of interest. These criteria help determine the internal validity and external applicability of findings.

Finally, the JBI checklist for prevalence studies will be applied to ensure proper evaluation of study designs reporting epidemiological data, particularly prevalence estimates. This triangulation approach strengthens the reliability of the evidence synthesis.

All data extraction and screening processes will be managed using EndNote X9 [33] for reference management and Rayyan software [34] for systematic screening, ensuring transparency and reproducibility.

3.6 Statistical Analysis

The synthesis of data will be undertaken through both narrative and quantitative approaches. A structured narrative synthesis will initially be provided, organized around the type of intervention assessed, the characteristics of the target population, the nature of the outcomes measured, and the specific content of the interventions. For each included study, intervention effects will be expressed as risk ratios for dichotomous outcomes and as standardized mean differences (SMDs) for continuous outcomes, thereby ensuring comparability across heterogeneous measures (Table 3).

To enhance methodological rigor, all continuous outcomes reported in different measurement units will be converted into standardized values, allowing the computation of SMDs expressed in a uniform direction. Whenever studies report incomplete or missing data, corresponding authors will be contacted to obtain the necessary information. In cases where retrieval is unsuccessful, established imputation techniques (e.g., deriving standard deviations from reported standard errors, confidence intervals, or p-values) will be applied. Studies for which imputation is not feasible will be excluded from the meta-analysis but retained for qualitative synthesis. Sensitivity analyses will subsequently be performed to evaluate the robustness of pooled results to assumptions regarding missing data. For multi-arm trials, all eligible intervention groups will be considered. To prevent unit-of-analysis errors, data will either be appropriately combined into a single pairwise comparison or, where required, evenly distributed across comparator groups to avoid duplication of participant counts (Table 3).

Although the diversity of outcome measures and study designs may limit the scope for meta-analysis, quantitative pooling will be conducted when studies are sufficiently homogeneous in terms of intervention type, comparator, and outcome. A random-effects model will be applied to account for between-study variability, with results presented as pooled effect estimates and their 95% confidence intervals. Statistical heterogeneity will be assessed using the chi-squared test and quantified by the I^2 statistic, with an I^2 value above 50% interpreted as evidence of substantial heterogeneity. Analyses will be conducted using Review Manager software (RevMan, version 5.4) (Table 3).

Table 3. Subgroup and sensitivity analyses plan.

Analysis Type	Subgroups or Criteria
By Region	West Africa, East Africa, Southern Africa
By Host Species	Sheep, Goats
By Plant Type	Leaves, Roots, Bark, Whole plant
By Plant Preparation	Powder, Extract, Decoction, Others
By Parasite Species	Haemonchus contortus, Trichostrongylus spp., others
By Study Quality	High vs low risk of bias

Further exploration of heterogeneity will be undertaken through stratified and subgroup analyses. These will be performed according to study quality, geographic setting (continent), small ruminant species, diagnostic methods

employed, and the logistical and compositional features of the interventions. Sensitivity analyses excluding lower-quality studies will also be performed to assess the stability of the findings.

Finally, the risk of publication bias will be investigated through visual inspection of funnel plots complemented by formal statistical testing using Egger's regression method [35]. This comprehensive synthesis plan will ensure methodological transparency and strengthen the validity and reliability of the meta-analytic conclusions (Table 3).

4. Ethical Considerations and Dissemination

This article is a review of previously published studies and does not involve any new studies with human participants or animals performed by the authors. Therefore, ethical approval was not required. However, the protocol will ensure that all included animal studies had obtained prior ethical clearance, which will be explicitly verified during the data extraction process. Additionally, this protocol will be registered in the International Prospective Register of Systematic Reviews (PROSPERO) to promote transparency, avoid duplication, and ensure methodological rigor. The results of this review will be disseminated through publication in a peer-reviewed journal, presentations at relevant international conferences, and sharing with global health and livestock development agencies.

5. Timeline

Table 4 presents the timeline of activities, outlining the sequence and duration of the planned tasks. It provides a structured overview of the key milestones, deadlines, and expected outputs, thereby facilitating effective monitoring, coordination.

Table 4. Timeline of activities.

