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Efficacy of *Aloe Vera* and *Curcuma Longa* in Managing Porcine Staphylococcal Infections

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ABSTRACT

AntiMicrobial Resistance (AMR) poses a global public health threat, and impacts the livestock sector. In Southern Africa, alternative ethno-remedies for AMR in pigs are under-researched. This study evaluated the efficacy of *Aloe vera* and *Curcuma longa* in managing *Staphylococcus aureus* infections in pigs.

Herbs were collected following a non-participatory rapid appraisal from Luanshya and Lusaka Districts of Zambia, while *S. aureus* was sourced from porcine nasal swabs. Crude extracts were prepared using ethanol, ethyl acetate, and aqueous solvents. The agar dilution method assessed the efficacy of three groups: *Aloe vera*, *Curcuma longa*, and a combination (5:1). Cephalexin, neomycin, and kanamycin served as positive controls, while DMSO was the negative control.

Curcuma longa showed the highest bacterial susceptibility (S=75%, I=25%), followed by *Aloe vera* (S=56%, I=19%, R=25%). The combined formulation yielded S=48 per cent, I=26 per cent, R=26 per cent. The positive control produced S=63 per cent, R=37 per cent, and the negative control had R=100 per cent.

Curcuma longa and *Aloe vera* exhibited potential in managing porcine upper respiratory tract infections caused by *S. aureus* in Zambia. These findings warrant further safety and clinical tests to validate their use, determine minimum inhibitory concentrations, and establish appropriate dosages for effective application.

Keywords: *Aloe vera, Antimicrobial Resistance, Curcuma longa, Ethnoveterinary medicine, pigs, Staphylococcus aureus*

Introduction

AntiMicrobial Resistance (AMR) is a global public health concern, and the livestock sector is not immune to this problem [1]. Pork remains one of the major meat sources and due to the intensive production systems, a lot of antimicrobials continue to be used during pig rearing for purposes of treatment, prophylaxis and also growth promotion [2],[3],[4]. Pigs have also been shown, from recent disease outbreaks, to be a pivotal reservoir for interspecies transmission of pathogens [5]. Despite the global action plan on AMR indicating the need to increase investment in new medicines, diagnostic tools, vaccines and other interventions, Southern

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Africa in particular has lagged behind, because very diminutive research has been conducted on alternative ethno-remedies that could potentially curb AMR in pigs despite local evidence of the prospects [6]·[7]. This study evaluated the efficacy of locally accessible herbs, *Aloe vera* and *Curcuma longa*, in managing respiratory colonisation by *Staphylococcus aureus* in Zambian pigs. Although the *S. aureus* isolates were from colonised sites, Whole Genome Sequencing (WGS) data indicated their pathogenic potential with numerous virulence and AMR genes [8].

Aloe vera and *Curcuma longa* have been successfully used topically, to treat infections often caused by gram positive microbes in conditions such as mastitis in the bovine species [9]. In Zambia, the crude extracts from the herbs have shown efficacy against similar mastitis-causing gram-positive bacterial isolates [10]. However, very few ethnoveterinary formulations have been traditionally used in treating respiratory infections in animals, less so in pigs. Studies have indicated that many small scale and resource-poor livestock farmers cannot afford synthetic pharmaceutical drugs and resultantly turn to indigenous ethnoveterinary medicinal plants knowledge as an alternative way to treat animal diseases [7]. However, the absence of an ethnoveterinary pharmacopeia and scarcity of data on ethnoveterinary usage of plants continues to pose a challenge in the validation and development of these herbal resources.

Materials and methods

In this experimental study, the researchers used a 5:1 formulation of *A. vera* (300g) and *C. longa* (60g), alongside each herb individually. The maceration method was used for extraction in ethanol, ethyl acetate, and aqueous solvents, following established protocols [11,12]. A synthetic formulation containing Cephalexin, Neomycin and Kanamycin was used as a positive control, while DimethlySulfoxide (DMSO) served as the negative control. The herbs were locally sourced from Luanshya and Lusaka districts of Zambia following a non-participatory rapid appraisal. The test microbes were obtained from pig nasal swabs as part of a concurrent study [5]. The agar dilution method at 0.5 per cent dilution as prescribed by the 2018 Clinical and Laboratory Standards Institute (CLSI) was used for the assays with the bacterial isolate inoculated at the 0.5 McFarland standard [13]. The data was collected by descriptive observation of the susceptibility using the CLSI recommended grading system [13]. Observations were conducted over a thirty-day period to monitor changes in susceptibility, in order to determine whether the effects were bactericidal or bacteriostatic. Data was collected and analysed graphically using MS Excel (2010). Ethical approval was obtained from the University of Zambia Biomedical Research Ethics Committee (UNZABREC), approval number 1073-2020, with further authorisation from the Zambia National Health Research Authority (NHRA). Permission and consent were obtained from pig farmers to collect nasal swabs during the concurrent study, from which this sample was derived [5]. The susceptibility results were communicated to the farm owners as part of their participatory beneficence.

