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An inventory of ethnoveterinary knowledge for chicken disease control in Soroti district, Uganda

Authors:
Gerald Zirintunda[1,2]
John Kateregga[1]
Sarah Nalule[1]
Patrick Vudriko[1]
Savino Biryomumaisho[1]
James O. Acai[1]

Affiliations:
[1]Department of Veterinary Pharmacy and Comparative Medicine, College of Veterinary Medicine & Biosecurity, Makerere University, Kampala, Uganda

[2]Department of Animal Production and Management, Faculty of Agriculture and Animal Sciences, Busitema University, Tororo, Uganda

Corresponding author:
Gerald Zirintunda,
zirintunda@yahoo.co.uk

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Background: Knowledge regarding the use of ethnoveterinary products in the control of chicken diseases in Uganda is hardly documented.

Aim: The study documented the ideas of controlling chicken diseases using herbal remedies as shared by chicken owners.

Setting: The study was conducted among backyard and free-ranging chicken owners.

Methods: Mixed methods of focus group discussions (FGDs) and farmer questionnaires were used.

Results: Most respondents, 91% (71/78), were using ethnoveterinary medicine (EVM) and 96.2% (75/78) knew others who were also using them. Of the respondents, 82% (64/78) were convinced that EVMs are effective alternative to conventional treatments. Ethnoveterinary medicines are acceptable and promoted during informal and formal training. The sources of EVM were home gardens, wild sources and markets. Most respondents had their planted EVM materials and acquired knowledge from neighbours and friends. About 37.2% (29/78) of the respondents affirmed that they could not freely share their EVM knowledge with others.

Conclusion: The participants of the FGDs and the respondents of the questionnaires knew the acceptable opportunities of alternative drugs of unproven efficacy and safety. The practices pose risks to chickens and the possible development of antimicrobial resistance (AMR) in chickens and humans. The study shows the need for claim validations to guide the safe use of EVM in chicken.

Contribution: The study documents plant materials for treating various chicken diseases. The information is essential in the era of AMR and among communities that cannot afford drugs.

Keywords: herbal; Newcastle disease; coccidiosis; preparation; adverse effects; drugs.

Introduction

Information on ethnoveterinary knowledge is not widely documented despite the increased use of these alternative medicines in the control of chicken diseases (Amoia et al. 2021). Ethnoveterinary knowledge is passed to generations through verbal communications which are rarely converted into durable records (Yineger et al. 2007). Ethnoveterinary medicines have been attempted on various types of chicken diseases (Aremu & Lawal 2022). Ethnoveterinary medicine (EVM) are alternative to expensive or inaccessible extension services and synthetic drugs. Ethnoveterinary knowledge in Soroti, Teso sub-region has not been scientifically evaluated despite the claimed advantages of being cheap, organic, acceptable and sustainable (Byaruhanga et al. 2015). Every homestead in rural and peri-urban Soroti owns chicken. The dual-purpose indigenous chickens are kept on free range (Mwesigwa et al. 2015). This predisposes them to parasites and infectious conditions (Byaruhanga et al. 2017). These parasitic and infectious conditions lack effective control measures in the communities (Byaruhanga et al. 2017). This is even more challenging as some farmers transform from subsistence to commercial poultry farming (MAAIF 2019).

Knowledge of EVM is shared from ancestors through informal sharing and storytelling (Yineger et al. 2007). Usually, this knowledge is traded by specialised community members called herbalists. Herbalists have usually focused on human diseases, but animal disease herbalists are a recent trend in Uganda, and they are succinctly called chicken herbalists. The knowledge is usually presumptive including claims of many actions of particular plants. The attitudes are affected by the knowledge, beliefs and experiences of the chicken farmers. Although some

people demonise the use of plant materials, it is widely used among even elite farmers as just drugs devoid of spiritual attachments. The spiritual attachment to the use of EVM is still practised by traditional users and most herbalists.

The study intended to document the ethnoveterinary knowledge for chicken disease control. The knowledge study model was used to underpin the adherence to the pragmatic and coherence theories of the use of ethnomedicine. The Pragmatic theory points out that the truth of EVM should be tested and based on utility. The theory connects facts to epistemic practices, commitments, assertions and scientific inquiry found out through prudent inquiries. The facts should withstand continuous critical examinations. The theory is an alternative to the coherence theory which is common in the EVM practice (Capps 2019). The Coherence theory points out that the truth is a property of propositions (bearers of truth values) that can be analysed in terms of the nature of truths (Young 2018). Knowledge data are the starting point for claim validation, phytochemical screening and metabolome separations for pharmacognosy of effective fraction candidates (Tlotlo, Mfengwana & Olivier 2022). Although some users have EVM as the only choice for the control of chicken diseases, some users have pragmatically tested the EVM and their choice is based on observed results.

Soroti district was selected because it has a high number of households that keep chicken and it is a commercial centre for local chicken in Uganda. Although related studies have been done in livestock and humans, no explicit study has been done on the use of EVM in chickens. Other users have started even packing and marketing the undocumented and obscure materials (Soroti District Production Department 2021).

This research purposed to consolidate data on EVM in control of chicken diseases and to document the ethnoveterinary knowledge, attitudes and practices in Soroti district, Eastern Uganda.

Research methods and design

A cross-sectional design using a modified ethnography approach was followed using mixed methods of focus group discussions (FGDs) and Farmer questionnaires (Seele et al. 2021). Focus group discussions were used to inform the protocol for detailed farmer questionnaires. Mixed methods were chosen for the purposes of triangulating information from different sources and comparing different data sets for consistency. Chicken owners having the highest number of chickens were selected for participation in FGDs and questionnaires. Open-ended guiding tools were used to allow participants to express themselves explicitly. The approach was chosen such that actual themes for analysis are developed. Plant samples were collected with the