Activity	Duration
Protocol registration (PROSPERO)	2 weeks
Literature search	3 weeks
Screening and selection	2 weeks
Data extraction and quality appraisal	3 weeks
Data analysis and interpretation	3 weeks
Manuscript writing and submission	3 weeks

6. Expected Outcomes

- A pooled global estimate of selected medicinal plants efficacity on GIPs in small ruminants.
- Regional and species-specific insights to inform One Health interventions (identification of high-risk regions)
- Identification of effective plant species and protocols.
- Policy guidance for integration of ethnoveterinary practices.
- Identification of research gaps for future studies.
- Evidence-based insights for GIPs control programs

7. Conclusion

In conclusion, while this systematic review is expected to provide robust evidence on the antiparasitic efficacy of medicinal plants, these limitations will be kept in mind when interpreting the results. Strategies such as subgroup analysis, sensitivity analysis, and inclusion of diverse sources of data will be employed to minimize the impact of these limitations and enhance the reliability of conclusions drawn from the evidence.

8. Limitations & Recommendation

8.1 Limitation

Potential publication bias remains a concern, as selective reporting may distort the true evidence base. The restriction of included studies to English and French introduces a linguistic limitation that could exclude valuable data from other regions. Variability in medicinal methodologies and study quality further challenges the robustness of findings. Considerable heterogeneity exists across plant species and preparation techniques, complicating comparative analyses. Moreover, the limited standardization of outcome measures undermines consistency and weakens the reliability of pooled interpretations.

8.2 Recommendations

8.2.1 Evidence-based Policy Guidance for the Integration of Ethnoveterinary Medicine

Findings from this research are also expected to support the formulation of policy recommendations for integrating ethnoveterinary practices into conventional animal health systems. With the increasing global concern over drug resistance and chemical residues in livestock products [15], there is growing interest in the use of natural, plant-based alternatives for parasite control. However, without structured evidence, policy adoption remains limited. This study will bridge that gap by offering scientifically backed data that policymakers, veterinarians, and livestock development agencies can rely on to support sustainable and locally appropriate interventions [36,37]. The inclusion of effective ethnoveterinary remedies in national animal health frameworks can strengthen resilience among rural livestock-dependent communities.

8.2.2 Identification of Research Gaps and Setting Priorities for Future Investigation

Finally, this study will provide a critical analysis of the limitations and inconsistencies in the existing literature. It is expected to identify significant gaps, such as the lack of standardized reporting of treatment outcomes, limited pharmacological characterization of bioactive compounds, insufficient toxicity studies, and the underrepresentation of certain geographic regions or animal breeds. Such insights will guide future research directions by highlighting priority areas where empirical data is lacking. Recommendations will also include methodological improvements for future trials to enhance reproducibility and comparability across studies [9,38]. This will contribute to the broader One Health agenda by supporting interdisciplinary research at the interface of human, animal, and environmental health.

Conflict of Interest

All the authors declared that there is no conflict of interest.

Generative AI Statement

The authors declare that no Gen AI was used in the creation of this manuscript.

References

[1] Park YW, Haenlein GFW. Goat milk, its products and nutrition. Handbook of Food Products Manufacturing. 2006, 449-488. DOI: 10.1002/9780470113554.ch69

[2] Food and Agriculture Organisation. La Situation mondiale de l'alimentation et de l'agriculture 2020. 2020, 28. DOI: 10.4060/cb1441fr

[3] Morgan ER, Charlier J, Hendrickx G, Biggeri A, Catalan D, Von Samson-Himmelstjerna G, et al. Global change and helminth infections in grazing ruminants in Europe: Impacts, trends and sustainable solutions. Agriculture. 2013, 3(3), 484-502. DOI: 10.3390/agriculture3030484

[4] Mehmood K, Zhang H, Sabir AJ, Abbas RZ, Ijaz M, Durrani AZ, et al. A review on epidemiology, global prevalence and economical losses of fasciolosis in ruminants. Microbial Pathogenesis. 2017, 109, 253-262. DOI: 10.1016/j.micpath.2017.06.006

[5] Rashid M, Akbar H, Rashid I, Saeed K, Ahmad L, Ahmad AS, et al. Economic significance of tropical theileriosis on a Holstein Friesian dairy farm in Pakistan. Journal of Parasitology. 2018, 104(3), 310-312. DOI: 10.1645/16-179

