Use of indigenous methods to control gastro-intestinal nematodes in chickens

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By

Nkanyiso G Majola

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Supervisor: Professor M Chimonyo

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Declaration

I, **Nkanyiso Goodman Majola** declare that the research reported in this dissertation, except where otherwise indicated is my original work. This thesis has not been submitted for any degree or examination at any other university besides the University of KwaZulu-Natal. This dissertation does not contain other person's writing, data, graphs or other information, unless specifically acknowledged as being sourced from other persons.

Signed .... Date..

Name: **Mr Nkanyiso Goodman Majola**

As the Research Supervisor, I agree to the submission of this dissertation/thesis for examination.

Signed .... Date..

Name: **Professor Michael Chimonyo**

General Abstract

Millions of resource-limited farmers depend on indigenous knowledge (IK) to sustain chicken health. The level of understanding on these IK systems is low. The objectives of the study were to: (1) explore IK used to control gastro-intestinal nematodes in chickens; (2) assess the extent of use of IK to control gastrointestinal nematodes (GIN) in chicken and to (3) evaluate the efficacy of selected medicinal plants used by farmers to control GIN in chickens. The study was conducted in the Jozini local community. Indigenous knowledge is sourced from parents, forefathers, knowledgeable community members through oral communication. Medicinal plants are prepared using different methods such as boiling and soaking in water. Chickens are dewormed after displaying clinical symptoms of GIN infestation. Birds take a maximum of three days to recover after treatment. Male farmers were 3.968 times likely to be using IK than females. Male farmers were more cultural and depended on IK more than females. Farmers owning larger flock sizes were 8.196 times more likely to use IK than farmers with small flock sizes. Resource-limited farmers were 1.701 times likely to use IK than less-poor farmers. Famers owning cattle were 1.998 times likely to use IK than farmers not owning cattle. The extent of use of IK was influenced by demographics and the availability of medicinal plants. The medicinal plants tested in Trial 3 were *Gomphocarpus physocarpus*, *Cissus quadrangularis* and *Aloe maculata*. These were the popular plants used in Jozini. Birds on the control had higher mean faecal egg count (FEC) (321.3) of than *Gomphocarpus physocarpus* (270), *Cissus quadrangularis* (185) and *Aloe maculata* (155). These results showed that the selected medicinal plants have anthelmintic potential and needs to be promoted.

Keywords: medicinal plants, gastro-intestinal nematodes, anthelmintics, faecal egg counts.

Dedication

I dedicate this dissertation to my mother (**Thuleleni Mavis Majola**) who did not get an opportunity to go to school but managed to raise us as a single parent.

Ngethulela lomqulu wocwaningo lwezobungcweti kwezolimo kumama wami (**Thulelemi Mavis Majola)** ongazange alithole ithuba lokuya esikoleni kodwa wakwazi ukusikhulisa engumfelokazi. Ngithi unwele olude Nkosikazi Majola, Ngqulunga, Phakade, Yeyese, Mchunu, Macingwane isandla sidlula ikhanda ngyabonga.

So that people may see and know, may consider and understand, that the hand of the LORD has done this, that the Holy One of Israel has created it.

Isaiah 41:20 (NIV)

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To the only wise God…

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N.G Majola, M.V Mkwanazi, S.Z Ndlela, M. Chimonyo. Exploitation of indigenous knowledge in controlling gastro-intestinal nematodes in chickens.

N.G Majola, M.V Mkwanazi, S.Z Ndlela, M. Chimonyo.Extent of the use of indigenous knowledge to control gastro-intestinal nematode infestations in chickens.

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Chapter 1
General Introduction

1.1 Background

Chickens contribute 70 % of meat and eggs and 20 % of protein intake in developing countries (Padhi, 2016). Most of the chickens kept under the scavenging systems are of the indigenous genotype. They are raised by resource-limited farmers at low input costs and mostly raised in combination with goats, sheep and cattle (Mtileni *et al*., 2011; Malatji *et al*., 2016). In addition to providing meat and eggs, chickens have economic potential and cultural or aesthetic interest to resource-limited households (Mitileni *et al*., 2012). Extensive production systems expose chickens to nematode infestations (Mwale and Masika, 2009).

Nematode infestation is a major health issue to chickens due to its cause in economic losses and declined productivity of chickens (Mwale and Masika, 2009). Nematodes are deleterious on nematode-infected birds, especially in chicks, where mortalities can be high (Radfar *et al*., 2012). Nematodes are chronic infestation that contributes to morbidity and mortality in chickens (Koski and Scott, 2003). The most common species of nematodes include *Ascarida galli, Hetarakis gallinarum, Subulura brumpti, Capillaria apillarias* (Baboolal *et al*., 2012).

Anthelmintics are widely used to control nematodes in chickens, particularly in the deep litter system. The challenge is that some nematode species has developed resistance to anthelmintics. The resistance of nematodes to anthelmintics calls for the need to explore alternatives (Mwale and Masika, 2009). Locally available indigenous medicinal herbs are potential alternatives for the control of nematodes in chickens.

Indigenous knowledge develops within the community through observations and life experiences over time. Indigenous knowledge systems are communicated orally or otherwise from one generation to the other with the aim of ensuring survival and progress (Offial *et al*., 2011). The knowledge develops in the process as people interact with their environment and science (Hunde *et al*., 2006). Indigenous knowledge and practices are, however, threatened by the rapid rural-urban migration and substitution of indigenous with modern practices. The population of the older generation is fast depleting due to death and short life expectancies, whereas the knowledge they possess is largely undocumented. Ethno-veterinary information is in danger of extinction because of lack of institutional support.

1.2 Justification

It is worth conducting and documenting the dying information on indigenous methods that are used to treat nematodes in chickens. Resource-limited farmers and traditional practitioners usually are the reservoirs of the effective medicinal herbs. It is important to widely disseminate optimum dosages for such medicines which increases accuracy and efficacy. This also helps to reduce overharvesting of medicinal plants. Understanding the efficacy of medicinal plants is likely to prevent over-exploitation of these plant parts that are effective and could encourage farmers to grow these plants in their surrounding environments. Farmers may learn that even the little portion of the plant part is effective. Instead of harvesting much more of that plant part the farmers will then harvest with reference to the dose requirements. Researchers are expected to continue exploring potential alternative and sustainable ways of nematode control and expand in the field of ethnophamacology. Increased funding may be channelled towards promoting research in IK and identifying the most effective remedy for different environmental locations. The findings from these investigations are expected to benefit future generations. Animal health experts, who constantly work closely with farmers, use the outcomes of the research to develop appropriate recommendations on how to use indigenous methods to successfully improve poultry production and health care. Animal health experts can use indigenous plant herbs and process them in different ways and forms. The outcomes from this research encourages agricultural extension services to promote the use of IK in animal health. The outcomes of enhance sustainable agricultural development because it will identify, document and incorporate IK to agricultural extension organisations. The study provides the basis for local level decision-making, which is most apparent in formal and informal community associations and organisations. Communities should be able to identify challenges and seek solutions through experimentation and innovations.