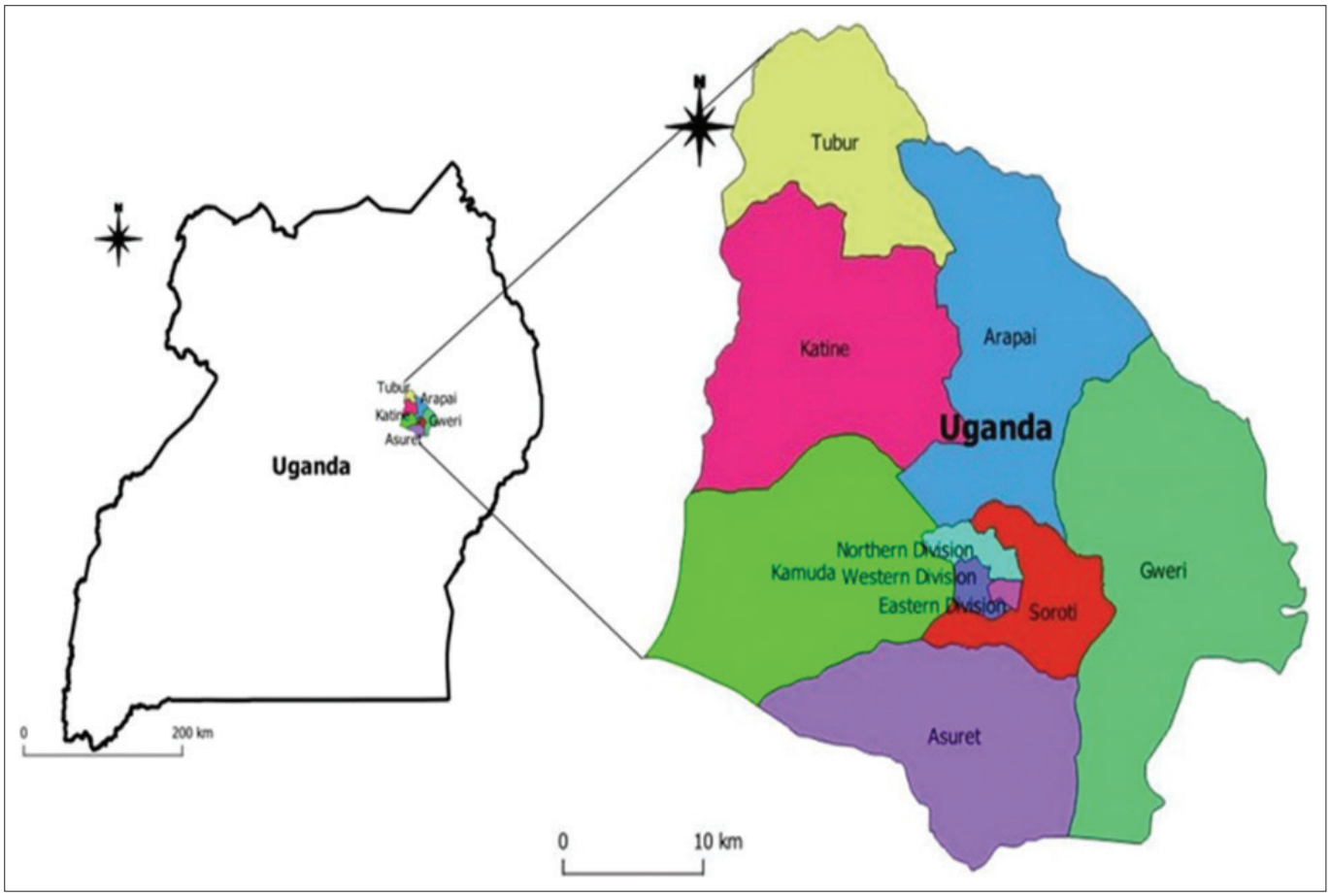

FIGURE 1: The map of Uganda showing the position of Soroti district and its sub-counties.

participants' consent during the survey. These were collected during and after interactions with participants. The samples were air-dried pending submission for taxonomic identification and giving of voucher numbers.

Four rural sub-counties with the highest number of households with chicken (Arapai, Katine, Gweri and Kamuda) were purposively selected (Soroti District Production Department 2021). Two of the urban sub-counties with the highest number of households with chicken (Northern Division and Western Division) were also purposively selected as shown in Figure 1 and Figure 2 (Soroti District Production Department 2021).

Sampling frames of lists of chicken farmers were developed from the sub-county production records. Two FGDs were held per sub-county, one in each parish as these were deemed sufficient to attain data saturation. Fifteen chicken owners per sub-county were purposely selected for questionnaires from the parishes that had not participated in FGDs.

Focus group discussions were conducted using guiding tools in the native 'Ateso' language. The Farmer questionnaires were also in native 'Ateso' and conducted with the help of an interpreter. The respondents consented to the recording of voices, videos and photography. The participants usually walked the research team around, showed the mentioned plants and made illustrations of the preparations. The qualitative data of FGDs were transcribed and translated by two different people proficient in native Ateso and English languages. Themes and codes were developed in QDA miner 6 and WordStat (PROVALIS).

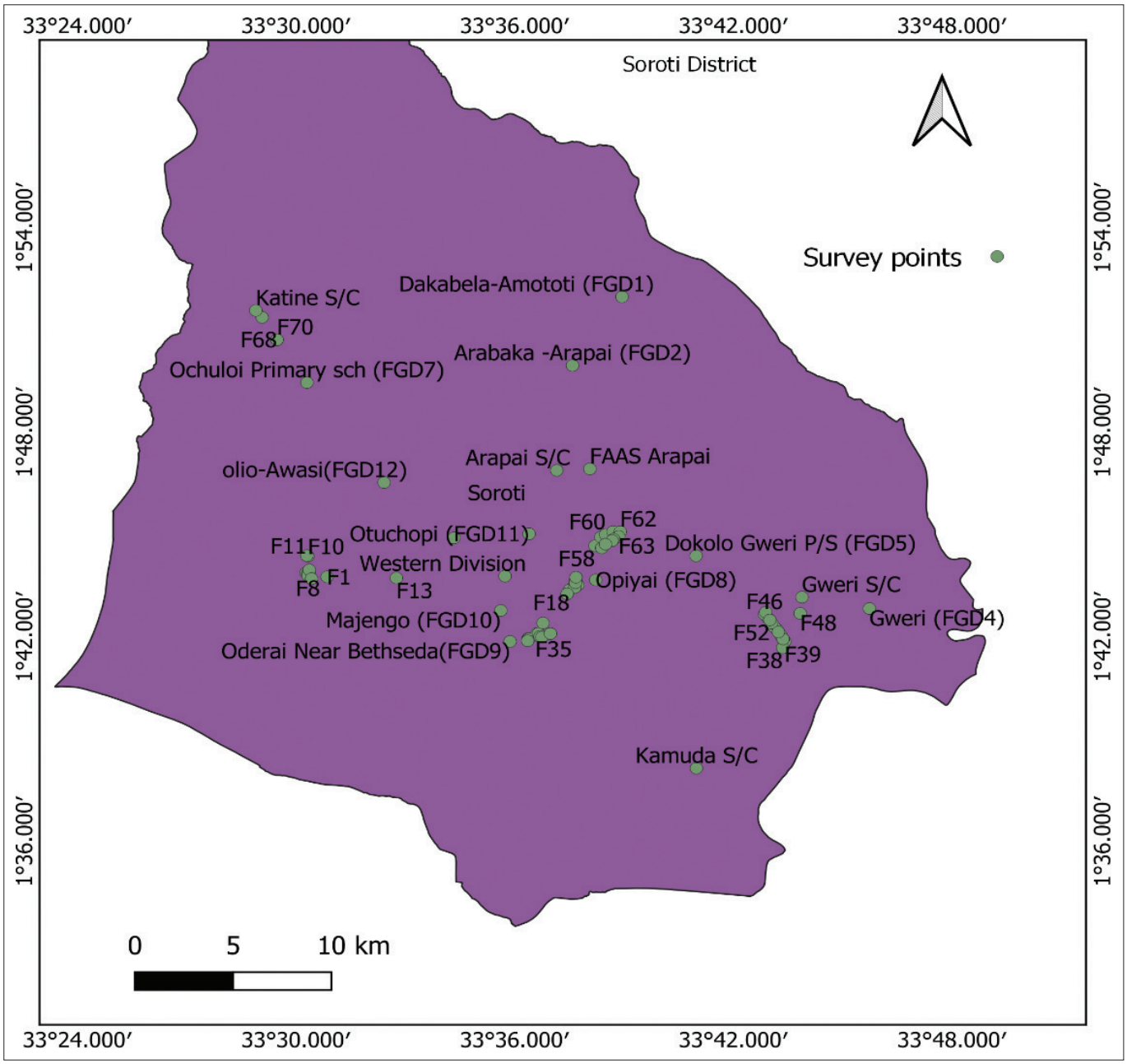

FIGURE 2: The survey points in Soroti district.

TABLE 1: Ethnoveterinary famers' practices for the treatment of chicken diseases in Soroti district.