[6] Fentahun T. Systematic review on gastrointestinal helminths of domestic ruminants in Ethiopia. Online Journal of Animal and Feed Research. 2020, 10(5), 216-230. DOI: 10.51227/ojafr.2020.31

[7] Showkat Ahmad Bhat, Manzoor Ur Rahman Mir, Sawleha Qadir, Idrees Mehraj Allaie, Hilal Musadiq Khan, Ishraq Husain, et al. Prevalence of gastro-intestinal parasitic infections in Sheep of Kashmir valley of India. 2012, 5(11), 667-671. DOI: 10.5455/vetworld.2012.667-671

[8] Mezgebu T, Tafess K, Tamiru F. Prevalence of gastrointestinal parasites of horses and donkeys in and around Gondar town, Ethiopia. Open Journal of Veterinary Medicine. 2013, 3(6), 267-272. DOI: 10.4236/ojvm.2013.36043

[9] Kaplan RM, Vidyashankar AN. An inconvenient truth: global anthelmintic resistance. Veterinary Parasitology. 2013, 186(1-2), 70-78. DOI: 10.1016/j.vetpar.2011.11.048

[10] Kotze AC, Prichard RK. Anthelminthic resistance in *Haemonchus contortus*: history, mechanisms and diagnosis. Advances in Parasitology. 2016, 93, 397-428. DOI: 10.1016/bs.apar.2016.02.012

[11] Molento MB. Parasite control in the age of drug resistance and changing agricultural practices. Veterinary Parasitology. 2009, 163(3), 229-234. DOI: 10.1016/j.vetpar.2009.06.007

[12] Hrckova G, Velebny S. Parasitic helminths of humans and animals: health impact and control. In: Pharmacological Potential of Selected Natural Compounds in the Control of Parasitic Diseases. Springer. 2013, 29-99. DOI: 10.1007/978-3-7091-1325-7_2

[13] Hoste H, Torres-Acosta JF, Sandoval-Castro CA, Mueller-Harvey I, Sotiraki S, Louvandini H, et al. Tannin-containing legumes as a natural alternative to control gastrointestinal parasites in grazing livestock. Veterinary Parasitology. 2015, 212(1-2), 5-17. DOI: 10.1016/j.vetpar.2015.06.026

[14] Pohl F, Kong T, Lin P. The potential use of plant natural products and plant extracts with antioxidant properties for the prevention/treatment of neurodegenerative diseases: *in vitro*, *in vivo* and clinical trials. Molecules. 2018, 23(12), 3283. DOI: 10.3390/molecules23123283