1.3 Objectives

The broad objective of the study was to determine the indigenous methods used in controlling nematodes in chickens. The specific objective(s) are to:

1. Explore indigenous knowledge (IK) used to control gastrointestinal nematodes in chickens;
2. Assess the extent of use of IK to control gastrointestinal nematodes in chickens and
3. Affirm the efficacy of selected medicinal plants used by farmers to control gastrointestinal nematodes in chickens.

1.4 Hypotheses

1. Indigenous knowledge is used by resource-poor farmers to control GIN in chickens
2. The extent of use of IK is varies with demographics and the availability of medicinal plants.

3. Medicinal plants are effective in controlling GIN in chickens

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Chapter 2
Literature Review

2.1 Introduction

There is a resurgence of interest for poultry products from free-range and deep-litter production systems (Abdelqader *et al*., 2012). Chickens contribute immensely to resource-limited households, especially to landless women by enabling access to healthcare and education. Moreover, they contribute to sustainable development goals, and to future food security through maintaining biodiverse genomes (Wong *et al*., 2017). Keeping of chickens is more advantageous to woman as they have more control over poultry production and marketing without seeking permission from their husbands (Abebe and Tesfaye, 2017). The importance of chickens in communal production systems is along with many consumer preferences for their products, which suggests that these genetic resources are promising options to enhance food security in the rural communities. In extensive production systems the rearing of chickens is, however, characterised by low productivity and high mortality (Malatji *et al*., 2016). Amongst other challenges, resource-limited farmers face serious feed shortages, as most of them are food insecure (Mwale and Masika, 2009). As a result, chickens scavenge around homesteads in contaminated surroundings with infective nematode eggs.

Nematode infestations reduce productivity and increases morbidity and mortality in chickens. The high prevalence of nematode infestation is strongly associated with low levels of management and poor hygiene (Alam *et al*., 2014; Butboonchoo and Wongsawad, 2015). Nematodes are usually controlled using anthelmintics in intensive production systems. These are, however out of reach for majority of resource-limited farmers as they are expensive and, at times, their supply is erratic.

The use of anthelmintics also imposes negative impacts, such as development of nematode resistance against anthelmintics, especially if overdosed or due to infrequent applications (Mwale and Masika, 2009). This has, therefore, increased interest towards alternative control strategies such as use of IKS and utilization of ethno-veterinary remedies.

Indigenous knowledge are a set of perceptions, information and behaviours that guide community members of how to best use their natural resources (Ngulube, 2017). Use of IK has always been part of practice to resource-limited farmers for centuries (McGaw and Eloff, 2008). The ethno veterinary remedies are effective and locally available to resource-limited farmers (Malatji *et al*., 2016). The preparation and the method of use depend on the knowledge, beliefs and experience that the user might have. The review also discusses the role of chickens in empowering women, enhancing food security, promotion of organic meat production. This chapter explores existing information on the potential use of IK to control GIN in chickens. Importance of IK in controlling nematodes in chickens and common types of nematodes infesting chickens. The review also identifies possible areas needing further research, concerning IK.

2.2 Importance of chickens in rural economies

Women are, generally, less privileged when it comes to livestock ownership, under normal circumstances woman are owners and managers of chickens. Whereas males, on the other hand are owners of cattle and goats. Chickens contribute substantially to women empowerment, ensuring seasonal food security and provision of cash flow and organic meat.

2.2.1 Role of chickens in empowering women and youth

The empowerment of women is determined by the increase of economic benefits and role within the household economy (Kabeer, 2005). Empowerment is a long-term process to achieve, whereby women can take control of their lives, setting their own agendas, gaining skills, increasing self-confidence, solving challenges and being self-reliant (Kabeer, 2005). Chickens empower women socially, economic, phycologically and technically (Mathialagan, 2014). Chickens are the useful tool to empower rural woman and improving their social status. Farming scavenging poultry should, therefore, be promoted by public institutions such as government and non-governmental development agencies. Farming chickens by women increases independent decision-making authority and enhance the involvement of women in their family affairs, thereby promoting socio-economic development of the rural sector (Kabeer, 2005). Participating in poultry rearing projects positions rural women in business management skills (Ruchi and Jadoun, 2014). Therefore, such projects empower women through enhancing their economic benefits. Rearing of scavenging chickens is the most significant factor associated with women empowerment because these chickens are raised at minimal financial inputs and resources such as land, feed supplements and housing. Scavenging chicken farming should, therefore, be promoted to benefit rural women. Figure 2.1 shows empowerment categories and their beneficial effects to women in communal production systems. Approximately 80 % of poultry in Africa is found in communal production systems (Goromela *et al*., 2006). However, these largely available chickens are not fully exploited to benefit women and youth (Ajani *et al*., 2015). The higher increase in urbanisation means that the demand of animal products are going to increase (Melesse, 2014) to feed the growing human population. These chickens therefore have the potential of creating opportunities for majority of youth that remains unemployed.