Disease	Vernacular name (Ateso)	Plant name	Plant species	Family	Voucher number	Plant part	Preparation
Newcastle disease	Ecucuka	Aloevera	*Aloe barbadensis* Miller	Aloeaceae	SSP/MAK/23	Leaves	Crushing
	Emutungulu	Onions	*Allium cepa* L.	Amaryllidaceae	SSP/MAK/57	Bulb	Crushing
	Emutungulu simu	Garlic	*Allium sativum* L.	Amaryllidaceae	SSP/MAK/58	Bulb	Crushing
	Ebwolo	African custard apple	*Annona senegalensis* Pers.	Annonaceae	SSP/MAK/45	Bark	Pounding
	Eligoi	Yellow oleander	*Thevetia peruviana* (Pers.) Schum	Apocynaceae	SSP/MAK/26	Leaves	Crushing
	Emujajut	Sisal	*Agave sisalana* Perr. Ex. Engelm	Asparagaceae	SSP/MAK/62	Leaves	Crushing
	Enyeku mon	Black jack	*Bidens pilosa* L.	Asteraceae	SSP/MAK/18	Leaves	Crushing
	Edia apoo	Coatbuttons	*Tridax procumbens* L.	Asteraceae	SSP/MAK/15	Leaves	Crushing
	Edodoi	Sausage tree	*Kigelia africana* (Lam.) Benth	Bignoniaceae	SSP/MAK/01	Leaves, bark	Pounding
	Epopong	Cactus	*Nopalea conchenillifera*	Cactaceae	SSP/MAK/64	Leaves	Crushing
	Egasia	Kassod tree	*Senna siamea* Lam.	Caesalpinioideae	SSP/MAK/05	Leaves	Crushing
	Epeduru	Tamarind	*Tamarindus indica* L.	Caesalpinioideae	SSP/MAK/21	Leaves, bark	Pounding
	Ejaye	Marijuana	*Cannabis sativa* L.	Cannabaceae	SSP/MAK/60	Leaves, seeds and roots	Crushing
		Pencil cactus	*Euphorbia tirucalli* L.	Euphorbiaceae	SSP/MAK/20	Sup	Collecting sup
	Ekakale	Castor bean	*Ricinus communis* L.	Euphorbiaceae	SSP/MAK/32	Leaves	Crushing
	Ejumula	Jatropha	*Jatropha curcas* L.	Euphorbiaceae	SSP/MAK/34	Leaves	Crushing
	Etigo	Okra	*Abelmoschus ficulneus* (L.) Wight & Arn.	Malvaceae	SSP/MAK/47	Leaves	Crushing
	Neem	Neem tree	*Azadirachta indica* Juss.	Meliaceae	SSP/MAK/31	Leaves	Crushing
	Ekisimu (b)	Shittim wood	*Acacia hockii* De wild.	Mimosoideae	SSP/MAK/44	Leaves, bark	Pounding
	Etekwa	Light wood	*Albizia coriaria* Oliv.	Mimosoideae	SSP/MAK/14	Leaves, bark	Pounding
	Efene	Jackfruit	*Artocarpus heterophyllus* Lam.	Moraceae	SSP/MAK/35	Leaves	Crushing
	Emoringa	Moringa	*Moringa oleifera* Lam.	Moringaceae	SSP/MAK/07	Leaves	Crushing
	Emapela	Guava	*Psidium guajava* L.	Myrtaceae	SSP/MAK/13	Leaves	Crushing
	Enyait lo chai	Lemon grass	*Cymbopogon citratus* (DC.) stapf	Poaceae	SSP/MAK/50	Leaves	Crushing
	Ekosile	Giant rat tail's grass	*Sporobolus pyramidalis* Beauv.	Poaceae	SSP/MAK/08	Roots	Pounding
	Emucuga	Orange	*Citrus sinensis* (L.) Osbeck	Rutaceae	SSP/MAK/37	Leaves	Crushing
	Usuk	Sand knobwood	*Zanthoxylum leprieurii* Guill. & Perr.	Rutaceae	SSP/MAK/06	Bark	Pounding
	Ekunguru	Shea butter tree	*Vitallaria paradoxa* Gaertn.f.	Sapotaceae	SSP/MAK/42	Roots	Pounding
	Emoto	Witch weed	*Striga hermontica* Benth.	Scrophulariaceae	SSP/MAK/39	Flowers	Crushing
	Etaaba	Tobacco	*Nicotianum tabacum* L.	Sonanaceae	SSP/MAK/17	Leaves	Crushing
	Emajani	Green tea	*Camellia sinensis*	Theaceae	SSP/MAK/70	Leaves	Crushing
	Ebisali	Turmeric	*Curcuma longa* L.	Zingiberaceae	SSP/MAK/48	Rhizome	Crushing
	Etangawuzi	Ginger	*Zingiber officinale* Rosco.	Zingiberaceae	SSP/MAK/59	Rhizome	Crushing
Coccidiosis	Ecucuka	Aloevera	*Aloe barbadensis* Miller	Aloeaceae	SSP/MAK/23	Leaves	Crushing
	Epapaile	Pawpaw	*Carica papaya* L.	Caricaceae	SSP/MAK/36	Leaves, roots, seeds, flowers	Pounding
	Edodoi	Sausage tree	*Kigelia africana* (Lam.) Benth	Bignoniaceae	SSP/MAK/01	Leaves, bark	Pounding
	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
	Eniimu	Lemon	*Citrus limon* (L.) Burm.f.	Rutaceae	SSP/MAK/38	Leaves	Crushing
	Emulalu	Redpepper	*Capsicum annuum* L.	Solanaceae	SSP/MAK/41	Fruits	Crushing
Cough	Ecucuka	Aloevera	*Aloe barbadensis* Miller	Aloeaceae	SSP/MAK/23	Leaves	Crushing
	Eligoi	Yellow oleander	*Thevetia peruviana* (Pers.) Schum	Apocynaceae	SSP/MAK/26	Leaves	Crushing
	Edia apoo	Coatbuttons	*Tridax procumbens* L.	Asteraceae	SSP/MAK/15	Leaves	Crushing
	Enanansi	Pineapple	*Ananas comosus* (L.)	Bromeliaceae	SSP/MAK/54	Fruit, leaves	Crushing
	Egasia	*Kassod tree*	*Senna siamea* Lam.	Caesalpinioideae	SSP/MAK/05	Leaves	Crushing
	Abacci	Ugandan green heart	*Warburgia ugandensis* Sprague subsp.ugandensis	Canelaceae	SSP/MAK/29	Bark	Pounding
	Ejaye	Marijuana	*Cannabis sativa* L.	Cannabaceae	SSP/MAK/60	Leaves, roots, seeds	Pounding
	Ecadoi	Spiderwisp	*Cleome gynandra* (L.) Briq.	Cleomaceae	SSP/MAK/19	Leaves, stem	Pounding
		Snake weed	*Euphorbia hirta* L.	Euphorbiaceae	SSP/MAK/12	Whole plant	Crushing
	Emoringa	Moringa	*Moringa oleifera* Lam.	Moringaceae	SSP/MAK/07	Leaves	Crushing
	Etaget	Banana	*Musa* Pisang Awak	Musaceae	SSP/MAK/68	Banana peelings	Burning to ashes
	Ejambula	Black plum	*Syzygium eminii* (L.) Skeels	Myrtaceae	SSP/MAK/09	Leaves, bark	Pounding
	Ekaka	*Gambian indigo*	*Philenoptera laxiflora* (Guill. & Perr.) Roberty	Papilionaceae	SSP/MAK/02	Bark	Pounding
	Engosorot	Uganda coral	*Erythrinica abyssinica* DC.	Papilionaceae	SSP/MAK/24	Bark	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing

Table 1 continues on the next Page→

TABLE 1 (Continues...): Ethnoveterinary famers' practices for the treatment of chicken diseases in Soroti district.