Results

The susceptibility of the isolates to the treatments was graded using the Clinical and Laboratory Standards Institute (CLSI) guidelines (2018) as Susceptible (S), Intermediately Susceptible (I), and Resistant (R)[13]. Figure 1 below graphically presents the results of all treatments on the test bacteria. Multiple trials were conducted for the formulated remedy, resulting in a higher frequency compared to other treatments. As anticipated, the negative control revealed 100 per cent resistance.

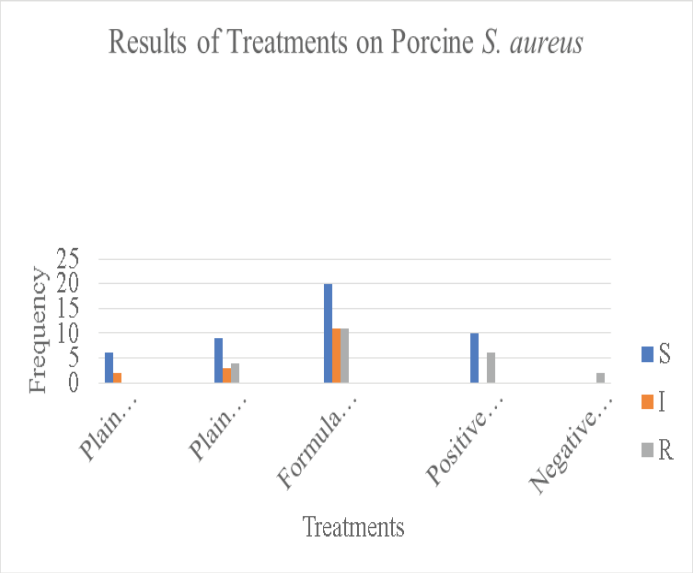

Figure 1: Overall Porcine *S. aureus* Susceptibility graph (S= Susceptible, I= Intermediately Susceptible, R= Resistant)

Figure 2 below highlights the performance of the *C. longa* treatment alone, which notably recorded the highest susceptibility compared to the other treatments (S=75%, I=25%)

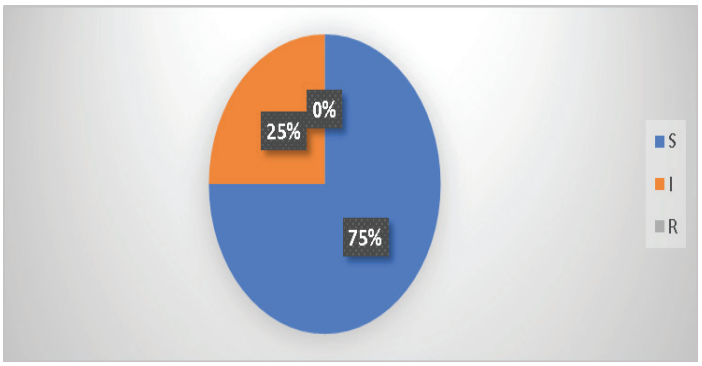

Figure 2: Susceptibility of Porcine *S. aureus* to *Curcuma. Longa* (S= Susceptible, I= Intermediately Susceptible, R= Resistant)

The plain *Aloe vera* ranked second in bacterial Susceptibility among the test crude herbal extracts (S=56%, I=19%, R=25%) as depicted in the chart in Figure 3