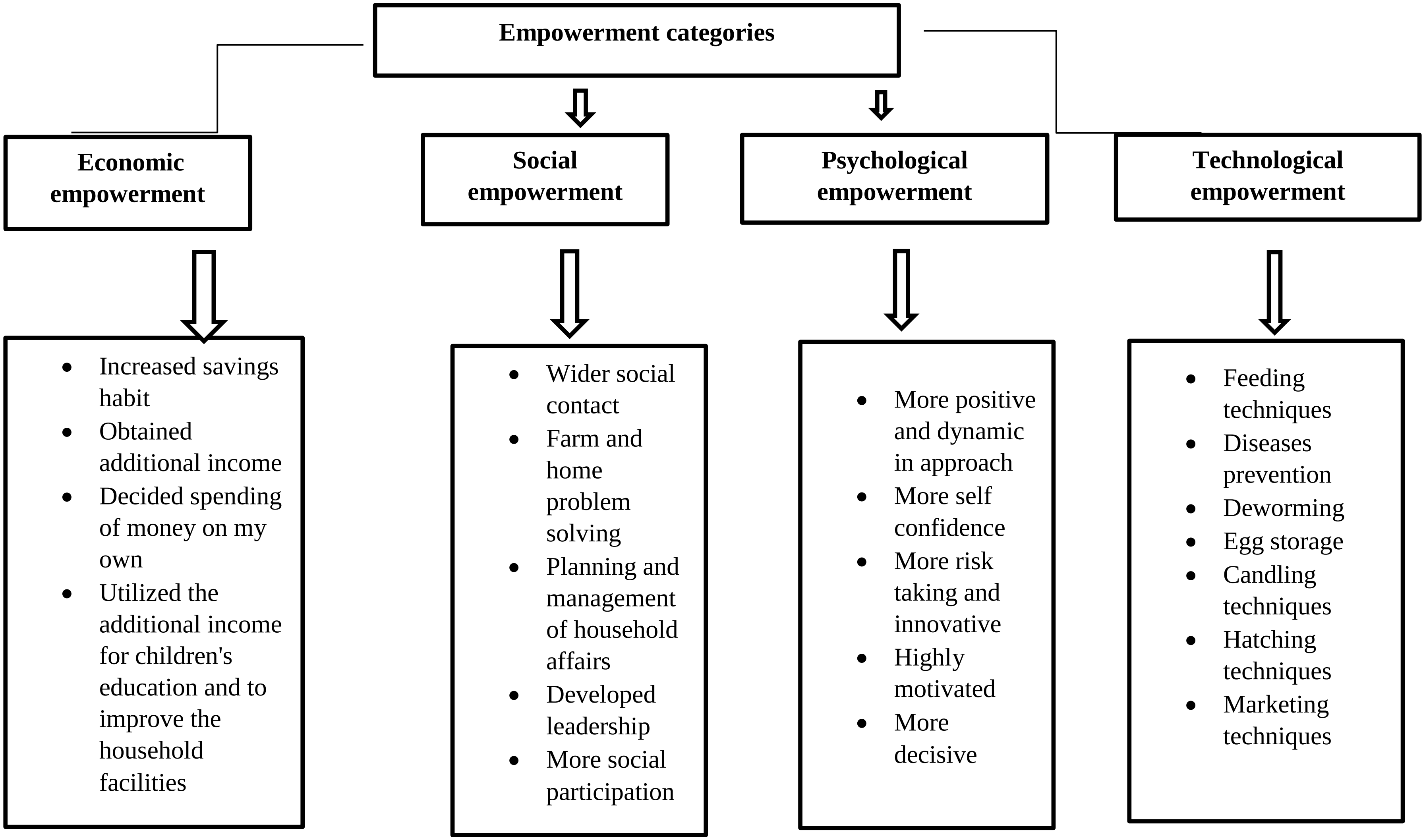

Figure 2.1: Empowerment categories and their beneficial effects to women

2.2.2 Enhancing food security

Food security occurs when all people, during all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preference for an active and healthy life (Yusuf, 2014). This definition is based on two related pillars that comprises of availability and access to food. FAO (2006) defined food availability as foods of appropriate quality that are culturally and socially acceptable by a given population. Even though food may be available, however lack of purchasing potential or power to the less fortunate households make them suffer from food insecurity. Although most countries are food secure at the national level, however majority of rural households still suffer from food insecurity. One of the possible ways to achieve food security at household level is to improve the productivity of scavenging chickens. This is attributed to meat and eggs being consumed at household level without going through formal marketing channels. Four out of five households in resource-limited communal production systems keep chicken strains. The conditions are fragile and marginal. Efforts to enhance the availability and access to proper nutrition is needed to improve the livelihoods of communities. Chicken provides cheap, readily harvestable protein-enriched white meat and eggs with high digestible protein (Mapiye and Sibanda, 2005). Chickens contribute through increasing the availability, accessibility, utilisation and stability of supply of food and nutrients leading to zero hunger, good health and well-being of rural people.

2.2.3 Provision of household income

Chickens are important to rural households in the provision of cash flows, though their contribution to household economy is relatively scant (Muchadeyi *et al*., 2005; Mapiye *et al*., 2008) and undocumented. As a result, their economic importance and contribution to food security is unappreciated at a national level in most African countries. Poultry contribute significantly through meeting welfare needs and raise living standards of resource-poor communities. Chickens serve as buffers or banks where they are sold to meet household necessities such as paying school fees and medical costs (Yusuf, 2014). Chickens have a potential to raise income for rural people hence, proper development of chicken production systems is crucial particularly in this era where human population is also increasing, as a gateway to sustainable provision of cash flows.

2.2.4 Provision of organic meat

Organic meat is meat produced using ecological resources, such as natural by-products with low alternative value (Kumm, 2002). For example, feed produced without use of artificial fertilizers, chemical pesticides and genetically modified organisms (Chander *et al*., 2011; Bodapti *et al*., 2013). Chickens raised organically are expose to natural behaviour having access to outdoor throughout seasons and use of simple buildings. Promotion of organic meat production is crucial due to its importance in sustainable food supply. Organic meat production from inherent indigenous breeds has the potential for ensuring food security for communal farmers and their generations by turning unusable materials into usable products. Indigenous knowledge of farmers could determine the success of organic poultry meat production. Knowledge of ecological systems, environment and on-farm renewable resources as organic farming is concerned (Bodapti *et al*., 2013). Indigenous knowledge and practices that farmers use in rearing village chickens enhance the taste and safety attributes of organically produce meat. Communal farmers value their production systems, which they consider wholesome resulting in mature and tasty organic meat with several nutritional benefits. All these functions of villages are compromised by nematode infestations.

2.3 Common types of gastro-intestinal nematodes infesting chickens

Generally, resource limited farmers identify and classify GIN using colour patterns, shape, size and predilection site. The naming of GIN species is also done using indigenous names through the different colour patterns and size. However, when it comes to control farmers do not separate GIN because the plant remedies are broad spectrum. Gastro-intestinal nematodes are one of the three important classes of helminths, which are cestodes and trematodes (Khan *et al*., 2016). Table 2.1 shows the prevalence of GIN and cestodes examined in free-range local chickens Amongst helminths, GIN are the most widely known for the level of damage they cause in chickens, particularly in situations of heavy infestation (Tesfaheywet *et al*., 2012; Khan *et al*., 2016). Gastro-intestinal nematodes cause severe chronic diseases and economic losses to farmers (Radfar et al., 2012). The three GIN species are *Ascaridia galli*, *Heterakis gallinarum* and *Capillaria* species (Uhou *et al*., 2013; Khan *et al*., 2016).

Table 2.1: Prevalence of gastro-intestinal nematodes and cestodes examined in free-range local chickens

Helminth species	Number of chicken sampled	Prevalence (%)
Raillietina echinobothridia	125	65
Raillietina tetragona	125	50
Raillietina cesticillus	125	4.9
Choanotaenia infundibulum	125	9.9
Heterakis gallinarum	125	12
Ascaridia galli	125	22

Source: Idika *et al*. (2016)

2.3.1 *Ascaridia galli*

Ascaridia galli are the most prevalent nematode in terms of number and percentage of infection they cause in chickens (Table 2.1). Idika *et al*. (2016) study confirmed, that *A. galli* are the most prevalent nematode and third most prevalent helminth species in the local chickens with a prevalence rate of 22 % followed by *H. gallinarum* (12 %) which ranked 4th in the overall prevalence.