Disease	Vernacular name (Ateso)	Plant name	Plant species	Family	Voucher number	Plant part	Preparation
Diarrhoea	Aboga	Smooth pig weed	*Amaranthus hybridus* L. subsp. Cruentus (L.) Thell.	Amaranthaceae	SSP/MAK/25	Leaves	Crushing
	Edia apoo	Coatbuttons	*Tridax procumbens* L.	Asteraceae	SSP/MAK/15	Leaves	Crushing
	Ekabegi	Cabbage	*Brassica oleracea* L.	Brassicaceae	SSP/MAK/61	Leaves	Crushing
	Abacci	Ugandan green heart	*Warburgia ugandensis* Sprague subsp.ugandensis	Canelaceae	SSP/MAK/29	Bark	Pounding
	Ecadoi	Spiderwisp	*Cleome gynandra* (L.) Briq.	Cleomaceae	SSP/MAK/19	Leaves, stem	Pounding
	Esuju	Pumpkin	*Cucurbita moschata*	Cucurbitaceae	SSP/MAK/74	Leaves, seeds	Crushing
	Ekoko	Cocoa	*Theobroma cacao*	Malvaceae	SSP/MAK/67	Seeds	Crushing
	Neem	Neem tree	*Azadirachta indica* Juss.	Meliaceae	SSP/MAK/31	Leaves	Crushing
	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves, bark	Pounding
	Ekisimu (a)	Apple ring acacia	*Acacia albida* Delile	Mimosoideae	SSP/MAK/04	Leaves, bark	Pounding
	Etekwa	Light wood	*Albizia coriaria* Oliv.	Mimosoideae	SSP/MAK/14	Leaves, bark	Pounding
	Emoringa	Moringa	*Moringa oleifera* Lam.	Moringaceae	SSP/MAK/07	Leaves	Crushing
	Ejambula	Black plum	*Syzygium eminii* (L.) Skeels	Myrtaceae	SSP/MAK/09	Leaves, bark	Pounding
	Ekaka	Gambian indigo	*Philenoptera laxiflora* (Guill. & Perr.) Roberty	Papilionaceae	SSP/MAK/02	Bark	Pounding
	Emudung	Maize	*Zea mays* L.	Poaceae	SSP/MAK/49	Seed	Eaten directly
	enyait lo echai	Lemon grass	*Cymbopogon citratus* (DC.) stapf	Poaceae	SSP/MAK/50	Leaves	Crushing
	Imumwa	Sorghum	*Sorghum bicolor* (L.) Moench	Poaceae	SSP/MAK/66	Seeds	added to feeds
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
	Usuk	Sand knobwood	*Zanthoxylum leprieurii* Guill. & Perr.	Rutaceae	SSP/MAK/06	Bark	Pounding
	Etulelut	Sodom apple	*Solanum incanum* L.	Solanaceae	SSP/MAK/40	Leaves, fruits	Burning to ashes
		Thorn apple	*Datura stramonium*	Solanaceae	SSP/MAK/75	Leaves	Crushing
	Etangawuzi	Ginger	*Zingiber officinale* Rosco.	Zingiberaceae	SSP/MAK/59	Rhizome	Crushing
Bacterial infections	Emoringa	Moringa	Moringa oleifera Lam.	Anacardiaceae	SSP/MAK/22	Leaves, bark	Pounding
	Ematomboko	Soursop	*Annona muricata* L. f. mirabilis R.E.Fr.	Annonaceae	SSP/MAK/56	Leaves, fruits	Crushing
	Epeduru	Tamarind	*Tamarindus indica* L.	Caesalpinioideae	SSP/MAK/21	Leaves, bark	Pounding
	Elakasi	Common Bush weed	*Flueggea virosa* (Wild.) Voigt	Euphorbiaceae	SSP/MAK/03	Roots	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
	Ekele		*Harrisonia abyssinica* Oliv.	Samourabaceae	SSP/MAK/27	Leaves	Crushing
Body weakness	Aboga	Smooth pig weed	*Amaranthus hybridus* L. subsp. Cruentus (L.) Thell.	Amaranthaceae	SSP/MAK/25	Leaves	Crushing
	Emulondo	Tonic root	*Mondia whytei* (Hook.f.) Skeels	Apocynaceae	SSP/MAK/55	Roots	Pounding
	Equinini	Dwarf Mexican Marigold	*Schkuhria pinnata* (Lam.) O. Ktze.	Asteraceae	SSP/MAK/10	Whole plant	Pounding
	Ekoropot	Wondering Jew	*Commelina benghalensis* L.	Commelinaceae	SSP/MAK/52	Leaves, stems	Pounding
		Thyme	*Thymus vulgaris*	Lamiaceae	SSP/MAK/63	Leaves	Crushing
	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves, bark	Pounding
	Emuria	Bermuda grass	*Cynodon dactylon* (L.) Pers.	Poaceae	SSP/MAK/51	Leaves, stems	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
Chronic respiratory disease	Ecucuka	Fez aloe	*Aloe peglerae*	Aloeaceae	SSP/MAK/28	Leaves	Crushing
	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	leaves, bark	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
Wounds		Mercury goosefoot	*Chenopodium opulifolium* Koch & Ziz	Chenopodiaceae	SSP/MAK/11	Leaves	Crushing
	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves, bark	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
Infectious Coryza	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves, bark	Pounding
	Ekaka	Gambian indigo	*Philenoptera laxiflora* (Guill. & Perr.)	Papilionaceae	SSP/MAK/46	Leaves, bark	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
Fowl pox	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves, bark	Pounding
	Etaget	Banana	*Musa* Pisang Awak	Musaceae	SSP/MAK/68	Peeling	Burning to ashes
	Emaragwe	Common bean	*Phaseolus vulgaris* L	Fabaceae	SSP/MAK/65	Leaves, stems, roots	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
Fowl cholera	Ecucuka	Aloevera	*Aloe barbadensis* Miller	Aloeaceae	SSP/MAK/23	Leaves	Crushing
	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves, bark	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
	Emajani	Green tea	*Camellia sinensis*	Theaceae	SSP/MAK/70	Leaves	Crushing

Table 1 continues on the next Page→

TABLE 1 (Continues...): Ethnoveterinary famers' practices for the treatment of chicken diseases in Soroti district.

Disease	Vernacular name (Ateso)	Plant name	Plant species	Family	Voucher number	Plant part	Preparation
Histomoniasis	Ecucuka	Aloevera	*Aloe barbadensis* Miller	Aloeaceae	SSP/MAK/23	Leaves	Crushing
	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves, bark	Pounding
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing
	Emajani	Green tea	*Camellia sinensis*	Theaceae	SSP/MAK/70	Leaves	Crushing
Ectoparasites	Enyeku mon	Black jack	*Bidens pilosa* L.	Asteraceae	SSP/MAK/18	Whole plant	Bracing with crushed plant in water solution
	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves, bark	Bracing with crushed plant in water solution
	Engosorot	Uganda coral	*Erythrinica abyssinica* DC.	Papilionaceae	SSP/MAK/24	Bark	Bracing with crushed plant in water solution
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Bracing with crushed plant in water solution
	Etulelut	Sodom apple	*Solanum incanum* L.	Solanaceae	SSP/MAK/40	Leaves, fruits	Bracing with crushed plant in water solution
	Etaaba	Tobacco	*Nicotianum tabacum* L.	Sonanaceae	SSP/MAK/17	Leaves	Bracing with crushed plant in water solution
Infectious bronchitis	Ecucuka	Aloevera	*Aloe barbadensis* Miller	Aloeaceae	SSP/MAK/23	Leaves	Crushing and soaking in water
	Ejaye	Marijuana	*Cannabis sativa* L.	Cannabaceae	SSP/MAK/60	Leaves, roots, seeds	Crushing and soaking in water
	Elira	Chinaberry	*Melia azedarach* L.	Meliaceae	SSP/MAK/43	Leaves, bark	Crushing and soaking in water
	Emoringa	Moringa	*Moringa oleifera* Lam.	Moringaceae	SSP/MAK/07	Leaves	Crushing and soaking in water
	Engosorot	Uganda coral	*Erythrinica abyssinica* DC.	Papilionaceae	SSP/MAK/24	Bark	Crushing and soaking in water
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing and soaking in water
Fowl Typhoid	Ecucucka	Aloevera	*Aloe barbadensis* Miller	Aloeaceae	SSP/MAK/23	Leaves	Crushing and soaking in water
	Ejaye	Marijuana	*Cannabis sativa* L.	Cannabaceae	SSP/MAK/60	Leaves, roots, seeds	Crushing and soaking in water
	Epapaile	Pawpaw	*Carica papaya* L.	Caricaceae	SSP/MAK/36	Leaves	Crushing and soaking in water
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing and soaking in water
Pullorum or Salmonellosis	Ecucuka	Aloevera	*Aloe barbadensis* Miller	Aloeaceae	SSP/MAK/23	Leaves	Crushing and soaking in water
	Ecucuka	Fez Aloe	*Aloe peglerae*	Aloeaceae	SSP/MAK/28	Leaves	Crushing and soaking in water
	Emoringa	Moringa	*Moringa oleifera* Lam.	Moringaceae	SSP/MAK/07	Leaves	Crushing and soaking in water
	Eleketete	Portulaca	*Portulaca quadrifida* L.	Portulacaceae	SSP/MAK/30	Whole plant	Crushing and soaking in water

Data were retrieved into tables and used to make Table 1. Quantitative data were entered into MS spreadsheets and imported to Stata 14.2 (https://www.stata.com) and analysed using descriptive statistics.