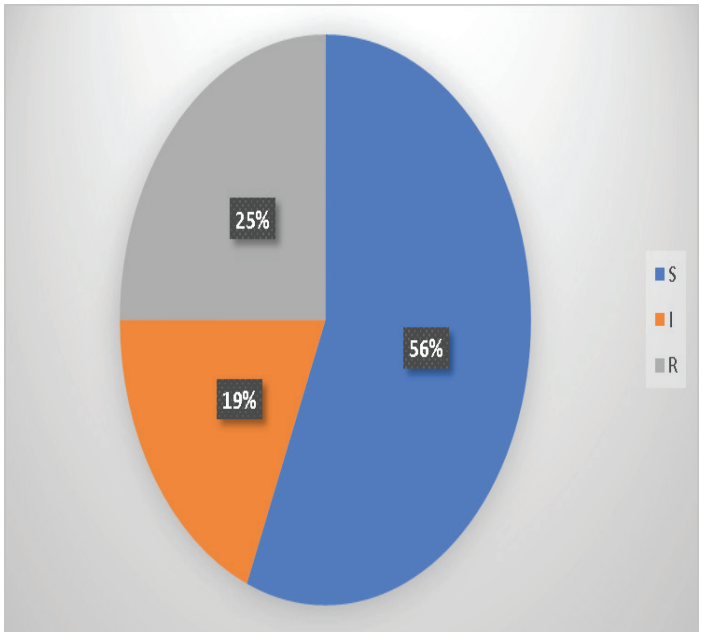

Figure 3: Susceptibility of Porcine *S, aureus* to Plain *A. vera crude* extract (S= Susceptible, I= Intermediately Susceptible, R= Resistant)

Figure 4 below shows performance of the combined crude extract treatment on the *S. aureus* bacterial isolate. The combined formulation yielded S=48 per cent, I=26 per cent, and R=26 per cent, and ranked third among the herbal treatments.

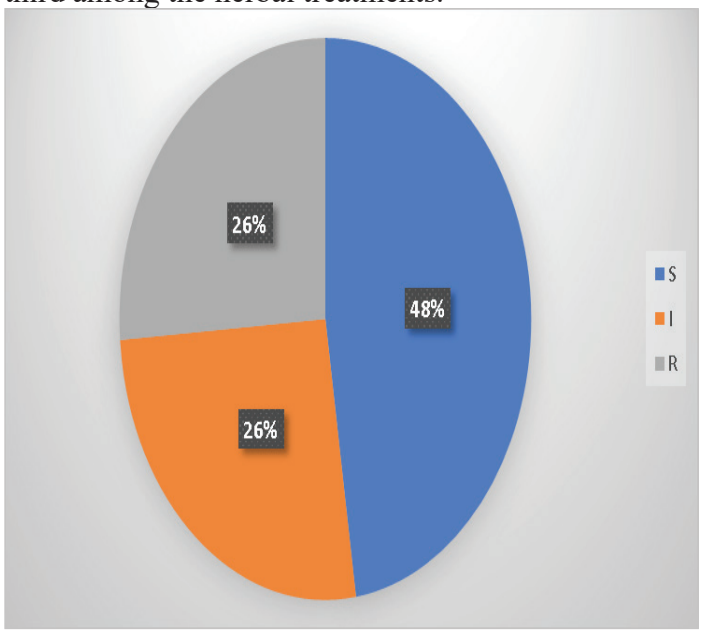

Figure 4: Susceptibility of Porcine *S. aureus* to the Combined *C.longa* and *A. vera* herbal formulation (S= Susceptible, I= Intermediately Susceptible, R= Resistant)

The results of our positive control are shown in Figure 5 below. The positive control produced S=63 per cent and R=37 per cent, with no intermediate susceptibility. The results were analysed using frequency graphs and charts in MS Excel 2010 and interpreted descriptively.

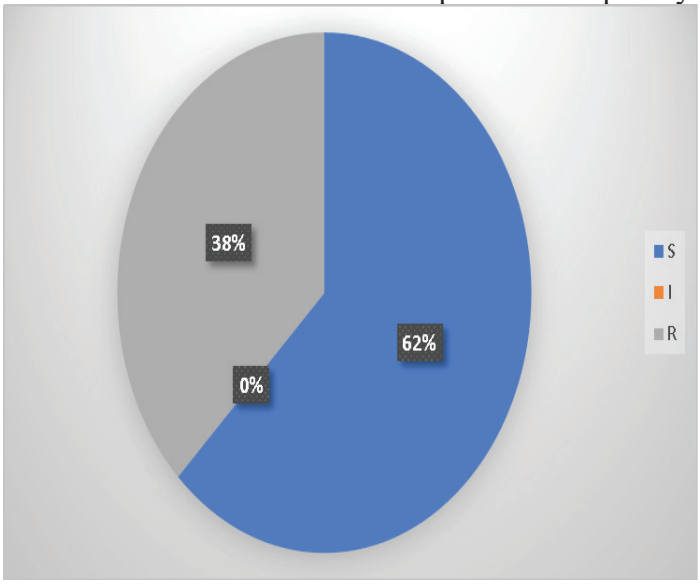

Figure 5: Susceptibility of *S aureus* to the positive controls (Cephalexin/Neomycin and Kanamycin) (S= Susceptible, I= Intermediately Susceptible, R= Resistant)