Ascaridia galli infects chickens of all age groups, although the greatest incidence of damage is normally seen in younger birds under 12 weeks of age (Belete *et al*., 2016). It causes ascaridiasis, a disease of poultry due to heavy worm infection, particularly in chicken. In addition, *Ascaridia galli* acts as a potential vector for Salmonella diseases (Kijlstra and Eijck, 2006). Heavily infested chickens with *Ascaridia galli* spp, have reduced feed efficiency leading to weight depression. More so, reduced egg production may occur (Belete *et al*., 2016). During heavy infestation adult worms of *Ascaridia galli* cause intestinal blockage and move up the oviduct, hence sometimes they are normally found in eggs (Jacobs *et al*., 2003). Naphande and Chaudhari (2013) reported that during infestation *Ascaridia galli* may accumulates toxins that are harmful to the enzyme systems of the intestinal mucosa of the chicken. The lifecycle of *Ascaridia galli* is direct its does not require an intermediate host as it lays eggs in the small intestine and multiplies quickly.

2.3.2 *Heterakis gallinarum*

Heterakis *gallinarum* (28 %) was the second most prevalent GIN parasites (Uhuo *et al*., 2013); these findings are not surprising because research has consistently reported *H. gallinarum* to have little pathogenicity. Findings by Katoch *et al*. (2012) also reported Ascaridia galli as the most prevalent helminth species (30 %) in the region, with *Heterakis gallinarum* (24.0%), *Raillietina cesticillus* (19 %) and *Raillietina echinobothrida* (14 %) also being common (Katoch *et al*., 2012). The differences in these studies, could be exacerbated by the view that nematode infection rates depend on numerous factors such as rainfall pattern, locality, soil type and type of feed given to chickens often differ from place to place. High prevalence of *Heterakis gallinarum* can be attributed to the wide spread and easy accessibility of intermediate hosts (beetle, houseflies) to the local chickens.

The presence of *Heterakis gallinarum* also possess enhanced danger of transmitting pathogenic infection called *Histomonas meleagridis* (Belete *et al*., 2016). Once the chicken is infested with Heterakis gallinarum, the caecal wall thickens and cause cloacal dirtiness (Uhou *et al*., 2013; Mwale and Masika, 2015). Bettrige *et al*. (2014) reported that *Heterakis gallinarum* infestation suppresses the immune system of the chicken.

2.3.3 *Capillaria*

Capillaria species are highly pathogenic and are more common in chickens kept in deep-litter or free-range systems (Park and Shin, 2010). In the deep-litter systems, there is increase accumulation of infective eggs of Capillaria species. Heavy infestations lead to thickening of the oesophagus, inflammation of the crop wall. Chickens also become emaciated, weak and anaemic, excrete bloody diarrhoea and haemorrhagic enteritis in heavy infecstations. *Capillaria* species are harmful to chicks that are less than three months of age due to underdeveloped immunity whereas adult birds tolerate infestations (Wuthijaree *et al*., 2017).

Even though research has consistently reported the effects of GIN on chicken productivity, however the definite thresholds of nematode infestations above which health, welfare and productivity is compromised have not been clearly outlined. Hence the need for further research. This will help producers to manage and understand the nematode-host interaction and providing methods for managing nematode infestations. Management strategies that can reduce GIN infestation in chickens need to be identified. Such strategies could include development of appropriate housing. National Government Organizations (NGO's) and extension services could help in providing capacity building concerning management to farmers. This could enhance the managerial skills of resource-limited farmers.

2.4 Importance of indigenous knowledge in controlling chicken gastro-intestinal nematodes

Indigenous knowledge is slowly diminishing while its role is huge in terms of controlling gastro-intestinal nematodes, enhancing production, and immunity of chickens and treating diseases. Resource-limited farmers use personal experience to notice GIN in different age groups of chickens (Chege *et al*., 2014). This observation indicates that farmers use their IK to diagnose chickens infested with nematodes such as behavioral patterns. Farmers notice stunted growth, low productivity and poor production in their chicken flock and relate it to nematode infestation (Chege *et al*., 2014).

The frequency of deworming chickens varies with farmers; however, in most cases farmers deworm their birds when they show the clinical signs of nematode infestation (Mwale and Masika, 2009). Other farmers deworm their chickens every after three or six months and others deworm their birds anytime (Chege *et al*., 2014). The variation of dosing times indicates that GIN infestation varies within seasons since most resource-limited farmers deworm when signs start appearing. To ascertain that the bird has fully recovered farmers observe different symptoms of recovery such as alertness, bird movement, normal feeding behaviour and disappearance of green colouring of the faeces. Chickens recover at different times such that others can recover within 24 hours, within days while others within weeks (Mwale *et al*., 2005). This could be related to the type of remedy used such that other plants react faster compared to other remedies. Perhaps, this could mean that different medicinal plants exhibit different healing properties, hence the variation in recovery period. It would, therefore be of interest to understand these differences in efficacy.

Ethno-veterinary remedies are used over modern veterinary products by resource-limited farmers because these remedies are locally available, functional and convenient (Kunene *et al*., 2003). The use of ethno-veterinary remedies to control nematodes dates to decades ago in rural communities. There are different types of medicinal plants used to control nematodes in chickens. For example, Aloe is the most common used plant species (Maroyi, 2012). Its components are used such as *Aloe* leaf gel and exudates (Kaingu *et al*., 2013). Though Aloe is abundantly used, however there are other plant species that farmers use (Table 2.2).