Participants were identified using time of speaking (1st speaker, 2nd....), frequency of speaking (dominant speaker) and gender. All FGDs were video recorded for accuracy.

Ethical considerations

The survey followed the guidelines of the Uganda National Council for Science and Technology (UNCST) of March 2007 (pp. 21–29). The guidelines for research during the coronavirus disease 2019 (COVID-19) pandemic concerning the safety of respondents (UNCST, 2020) were followed. An ethical review certificate was acquired from the School of Veterinary Medicine and Animal Resources (SVAR_IACUC /93/2021). Approvals were given by the UNCST under the reference number A220ES. Permission to conduct research was also granted by the Soroti District Veterinary Office. The project was registered by the Uganda National Council of Science and Technology (UNCST) under the reference number A220ES.

Results

Focus group discussions on ethnoveterinary knowledge of chicken disease control

The participants were able to differentiate chicken diseases by describing signs; the commonest diseases were New Castle disease (NCD) locally called 'ecoro', coccidiosis, cough, diarrhoea, bacterial infections, weakness, Chronic respiratory disease (CRD), wounds, coryza, fowl pox, fowl cholera, histomoniasis, ectoparasites, Infectious bronchitis (IB), fowl typhoid and pullorum (Table 1). In one FGD, a member struggled to explain the disease that covers the eyes and the other participants unanimously responded 'fowl pox'. This is alluded to the fact that most of them had attained at least secondary education. However, the drugs are given as blanket approaches because it was said in one FGD that:

'We are not sure because we don't know how to differentiate diseases but we just give the drugs when the chicken appear dull.' (FGD1, Dakabela, Arapai Sub-county)

Although the practice has lasted for generations, the quantities that should be administered are still not clear to most users of EVM in chicken. Even participants of the FGDs expressed their uncertainty about the quantities to be administered and the regimen in the following ways;

'We don't have standard doses but when the chicken take voluntarily then what they take is the dose. We don't know for how long we should give these drugs even. We plan that chicken drink the drug for three days although sometimes they are given the drug for up to a week'. (FGD4, Gweri, Gweri Sub-county)

Some participants of the FGDs were aware of the possible occurrence of adverse effects in chicken with the use of EVM; some of them explained adverse effects as quoted below:

'When you overdose Aloe vera, the chicken die, even Moringa products also easily leads to death. Yes especially in severely sick birds or if there is overdose with most mixtures'. (FGD4, Gweri, Gweri sub-county)

The participants explained the circumstances that lead to adverse effects as high concentrations, delayed administration and some plants just having a narrow safety margin. The quotes below are the expressions of the participants about the causes of adverse effects with the use of EVM;

'Mainly Uganda green heart and red pepper damage the liver and lungs because when you slaughter the chicken will have an enlarged and sometimes rotten liver. Marijuana will make birds to have uncoordinated movements and in some cases birds die. Tamarind leads to constipation. The combination of turmeric and red pepper easily leads to death'. (FGD6, Ojama, Katine sub-county)

Generally, it was emphasised in the FGDs that delayed interventions exacerbate the adverse effects.

The participants expressed that ethnoveterinary medicines are widely used in the control of chicken diseases and it is a very acceptable practice by a majority of the communities in Soroti district. The FGD quotes below show positive perception and practice without restrictions:

'Yes we use and know several other that use.' (FGD7, Ochuloi, Katine sub county)

'Not only seeing others but we use plants to treat diseases in our chicken.' (FGD8, Opiyai-Aminit, Northern Division)

'Even me, I also saw where they pound onions and mix in water for chicken to recover from weakness/dullness, when I tried it the chicken even recovered from NCD.'

'My chickens have never died due to diseases, I always get the pawpaw roots, pound and mixed in water against that disease which makes the chicken to emaciate (progressive wasting).' (FGD4, Gweri, Gweri sub-county)

'Marijuana leaves are pound and mixed in water for chicken. Laughter with chorus response "it's like 10% OTC because it treats so many diseases"'.(FGD4, Gweri, Gweri sub-county)

The plant materials are either crushed when fresh or dried and grounded for use. The participants mentioned the various ways of preparing the EVM using water as a solvent in various ways:

'I pound and mix in water, I dilute and prepare a filtrate for chicken to drink against NCD.' (FGD4, Gweri, Gweri sub-county)

'We use the wild Aloe vera against coccidiosis, we pound the leaves after removing the outer layer and add to drinking water.' (FGD4, Gweri, Gweri sub-county)

Some participants mentioned the heating processes of preparation and use of solutes. A combination of dried bean leaves, amaranths and Sodom apples are burned to form ash. The ash is used for topical application on wounds caused by fowl pox but also as a solute in the formulation below:

'I mix ash filtrate and Aloe vera leaves, boil in water and give the birds to drink after cooling.'

Marijuana was over-emphasised as being effective on many chicken diseases. Almost every part of the plant is important in the control of chicken diseases according to the farmers of Soroti district. The quotes below are some of the expressions during the FGDs:

'Marijuana leaves are pound and mixed in water for chicken. Laughter with chorus response "it's like 10% OTC because it treats so many diseases"'. (FGD4, Gweri, Gweri sub-county)

'The roots, stems, leaves and seeds of marijuana, we boil the leaves for about 25 minutes in water and give the chicken to drink against NCD. The seeds are fed directly to the chicken. The roots are pound and mixed in cold water for chicken to drink.' (FGD7, Ochuloi, Katine sub-county)

'Sorghum seeds [*Sorghum bicolor* (*L.*) *Moench*] mixed with marijuana seeds [*Cannabis sativum L.*] and chicken will eat against diarrhoea, it's not possible to determine the dose but just mix the marijuana seeds with sorghum and the bird will know the dose'. (FGD2, Arabaka, Arapai sub-county)

Sample characteristics

Pooled data were used to generate information about particular plants, especially how they are used and diseases treated (Table 1).

Figure 3 to Figure 8 are representative of the constructs of chicken owner questionnaire respondents (Supplementary file 2). Most respondents were males (73.0%; 57/78), and most

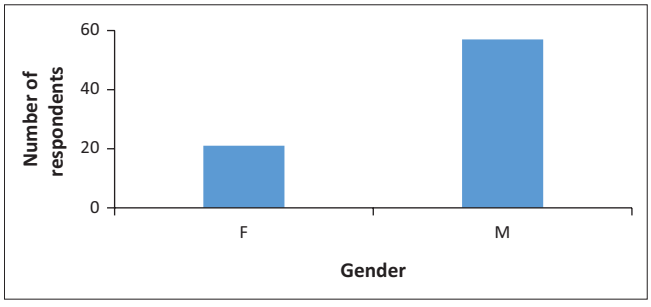

FIGURE 3: The gender of chicken owner questionnaire respondents.

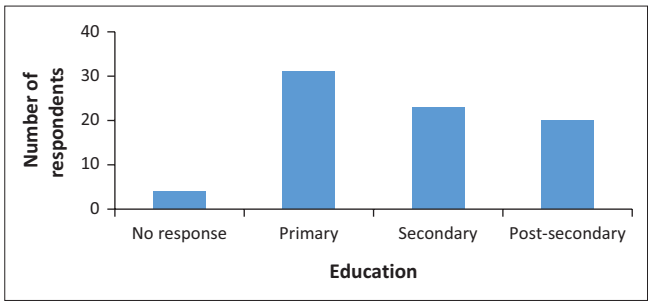

FIGURE 4: Education level of chicken owner questionnaire respondents.