Discussion

The results of this study indicate that *Aloe vera* and *Curcuma longa* possess significant potential for managing respiratory colonisation by *Staphylococcus aureus* in Zambian pigs. Among the treatments, *Curcuma longa* demonstrated the highest antibacterial efficacy, with 100 per cent of isolates showing either full or intermediate susceptibility. This was followed by *Aloe vera*, which exhibited 75 per cent susceptibility, and the combined crude extract, which displayed a similar but slightly lower efficacy of 74 per cent. The synthetic positive control containing Cephalexin, Neomycin, and Kanamycin also showed considerable effectiveness, achieving 63 per cent susceptibility [14].

The superior efficacy of *Curcuma longa* may be attributed to its high concentration of bioactive secondary metabolites, including curcumin, demethoxycurcumin, and bisdemethoxycurcumin, all of which are known for their potent antimicrobial properties [15]. In contrast, the lower efficacy observed with the combined crude extract could suggest that it requires an external catalyst, such as lime, which is traditionally used in mastitis treatment in cattle, to fully activate its antimicrobial potential [16].

Extended observations at room temperature and pressure, following initial incubation at 37°C, suggest that the crude extracts primarily exert bacteriostatic rather than bactericidal effects. This is a critical observation, because it underscores the risk of bacterial resistance development over time, a common concern with bacteriostatic agents. Moreover, the variability in susceptibility observed with the semi-synthetic positive controls raises the potential issue of MultiDrug Resistance (MDR) with prolonged antibiotic exposure.

These findings align with earlier studies that have demonstrated the effectiveness of *Aloe vera* and *Curcuma longa* in treating *S. aureus* infections. For example, research conducted in India revealed that *Aloe vera* successfully treated bovine mastitis caused by *S. aureus* [16], while a study from China demonstrated the efficacy of *Curcuma longa* against skin infections caused by the same pathogen [17].

This Study has significant implications for the management of Anti Microbial Resistance (AMR) in pigs. AMR remains a growing global concern and poses a major challenge to the livestock industry [18]. The potential to use alternative therapies such as herbal remedies in place of conventional antibiotics can help reduce antibiotic dependency in livestock, thereby mitigating the development and spread of AMR [19].

While this study was limited by the number of bacterial isolates available, this was mitigated through sub-culturing on blood agar to increase bacterial yield and performing multiple time-point observations to assess whether the effects were bactericidal or bacteriostatic. Future research should focus on validating these findings through *in vivo* studies and investigating the potential for combining herbal treatments with natural catalysts to enhance their antimicrobial efficacy.

Conclusion

This study highlights the potential of *Aloe vera* and *Curcuma longa* as effective agents in managing respiratory infections caused by *Staphylococcus aureus* in Zambian pigs. The promising antimicrobial activity demonstrated by these plants suggests that they could serve as valuable alternatives to conventional antibiotics, offering a natural approach to combating bacterial infections in livestock. However, further research is essential to isolate and identify the specific active compounds responsible for their efficacy. Additionally, future studies should explore the influence of seasonal variations, diurnal cycles, and environmental factors on the concentration and potency of these bioactive compounds.

The findings underscore the potential role of herbal remedies in mitigating antimicrobial resistance (AMR) within the livestock industry, contributing to more sustainable and reduced reliance on antibiotics. As AMR continues to pose significant challenges globally, the use of such alternatives could become an integral part of a broader strategy to safeguard animal health and food security.

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Authors' Contributions

JN, KC and BMH conceived the idea, JN and MS collected the bacterial samples, JN and MS analysed the data, NJ drafted the manuscript MS, BMH, and KC critically reviewed the manuscript. All authors read and approved the final draft of the manuscript. KC and BMH supervised the research.

Competing Interests

The authors declare that there are no conflicts of interest associated with this study.

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