Table 2.2: Common indigenous medicinal plants that has been successfully used to control gastrointestinal nematodes in chickens

Scientific name	Family	Disease	Method of preparation	**Source**
Aloe maculata	*Asphodelaceae*	parasites, diarrhoea and Newcastle	Leaf infusions	McGaw & Eloff, 2008
Aloe secundiflora	*Asphodelaceae*	Diarrhoea and general weakness	Infusion made and given by drench	Kaingu et al., (2013)
Aloe marlothii	*Asphodelaceae*	parasites, diarrhoea and Newcastle	Leaves	McGaw & Eloff, 2008
Aloe ferox	*Asphodelaceae*	Parasites and diarrhoea	Infusion made of leaves	Mwale and Masika (2015)
Acacia karroo	*Fabaceae*	Intestinal parasites and diarrhoea	Bark, leaves	McGaw & Eloff, 2008
Agave sisalana	*Agavoideae*	Internal worms	Leaves sliced and grounded	Mwale and Masika (2015)
Gunnera perpensa	*Gunneraceae*	Internal parasites	Leaves sliced, grounded, put in water	Mwale and Masika (2015)

2.5 Efficacy of medicinal plants used to control gastro-intestinal nematodes in chickens

Validation of plants used against chicken GIN based on *in vitro* and *in vivo* studies might not be the ultimate goal of all ethno-veterinary studies (Luseba and Tshisikhawe, 2013). To promote the use of these medicinal plants for widespread use in modern veterinary care, their possible efficacy is a subject of interest. Plants such as *Aloe forex, Gunnera perpensa* and *Agave sisalana* have been successfully used to control nematodes (Mwale and Masika, 2015). At a dose of 100 mg/kg, *Aloe ferox* resulted in an egg reduction count (ERC) of 99 %. Also, a significant decrease was observed on 50 mg/kg dose from day 7 to day 14 (Table 2.3). A similar trend was seen on *Gunnera perpensa* whereas for *Agave sisalana*, the dose of 50 mg/kg lead to an egg count reduction of 86 % on day 7 and 100 % on day 14.

When tested, the crude extracts of *Aloe secundiflora*, thought to have inhibitory effect on the development of larval stages of *Ascarida galli*, showed high efficacy *in vitro* (Kaingu *et al*., 2013). Amongst the extracts, acetone and crude aqueous had the highest anthelmintic activity. Plants from *Vachellia spp.* have been reported to possess anthelmintic activity against *Ascarida galli* (Lalchhandama *et al*., 2009) though no scientific evidence was provided for *Vachellia karroo*. However, based on Lalchhandama *et al*. (2009) one can assume that all *Vachellia* spp. Have high efficacy against nematodes.

Table 2.3: Efficacy of indigenous medicinal plants in controlling chicken gastro-intestinal nematode counts

Plant	Dose (mg/kg)	Mean worm egg count			ECR (%)		Source
		Day			Day		
		0	**7**	**14**	**7**	**14**	
Aleo ferox	50	1150	350	62.5	96	83	Mwale and Masika, 2015
	100	1310	37.5	375	81	99	
Gunnera perpensa	50	9400	350	138	91	89	Mwale and Masika, 2015
	100	988	25.0	525	71	92	
Agave sisalana	50	263	12.5	62.5	86	100	Mwale and Masika, 2015
	100	213	50.0	150	33	67	

ECR: egg count reduction

2.6 Concluding remarks

Chickens contribute significantly to food security and woman empowerment while providing nutritious organic meat. Therefore, development of chickens could be a sustainable way of eradicating poverty or food insecurity at household levels in most African countries. Chickens are reared in an extensive environment where GIN infestation is very high. There is a need now to improve these production systems in order to make the best possible use of these resources. Management strategies that can reduce GIN infestation in chickens need to be identified such as development of housing systems. Amongst other challenges farmers face concerning indigenous chicken health parasitism ranks high.

Although farmers abundantly rely on ethno veterinary remedies to mitigate the challenges of GIN in chickens. The drawbacks to the use of medicinal plants includes inconveniences for the use or preparation of remedies and seasonal availability of medicinal plants. The preparation methods need to be understood when treating chickens, so that the remedy will be functional at an optimal level and reducing worm counts. The challenges to these practices is that resource-limited farmers do not account for dose measurements. Indigenous knowledge is useful in the control of GIN, enhancing chicken immunity and production. Although some of these plants are widely used such as *Aloe marlothii* and *maculata*, there is, however, not enough evidence on their efficacy, which is crucial for widespread dissemination of the knowledge. There is a need to assess appropriate doses of potential medicinal plants. Policies that governs the use and threats of medicinal plants need to be implemented for the conservation and future use of ethno veterinary remedies.

2.6.1 Exploring the potential benefits of medicinal plants

Data on usefulness plant remedies is unavailable and there is a need to understand how people classify illnesses and remedies. Effort to asses any possible nutritional benefits from these medicinal plants is needed, as some nutrients tend to boost the immunity of animals thereby enhancing healing.

2.6.2 Possible harmful effects of medicinal plants

It is also crucial to investigate the potential impact of these medicinal plants on the carcass characteristics and meat quality of birds. For example, plants from *Acacia spp* have been reported to improve the meat quality. Biological activity or toxic effects of ethno veterinary remedies need to be determined ensuring the safety of organic meat and egg production.

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Chapter 3

Exploitation of indigenous knowledge in controlling gastro-intestinal nematodes in chickens

Abstract

The objective of the study was to explore indigenous knowledge (IK) used to control gastrointestinal nematodes in chickens. Face-to-face interviews were conducted in Jozini local community. Indigenous knowledge is transferred to the next generation through oral communication. Chickens make unique continuous sounds to indicate early signs of nematode infestation. At advanced infestation stages, eggs laid rot as infested hens fail to incubate them. Medicinal plants are prepared using different methods such as boiling and soaking in water. A total of 17 medicinal plants were reported, amongst these plants 12 were used to treat GIN and five to prevent them from increasing GIN loads. The 12 medicinal plants for treatment were *Elephantorrhiza elephantine, Agave americana*, *Schkuhria pinnata*, *Plectranthus madagascariensis*, *Sanseviera hyacinthoieds*, *Sideroxylon inerme*, *Clerondendrum glabrum*, *Trichilia emetic*, *Pittosporu viridiflorum*, *Elaeodendron tranvaalense*, *Schotia afra* and *Huernia hystrix*. The five medicinal plants for prevention were *Aloe maculate, Cissus quandragular*, *Aloe malothii*, *Plectranthus madagascariensis* and *Aloe ferox*. Chickens are only dewormed after displaying clinical symptoms of infestation. Birds usually take a maximum of three days to recover after treatment and in some cases even one week when infestation is severe. Indigenous knowledge for the control of nematodes need to be exploited for sustainable chicken health management instead of over-reliance on anthelmintics. With more research, IK has a potential to be acknowledged, accepted and incorporated into sustainable health management.

Keywords: Anthelmintics, medicinal plants, gastro-intestinal nematodes.

3.1 Introduction

Indigenous knowledge classifies, diagnose, prevent and treat common diseases in chickens. Indigenous knowledge is a sustainable complement to conventional knowledge (Kumar *et al*., 2012). Use of locally available plant, animal and mineral resources is the most common practice in IK for the healthcare of livestock, chickens (Kumar *et al*., 2012). Indigenous knowledge is widely accessible and available in addressing challenges facing communities and societies. Use of IK is sustainable as farmers exploit locally available natural resources. Possibilities also exist that the use of indigenous methods can reduce chances of toxic residues in meat products and eggs intended for human consumption. Farmers have been relying on IK for centuries (McGaw and Eloff, 2008) until colonization and imperialism took over.