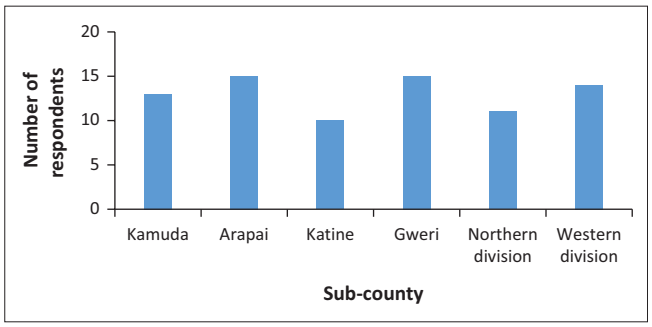

FIGURE 5: Sub-counties of chicken owner questionnaire respondents.

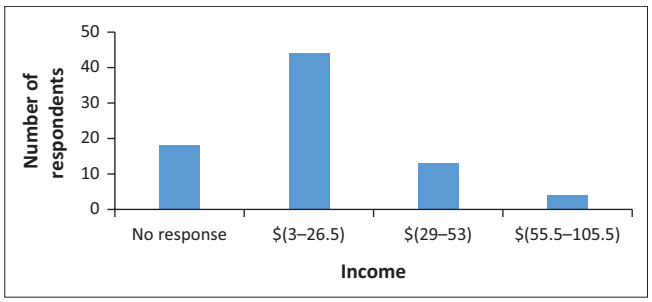

FIGURE 6: Monthly income from chicken of respondents in US dollars.

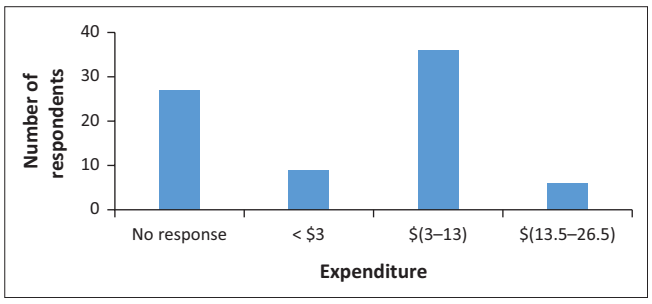

FIGURE 7: Monthly expenditure on chicken of respondents in US dollars.

chicken owners had attended above secondary education. Most chicken owners (56.4%; 44/78) reported an average monthly income of ($3.00–$26.50) and majority (46.2%; 36/78) reported an average monthly expenditure of ($3.00–$13.00). A majority (33.4%; 22/78) reported they had (41–100) chickens.

Constructs for knowledge about usage of ethnoveterinary medicine from farmer questionnaires

The constructs measuring knowledge are shown in Figure 9 to Figure 22. Up to 91% (71/78) of the respondents use EVM with 82% (64/78) believing that EVM are effective. About

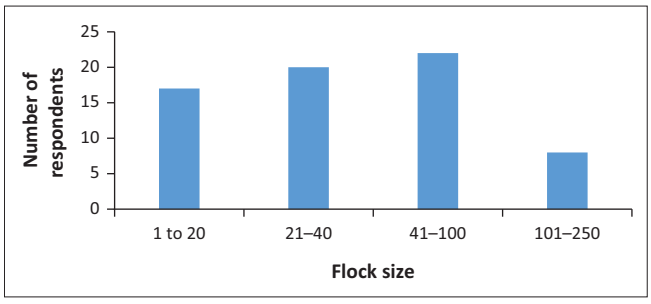

FIGURE 8: Chicken flock sizes of the respondents.

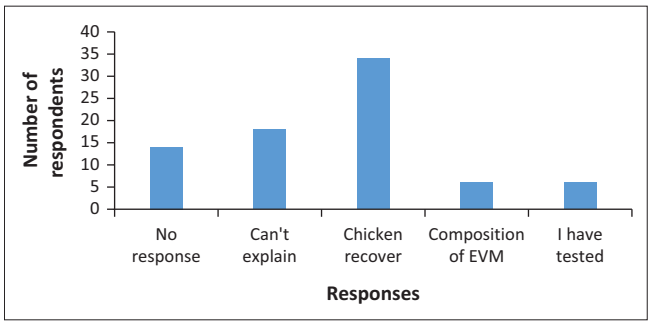

FIGURE 9: The reasons why respondents think that ethnoveterinary medicines are effective.

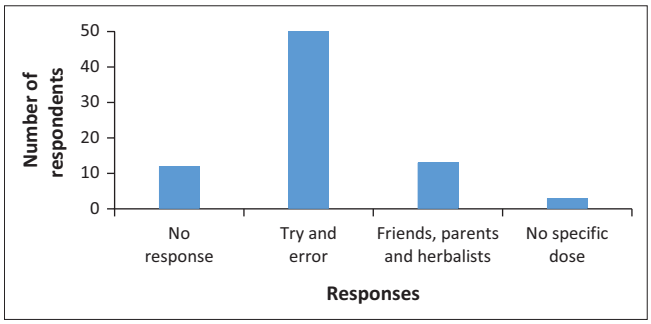

FIGURE 10: How respondents come up with ethnoveterinary medicine doses.

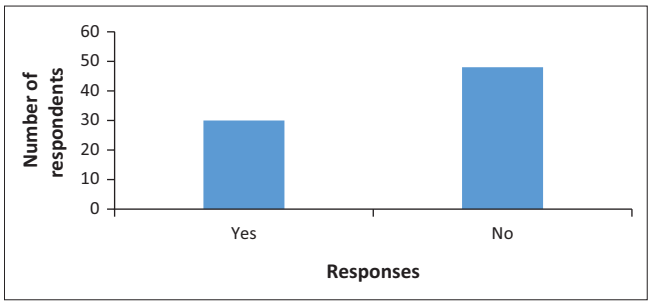

FIGURE 11: Whether respondents have noticed adverse effects or not after administering ethnoveterinary medicine.

42.3% (33/78) of the respondents considered EVM effective because when they use them, chickens recover although most of them (64.1%; 50/78) establish doses by trial and error. The respondents were familiar with EVM's adverse effects and 38.5% (30/78) had observed various adverse effects. The most reported adverse effects were weakness (25%; 14/56), diarrhoea (19.6%; 11/56), death (17.9%; 10/56), a lack of appetite (10.7%; 6/56) and a lack of body balance (10.7%; 6/56). The respondents (44.8%; 13/29) reported high concentration as the likely reason for the adverse effects.

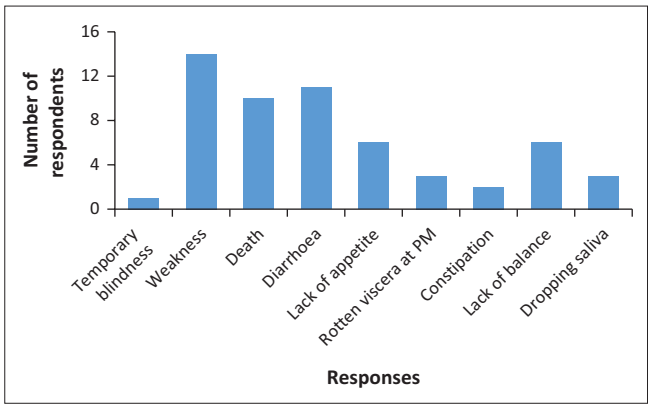

FIGURE 12: May you explain the adverse effects observed.

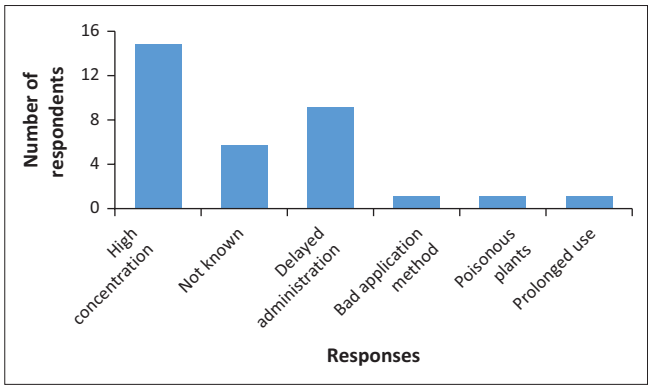

FIGURE 13: The possible reasons for the adverse effects.