[15] Adhikari B, Marasini BP, Rayamajhee B, Bhattarai BR, Lamichhane G, Khadayat K, et al. Potential roles of medicinal plants for the treatment of viral diseases focusing on COVID-19: A review. Phytotherapy Research. 2021, 35(3), 1298-1312. DOI: 10.1002/ptr.6893
[16] Hoste H, Jackson F, Athanasiadou S, Thamsborg SM, Hoskin SO. The effects of tannin-rich plants on parasitic nematodes in ruminants. Trends in Parasitology. 2006 22(6), 253-261. DOI: 10.1016/j.pt.2006.04.004
[17] Eguale T, Tadesse D, Giday M. *In vitro* anthelmintic activity of crude extracts of five medicinal plants against egg hatching and larval development of Haemonchus contortus. Journal of Ethnopharmacology. 2011, 137(1), 108-113. DOI: 10.1016/j.jep.2011.04.063
[18] Nawaz M, Sajid MS, Zulfiqar A, Muhammad W, Tanveer A, Abid H, et al. Anti-tick activity of leaves of Azadirachta indica, Dalbergia sisso and Morus alba against Rhipicephalus microplus (Acari: Ixodidae). Acta Parasitologica Globalis. 2015, 6(1), 60-64. DOI: 10.5829/idosi.apg.2015.6.1.93220
[19] Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. British Medical Journal. 2021, 372, n71. DOI:10.1136/bmj.n71
[20] Sayers EW, Beck J, Bolton EE, Bourexis D, Brister JR, Canese K, et al. Database resources of the national center for biotechnology information. Nucleic Acids Research. 2021, 49(D1), D10-D17. DOI: 10.1093/nar/gkaa892
[21] Halevi Gali; Henk Moed, Judit Bar-Ilan. Suitability of Google Scholar as a source of scientific information and as a source of data for scientific evaluatio–Review of the Literature. Journal of Informetrics. 2017, 11(3), 823-834. DOI: 10.1016/j.joi.2017.06.005
[22] Birkle C, David A. Pendlebury, Schnell J, Adams J. Web of Science as a data source for research on scientific and scholarly activity. 2020, 1(1), 363-376. DOI: 10.1162/qss_a_00018
[23] Thelwall M, Pardeep Sud. Scopus 1900-2020: Growth in articles, abstracts, countries, fields, and journals. Quantitative Science Studies. 2022, 3(1), 37-50. DOI: 10.1162/qss_a_00177
[24] Gusenbauer M, Haddaway NR. Which academic search systems are suitable for systematic reviews or meta-analyses? Evaluating retrieval qualities of Google Scholar, PubMed, and 26 other resources. Research Synthesis Methods. 2020, 11(2), 181-217. DOI: 10.1002/jrsm.1378
[25] That J. CABI Global Health, more than just a database: a fresh perspective on global literature with a not-for-profit impact. Journal of the European Association of Health Information and Libraries. 2025, 21(1), 8-13. DOI: 10.32384/jeahil21662
[26] Oermann MH, Wrigley J, Nicoll LH, Ledbetter LS, Carter-Templeton H, Edie AH. Integrity of databases for literature searches in nursing: Avoiding predatory journals. Advances in Nursing Science. 2021, 44(2), 102-110. DOI: 10.1097/ANS.0000000000000349
[27] Smart P. African Journals OnLine (AJOL). Serials Review. 2005, 31(4), 261-265. DOI: 10.1016/j.serrev.2005.09.007
[28] Puga MEDS, Atallah ÁN. Cochrane Library: the best evidence within everyone's reach. Sao Paulo Medical Journal. 2020, 138(5), 355-358. DOI, 10.1590/1516-3180.2020.138527102020
[29] Manterola C, Otzen T, Calo, L. Electronic resources for searching health scientific information. Database publication type. International Journal of Morphology. 2014, 32(4), 1484 -1491.
[30] Hooijmans CR, Rovers MM, de Vries RB, Leenaars M, Ritskes-Hoitinga M, Langendam MW. SYRCLE's risk of bias tool for animal studies. BMC Medical Research Methodology. 2014, 14, 43. DOI: 10.1186/1471-2288-14-43
[31] Macleod MR, Lawson McLean A, Kyriakopoulou A, Serghiou S, de Wilde A, Sherratt N, et al. Risk of bias in reports of *in vivo* research: a focus for improvement. PLoS Biology. 2015, 13(10), e1002273. DOI: 10.1371/journal.pbio.1002273
[32] Moola S, Munn Z, Tufanaru C, Aromataris E, Sears K, Sfetcu R, et al. JBI Manual for Evidence Synthesis: Systematic review of etiology and risk. Joanna Briggs Institute. 2020. DOI: 10.46658/JBIMES-24-06
[33] Muthuraj A, Rajkumar T, J. Issac Arputharaj. EndNote: Reference management tool for managing research. Online Tools for Librarians. 2018, 107-114.
[34] Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid N. Rayyan–A web and mobile app for systematic reviews. Systematic Reviews. 2016, 5(210). DOI: 10.1186/s13643-016-0384-4
[35] Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. British Medical Journal. 1997, 315(7109), 629-634. DOI: 10.1136/bmj.315.7109.629
[36] Githiori JB, Hoglund J, Waller PJ. Ethnoveterinary plant preparations as livestock dewormers: practices, popular beliefs, pitfalls, and prospects for the future. Animal Health Research Reviews. 2005, 6(1), 91-103. DOI:10.1079/AHR2005099
[37] Zinsstag J, Schelling E, Roth F, Bonfoh B, de Savigny D, Tanner M. Human benefits of animal interventions for zoonoses control. Emerging Infectious Diseases. 2007, 13(4), 527-531. DOI: 10.3201/eid1304.060381
[38] Roeber F, Kahn L. The specific diagnosis of gastrointestinal nematode infections in livestock: Larval culture technique, its limitations and alternative DNA-based approaches. Veterinary Parasitology. 2014, 205, 619-628. DOI: 10.1016/j.vetpar.2014.08.005