Chickens play a fundamental role in food security and income generation through sales (Okeno *et al*., 2011) in developing countries. They are an important source of meat and eggs to households (Mwale and Masika, 2009). Raising chickens is convenient for the landless as they require less space allocation and can survive at minimal inputs such as feed and housing (Swatson *et al*., 2003). These chickens are kept in an extensive production system where they scavenge freely for feed to meet their nutritional requirements. Feed supplements are scantly provided. As a result, chickens scavenge on insects, locusts and earthworms (Ncobela and Chimonyo, 2015; Malatji *et al*., 2016). During scavenging, they encounter infective eggs of nematodes through direct contact with soil and faeces contaminated with nematodes (Abdelqader *et al*., 2008). The constant improper usage of anthelmintics such as over- and under- dosage increases nematode resistance.

The challenge of anthelmintic resistance of gastro-intestinal nematodes in chickens is increasing, especially in intensive production systems (Hassan *et al*., 2015; Akter *et al*., 2016). The deep-litter production systems are restricted by the heavy burden of different poultry helminthes (Abdelqader *et al*., 2012). These systems could also benefit from exploiting IK. To reduce over-reliance on anthelmintics the use of safe and locally available medicinal plants as an alternative approach to treat GIN, various conditions could be beneficial. Such knowledge is locally available and sourced within the household or community, largely through oral communication (Dube *et al*., 2010; Parthiban *et al*., 2015). Utilisation of IK is slowly deteriorating due to lack of interest among the youths and advancement of technology. Indigenous knowledge is, therefore, in danger of extinction.

Indigenous chickens are faced by increased exposure to nematode infestation due to close contact with contaminated environments such as soil. Methods to reduce the rate of GIN infestation in chickens is unknown. Indigenous methods can be beneficial to both commercial and communal farmers through effective control of GIN in chickens. The IK is not fully exploited, hence, methods used to control GIN in chickens are unknown. It is regarded as backyard or old-fashioned. Agricultural institutions, government, extension officers and other decision makers need to develop and implement policies that support the use of IK in poultry healthy management. The objective of the current study was to identify indigenous methods used to control GIN in chickens. It was hypothesised that there are many medicinal plants that farmers use to control GIN in chickens

3.2. Materials and methods

3.2.1 Study site and ethical clearance

The study was conducted in the Jozini local communities, in uMkhanyakude District Municipality located in the extreme north of KwaZulu-Natal Province, South Africa. The study complied with the standards required by the Human Social Science Ethics Committee of the University of KwaZulu-Natal (Reference Number: HSS/0852/017).

The Jozini local municipality is situated at KwaZulu-Natal, South Africa with the co-ordinates of 27º 24' 06.9' S; 32º 11' 48.6 E (Gush, 2008). The land covers 3 082 km^2 and elevation ranging from 80 to 1900 m above sea level. The area experiences agro ecological and semi-arid environmental conditions. The average -annual rainfall of 600 mm is experienced, the rainy months are November to April and driest months are June and July. The minimum annual average temperatures are 20 ºC and 10 ºC. The area is characterized by sand-veld, bush-veld and foothill wooded grasslands vegetation type (Morgenthal *et al*., 2006). The agricultural production includes crops, vegetables and livestock species reared include chickens, cattle, sheep, and goats.

3.2.2 Selection of participants

Eight communities were visited across Jozini namely; Mamfene, Mkhayane, Mkhonjeni, Makhonyeni, Gedleza, Nyawushane, Madonela and Biva. The eight communities were randomly selected amongst communities active in chicken production. Selection of study experts was based on their deep understanding of indigenous knowledge, personal experience and willingness to participate in the study.

3.2.3 Collection of indigenous knowledge on poultry health management

The key informants were members of the livestock association in the Jozini municipality, officials from Veterinary services at Makhathini Research Station and local traditional. Data was collected through interviews. The data included a ranking challenges faced in chicken production systems, sources of IK, description of nematodes, symptoms of GIN infestation, predisposing factors of GIN, adverse effects of nematodes and effect of season, nutrition and housing to GIN infestation. Indigenous methods of controlling GIN in chickens and sources of IK were also discussed. In addition, the challenges of using medicinal plants were explored. Digital voice recorders were used to record data during interviews. Interviews were conducted in IsiZulu vernacular. The interview data were transcribed. Data were sorted and arranged into themes, sub-topics and analysed.

3.2.4 Plant collection and specimen identification

Following the interviews with the key participants, listed plant specimens used to control GIN in chickens were collected. The specimens were harvested, packed and stored according to the herbarium rules and regulations until transported to the Bews Herbarium at the University of KwaZulu-Natal, Pietermaritzburg, South Africa for identification using voucher specimen. The plant specimens were arranged by family name, scientific name and IsiZulu vernacular name.

3.3 Results

3.3.1 Challenges to chicken production

The ranking of challenges to free-range chicken production systems were as follows; the challenges to chicken production systems included diseases, predation, mortality, GIN and lack of veterinary services. Diseases such as Newcastle disease, which spreads rapidly amongst birds and kill the whole flock. Chickens are susceptible to diseases, especially chicks. Grain production for household consumption in communal production system is usually inadequate. As a result, free-range chickens rely on insects, earthworms and other non-conventional feed resources. Grain shortages make chickens to scavenge for long distances, exposing them to predators, especially chicks. The common chicken predators are hawks, wild cats, mongoose and dogs that mostly consume eggs, chicks and pullets are most vulnerable to predators. In terms of chick mortality, herbalists use *Schotia afra* tree. The flowers of this tree are placed on top of the eggs that the chickens are still incubating. The hen will incubate the eggs until they hatch. These flowers release its perfume to the egg and penetrates to the chick as it is still at the egg. The chicks develop resistance to harsh environmental conditions at the beginning of the wet season. Gastro-intestinal nematodes are a challenge to the sustainable production of chickens in the free-range production system. The GIN are attributed to chickens spending more time pecking the soil and due to a lack of feed variety. The other challenge in scavenging production systems is that there are poor veterinary services. The limited veterinary services given to communal production systems is focused on cattle. Virtually no time is accorded to indigenous chickens.

3.3.2 Sources of indigenous knowledge

Indigenous knowledge is sourced from knowledgeable community members, parents and forefathers and passed to children through oral communication and training. The IK is also acquired through personal experiences, observations, experimentation, dreams and visions. There is usually sufficient mentoring from their sources and appreciation of IK, highlighting dangers of malpractice. These include death of animals and loss of trust in IK. Children are taught by the parents especially women to inspect a sick chicken for clinical symptoms, prepare medication and then apply or dose the infected chicken. Indigenous knowledge is shared in a similar manner between male and females within a household, although the difference is that males have extra duties such as going to the forest for plant harvesting and preparation. Both males and females learn through observations while parents are performing the duties, until they are old enough take care of the livestock.