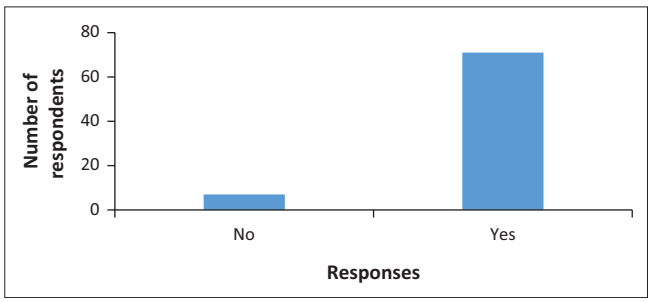

FIGURE 14: The respondents who use ethnoveterinary medicine.

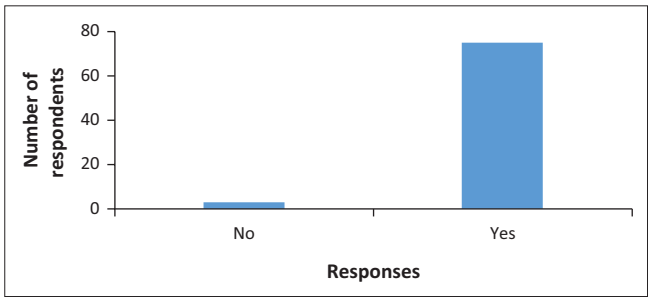

FIGURE 15: The respondents who know people using ethnoveterinary medicine.

About 29.5% (23/78) of the used EVM materials are planted, and 62.7% (42/67) got from neighbours and friends. Only 62.5% (49/78) of the respondents affirmed that they freely share their EVM knowledge. Some (21.8%; 17/78) respondents confessed using human drugs to treat chicken diseases, and various human formulation antibiotics are being used by chicken farmers to treat cough, diarrhoea, coccidiosis and NCD.

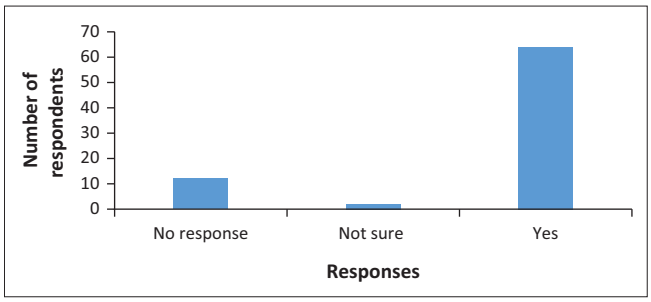

FIGURE 16: The respondents who feel ethnoveterinary medicines are effective.

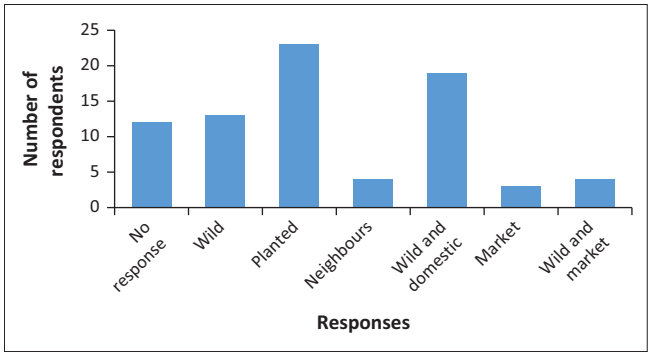

FIGURE 17: The sources of ethnoveterinary medicine.

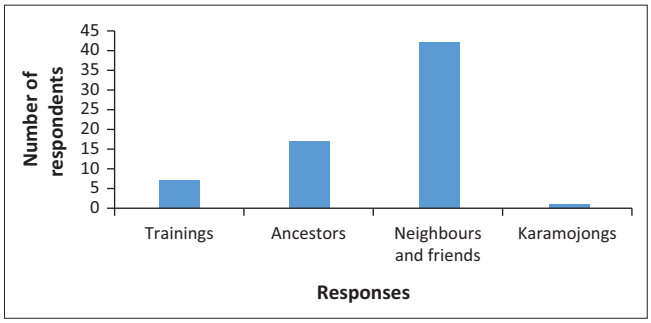

FIGURE 18: How is the knowledge of ethnoveterinary medicine acquired?

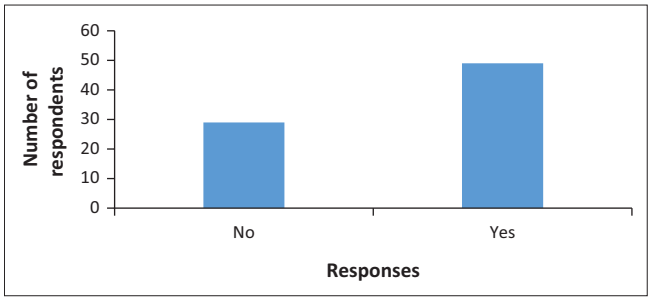

FIGURE 19: Whether respondents freely share ethnoveterinary medicine knowledge or not?

Figure 9 to Figure 22 show ethnoveterinary knowledge in chicken farming.

Discussions

The commonest families listed against NCD were Euphorbiaceae, Amaryllidaceae, Mimosoideae, Poaceae, Rutaceae and Zingiberaceae (Table 1). The use of the family Euphorbiaceae in ethnoveterinary practice is in agreement with Abd-Alla et al. (2019) who used *Jatropha curcas* and

Ricinus communis against NCD. Bulus and Zaro (2019) found garlic extracts (Amaryllidaceae) effective and Batiha et al. (2022) found the genus Acacia (Mimosoideae) effective against NCD. The use of the family Rutaceae in ethnoveterinary practice is in agreement with Nazhan, Majeed and Abd (2019) and those about Zingiberaceae are in agreement with Al-bawi and Rabee (2020). Abraham-Oyiguh et al. (2019) also found out that *Cymbopogon citrus* (Poaceae) were effective against NCD. The most mentioned families against coccidiosis were Aloeaceae, Caricaceae, Bignoniaceae, Meliaceae, Portulaceae, Rutaceae and Solanaceae. The use of the family Aloeaceae in ethnoveterinary practice is in agreement with Ahmad et al. (2020a) and the use of the family Caricaceae against coccidiosis is in agreement with Akhter et al. (2021). Onyiche et al. (2021) also affirm the actions of the Meliaceae against coccidiosis. The action of the family Rutaceae against coccidiosis is in agreement with Nazhan et al. (2019) and the action of the family Solanaceae against coccidiosis is in agreement with Ishaq et al. (2022). Papilionaceae was the most mentioned against cough, and this is in agreement with Ye et al. (2022) who worked on chicken. Poaceae was the most mentioned with genera against diarrhoea, and Vandebroek and Picking (2020) affirm the action of the family Poaceae against diarrhoea although their work was not in chicken. The families that were mentioned with genera against bacterial infections were Anacardiaceae, Annonaceae, Caesalpinioideae, Euphoribiaceae, Portulaceae and Samourabaceae. The use of the respective mentioned families in ethnoveterinary practice is in agreement with the experimental work of Calderón-Toledo et al. (2022), Da Silva et al. (2021), Ullah et al. (2021), Karunarathne et al. (2021), Egamberdieva et al. (2022) and Kilonzo and Munisi (2021). Meliaceae was mentioned against coryza, and this ethnoveterinary practice is in agreement with Jadeja et al. (2005). The mentioning of the family Meliaceae against fowl pox is in agreement with Singh and Tiwari (2021). The actions against ectoparasites of the families of Asteraceae, Meliaceae, Solanaceae and Sonanaceae are in agreement with the work of Lagat, Ng'wena and Mwaniki (2021), Abdel-Ghany et al. (2019) and Sahina and Esakkiammal (2022), respectively. The families of Moringaceae and Portulacaceae were mentioned to have actions against infectious bronchitis. However, Moringaceae and Portulacaceae only boost poultry immune systems according to Khan et al. (2021) and Khazdair et al. (2021), respectively.

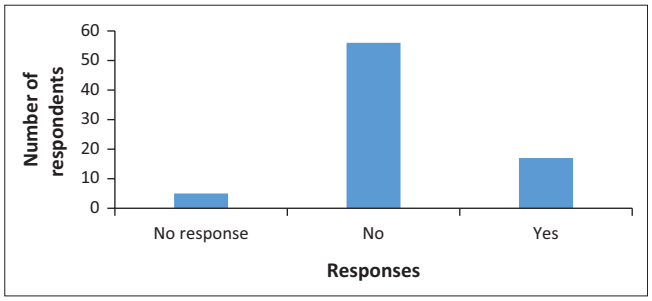

FIGURE 20: Whether human drugs are used to treat chicken diseases or not?

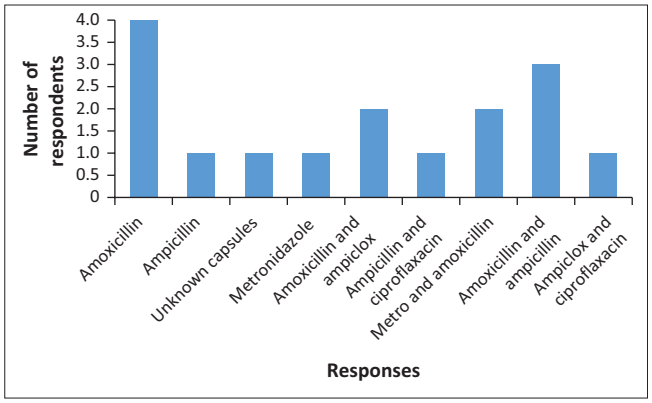

FIGURE 21: The human drugs that respondents use to treat chicken.

Most of the chicken owners gave pragmatic responses regarding why they said that EVM are effective (Figure 9 to Figure 13), and this implies that farmers showed knowledge; it was deduced that informal training on ethnoveterinary medicine in chickens is useful and impactful. This concurs with Sodjinou et al. (2022). The FGDs of knowledge reflect an inclination towards the coherence theory of truth rather than pragmatism. Some participants just depend on the claims of

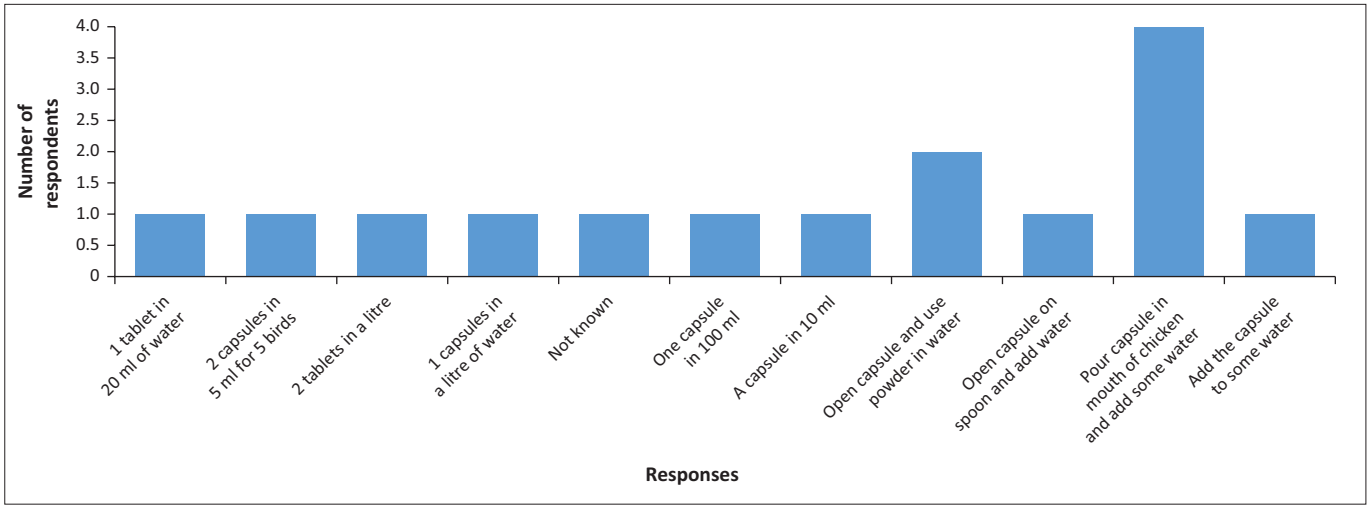

FIGURE 22: How do respondents constitute human drugs to treat chicken?

other users as plausible. The responses implied an over-dependence on unproven claims in the use of EVM to control chicken diseases. Participants did not have standard doses of EVM in chicken. The methods of dose and regimen establishment predispose the chicken to risks as evidenced by the EVM's adverse effects. Some farmers were knowledgeable of the adverse effects and could associate them with specific factors, predict the problem and propose solutions. Many of the participants were using EVM and knew others who were using EVM to treat chicken. The participants were satisfied with the action of EVM and were confident that EVMs are effective. The findings are in agreement with Bamidele et al. (2022) who found the participants agreeable with EVM. Ethnoveterinary medicine for treating chicken is acceptable possibly because they are usually cheap compared to conventional synthetic medicines (McGaw & Eloff 2008).

The use of wild sources which was a practice of the majority of the respondents is not sustainable because such sources wane because of destruction for agriculture and human settlement. The medicinal plants will get extinct with use unless a planting campaign is done. Knowledge is acquired mostly from neighbours and friends showing the role of informal sharing and relationship with peers in chicken disease control. Those who were not willing to share knowledge reflect the level of secrecy that is still in EVM practices in the protection of personal business, intellectual property and traditional norms. The human drugs that some participants confessed using treating chicken were amoxicillin, ampicillin, metronidazole, ampiclox, sodium hypochlorite, metronidazole and ciprofloxacin. They were stated to be used in treating cough, diarrhoea, NCD and coccidiosis. The use of human drug formulations in treating chicken can cause public health concerns and cascade to antimicrobial resistance (AMR) in chickens and humans. The use of human drugs in chicken can also lead to rejection of the chicken products by the national food regulatory bodies and markets.

There is a need to test the claims put forward by farmers regarding the action of the plants against chicken diseases. Research institutions need to plausibly study the safety of these plants to guide the farmers on acceptable doses. The government and chicken stakeholders together with drug authorities ought to monitor the researches on the use of plant medicines in chicken and guide the scaling up together with the international partners. The approved plants and plant materials should be included in school curricula for learning ethnoveterinary knowledge. The World Organization of Animal Health (WOAH) and the Food and Agriculture Organization (FAO) need to support investigations of the use of plant medicines in chickens given their advantages of guiding pharmacognosy, use in organic farming and as alternatives to AMR organisms. There is an urgent need for a policy on use of plant medicines from the wild forest reserves. There is a need for setting up centres for the propagation of endangered species and domesticating essential wild species. There is a need for quality standards and labels for products of chicken use to protect users from fraud. However, the risks that the use of plant drugs could exacerbate AMR should be studied and quantified.

Conclusions and implications

Ethnoveterinary medicines are useful in the search for alternative medicines to treat chicken diseases. The participants' knowledge of EVM in chicken is insufficient and predisposes the chicken to possible adverse events. Although EVMs are acceptable and popular, the users are concerned about adverse effects. The practices are woven into the coherence theory and need to be tested based on the Bayesian theorem which gives a critical holistic evaluation. The research shows opportunities for alternative drugs and exposes the risks of EVM's adverse drug events.

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

G.Z. conceptualised and designed the study, and collected data. G.Z., J.K., S.N., P.V., S.B. and J.O.A. interpreted the data. G.Z. wrote the initial draft of the article. All authors reviewed the article and approved it to be submitted for publication. All authors are in agreement regarding all aspects of the work.

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Data availability

The datasets compiled and analysed in this study are publicly available as supplementary files. The datasets used and/or analysed during the current study can also be accessed from the corresponding author (G.Z.) upon reasonable request.

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