Grandmothers are important in the food chain of transmitting the knowledge to female children as they accompany them when treating chickens. Grandfathers and fathers mostly teach male children during dipping sections. Other farmers also share their knowledge with them during dipping. In most cases, males learn about IK when assisting their fathers or male family member during treating cattle in the kraal. However, females do not get such opportunities, as they do not have permission to enter the kraals. Females or children look after chickens. At times, knowledge bearers do not divulge with their knowledge to outsiders because they lack trust on them with a feeling that they will steal their ideas and overharvest these herbs. Only divulge when paid using a chicken because rural people recognize and value their personal experience related to indigenous practices.

3.3.3 Identification of nematodes and their effects in chickens

The IK uses length, width, shape and colour to effectively identify different nematode species. Gastro-intestinal nematodes are observed on the ground after excretion by the bird, making it possible to see the visual characteristics. The local name for GIN is *izikelemu*, IsiZulu vernacular. Different species of nematodes found were roundworms (*imisundu*), gapeworms (*isikhuvethe*) and tapeworms (*imbhabhama*). Imisundu are long round and thick comprising of brown. The term, *imisundu* is an expression of colour known as *onsundu* meaning dark colour. Roundworms are the most toxic nematodes in chickens, as they lead to intestinal bleeding, weight loss and are observed after slaughtered if the chicken is prepared for household consumption. The other nematode species are gapeworms (*isikhuvethe*). These GIN are mostly seen in defecates of the chicken suffering from diarrhoea, thus, gapeworms lead to diarrhoea.

The GIN is named *isikhuvethe* because they are found in clusters in the gut of the chicken. Tapeworms are named as *imbhabhama*, which reflects its size and the belt-like shape. The *imbhabhama* species leads to inactiveness of the chicken and discharge of saliva. Females were most knowledgeable about nematodes that are seen after slaughter because they normally see them when preparing intestines in the ingesta. Males only know about GIN when they are young as they would normally prepare the intestines and head for consumption. The chicken continuously makes unique sound as an indication of early signs of nematode infestation. The sound is deep the chicken makes it as its breath and it is most common in chicks when heavily infested. The chicken becomes inactive, always lying down, reduced appetite and drinks lots of water. The birds isolate itself to avoid being annoyed by conspecifics. The combination of *Huernia hystrix*, *Agave americana* and *Aloe malothii* is prepared to treat chickens displaying these symptoms. *Aloe marlothii* leaves are chopped into pieces; *Agave americana* and *Huerna hystrix* leaves are ground and added to five litres of water for five minutes. After drinking the medication GIN are immediately expelled out and the chicken recovers from fatigue, gain its strength and develop appetite.

3.3.4 Predisposing factors of gastro-intestinal nematodes infestation in chickens

Drinking stagnant waters leads to nematode infestation in chickens because such waters are contaminated with infective eggs of GIN. Lack of proper housing cause chicken to sleep underneath trees leading to infestations since birds happen to peck the soil underneath these trees. Hens that are mothering chicks spend more time pecking the soil for themselves and for the chicks, thus the infestation is higher in them.

3.3.5 Use of indigenous knowledge to control nematodes

Birds are dewormed once they display visible signs of sickness. Some plant remedies are used either when fresh or dried, such as *Aloe* species (Table 3.1). Depending on the availability, plants are dried and stored for future use. Medicinal plants are prepared, administered differently and there are no known dosages (Table 3.1). To ensure all chickens receive treatment the medicine is provided throughout the day. Chickens are treated when it is sunny, because the hot weather will force them to drink more water, therefore, will drink the medication. The feed is also mixed with the prepared medicine so that when the chicken is feeding will receive the treatment. Plant remedies are either used individually or combined with conventional remedies. Medicinal plants have no distinguished resistance and are effective towards nematode control.

Preventions using medicinal plants are mostly done at the beginning of the wet season due to many other diseases other than nematodes that the chickens are prone to such as Newcastle disease. Medicinal plants that are commonly used are *Aloe maculate, Cissus quandrangularis, Plectranthus madagascariensis, Aloe malothii* and *Aloe ferox*. The herbs are prepared through grinding, chopping and mixing with drinking water. Chickens are given the medicine regularly approximately in the maximum space of three weeks because in this period the re-infestation could have been occurred. Table 3.2 shows medicinal plants used to prevent nematodes in chickens.

Table 3.1: Medicinal plants used to treat nematodes in chickens

Local name	Scientific name	Voucher number	Family name	Method of preparation
Intolwane	*Elephantorrhiza elephantine*	NU0068144	Fabaceae	Leaves are ground and put in drinking water
Uhalibhoma	*Agave americana*	NU0068137	Asparagaceae	Leaves are ground and put in drinking water
Ikhambi lesisu	*Schkuhria pinnata*	NU0068157	Ommelinaceae	Leaves are ground and put in drinking water
Ibozane	*Plectranthus madagascariensis*	NU0068145	Lamiaceae	Leaves are ground and put in drinking water
Iskholokotho	*Sanseviera hyacinthoieds*	NU0068147	Ruscaceae	Leaves are ground, boiled and put in drinking water ,
Amasethole	*Sideroxylon inerme*	NU0068160	Sapotaceae	Leaves are ground and put in drinking water
Phehlacwathi	*Clerondendrum glabrum*	NU0068162	Apocynaceae	Leaves are ground and put in drinking water
Umkhuhlu	*Trichilia emetic*	NU0068134	Meliaceae	Leaves are ground and put in drinking water.
Umfusamvu	*Pittosporu viridiflorum*	NU0068168	Pittosporaceae	The bark is ground, boiled and given to chickens
Uvovovo / Umgxamu	*Elaeodendron tranvaalense*	NU0068167	Fabaceae	Bark or leaves are ground into powder and mixed with water.
Umnala	*Schotia afra*	NU0068151	Leguminosae-Mimosoideae	Bark is dried and ground into powder and put in drinking water.
Umoyililo	*Huernia hystrix*	NU0068163	Asclepiadaceae	Compress the soft stem is compressed to release its juice content and put in drinking water.

Table 3.2: Medicinal plants used to prevent nematodes in chickens

Local name	Scientific name	Voucher number	Family name	Method of preparation
Icena	*Aloe maculate*	NU0068164	Asphodelaceae	Leaves are ground and put in drinking water
Inhlashwana	*Cissus quandragular*	NU0068142	Caesalpiniaceae	The stem is ground or chopped into pieces and put in drinking water
Inhlaba	*Aloe marlothii*	NU0068166	Asphodelaceae	Leaves are dried or freshly chopped into pieces, then infused or boiled. Ground leaves are put in drinking water
Ibozane	*Plectranthus madagascariensis*	NU0068145	Lamiaceae	Leaves are ground and decanted in water troughs/containers
Inkalane	*Aloe ferox*	NU0068138	Asphodelaceae	Leaves are ground and put in drinking water

3.3.6 Challenges of using medicinal herbs

The challenges faced with medicinal herbs include unsustainable harvesting methods, overharvesting, drought and seasonal availability. Unsustainable harvesting is when the plants are harvested improperly affecting regrowth of the plant. Overharvesting it is where the plants are harvested at larger amounts reducing the plant population in the environment. Drought is a result of water shortages such as limited rainfall. Unsustainable harvesting methods is mainly due to lack of training on harvesting techniques. These includes harvesting little to allow fast recovery and covering with soil after digging. Untrained people harvest the barks at large quantities that is harmful because when the tree has lost the bark it dries faster. Other people uproot the whole plant and not leave a small portion of roots for the plant to grow again.

Important plants such as *Aloe* species are in danger of extinction because they are overharvested, and the environmental conditions are not favourable. Some plant remedies are found in distant areas even on dangerous mountains and forests where there are wild animals and snakes. People overharvest medicinal herbs mostly for income generation, fencing, building houses and livestock pens for they do not know the importance of these medicinal plants to the residents of the community. During the rainy season, the rain is irregular, such that if it rains on one occasion, it takes more than three months for it to rain again. As a result, drought is experienced, affecting the growth of some medicinal herbs, except those found throughout the season such as *Aloe* species. Such medicinal plants do not grow well because the soil is dry and no enough moisture to suit their growth. The medicinal herb become stunted and show lower leaf yields and the number of trees in the fields decline.

Most medicinal plants are seasonally available except *Aloe* species and *Cissus quadrangular* that were reported to be available throughout seasons. It is difficult to find the herb when it is not available during that season. Farmers, therefore, harvest plants and sun-dry those before they are stored for future use. The herbs retain the same effectiveness as when they are fresh. The herbs do not grow well during dry season because of rain shortages. The plants dry, leaves fall and shed during this season. Hence, during wet season, medicinal plants are in abundance due to rains and moisture to favour plant growth.

3.4 Discussion

Indigenous knowledge plays an important role to understand possible methods that may need to be exploited, especially in cases where IK is to be integrated with conventional knowledge. Indigenous knowledge enables indigenous people to adapt changing environment and other social dynamics (Domfeh, 2007), that include drought and ailments. Indigenous knowledge is a foundation for sustainable and environmentally sound approaches to agriculture and natural resource management (Moos *et al*., 2010). Use of indigenous knowledge in livestock management such as treating common ailments using medicinal plants, in particular is an important approach. However, the knowledge based on empirical evidence through scientific methods need to be exploited.

The finding that shortage of feeds, outbreak of diseases and, shortage of vaccines challenge chicken production systems are in line with (Ndiweni, 2013). Gastrointestinal nematodes cannot be avoided due to that scavenging chickens will always access them during scavenging. Mwale and Masika (2009) reported similar findings that scavenging chickens are most vulnerable to nematode infestation compared to chickens with alternative feeding systems. Chickens infested with nematodes have low weight size compared to clinically healthy chickens, because nematodes feed on the chicken ingesta (Katakam *et al*., 2010). The ingesta contains bulk of nutrients needed by the chicken and are therefore absorbed by nematodes (Percy *et al*., 2012). Nematodes absorb mostly lipids and vitamins (Mondal *et al*., 2016).

Feed shortages and the increased scavenging period leads to GIN infestations agrees with (Mangube *et al*., 2008; Chege *et al*., 2015). Increasing chances of picking nematodes infective larvae in the scavenging environment leads to nematode infestation in chickens (Faizullah *et al*., 2013; Naphade and Chaudhari, 2013; Khan *et al*., 2016). Feed shortages are associated with limited supply of supplementary feeds due to financial constraints and seasonal availability (Mapiye *et al*., 2008). Scavenging chickens become more prone to nematode infestation if they are infected with other diseases, notably Newcastle and Salmonellosis (Bettridge *et al*., 2014). This may be attributed to their weakened immune system and reduced appetite due to sickness. Sick chickens may even loose resilience even when they have light infection they tend to show signs of worm infestation. Findings that nematodes lead to mortality is in line with the study (Mungube *et al*., 2008) because chickens may not display symptoms until heavily infested to a level whereby it becomes difficult to treat. It is not always easy to tell the causes of mortalities primarily because the chicken may be consumed or incinerated rather than inspected for autopsy. Mortalities could be due to extreme weather, unnoticed injuries, diseases and other causes.

Predation is a challenge because it hinders productivity of chickens. Avoiding them could take compromising scavenging chicken's natural behaviour such as restricting outdoor access. Literature reports predation to be the most limiting factor to chicken productivity especially if night shelter is not provided (Malatji *et al*., 2016). The lack of veterinary services could contribute to chickens experiencing nematodes and diseases, because chickens remain untreated. The finding that veterinary support is mostly based on cattle could be due to that cattle are large livestock and therefore farmers value them more. Lack of veterinary services support has been reported in rural areas to be the most limiting factor to chicken productivity (Malatji *et al*., 2016).

The finding that people source IK from knowledgeable people within the community and elders is in agreement with (Gakuubi and Walanza, 2012). Indicating that IK is different from place to place and that more knowledge has not been exploited on IK. Indigenous knowledge plays a huge role in promoting social relationship since it is shared within the community. The finding that people share IK of controlling nematodes agrees with (Eyssartier *et al*., 2008), which indicates that indigenous people do not want their knowledge to be extinct. The reason could be that indigenous people value IK and they see good results when chickens are treated using it. Older people are possessors of IK, and both men and women pass the knowledge to children through oral communication. The challenge now is lack of interest of learning and practicing IK by children (ba Ndob *et al*., 2016), making it difficult to preserve and sustain IK. The finding that these knowledgeable individuals are secretive agrees with the findings from the study (Akullo, 2007; Gakuubi and Walanza, 2012). Poultry keepers possess knowledge about the use of medicinal plants, but the knowledge is kept within the family (Gueye, 1999). The other possibility is that poultry keepers do not want to lose power of recognition within the community, therefore, want to be the only ones holding this knowledge.

The use of morphological features such as colour and shape is important as it assists in identifying scientific names of GIT nematodes because rural people may not know them. The use of descriptions in relating the nematode to its symptoms is more useful. For example, the description of imisundu (roundworms) can be related to *Ascaridia galli* since it leads to intestinal bleeding and loss of weight agrees with (Al-Daraji *et al*., 2013). Considering that indigenous people could relate specific nematodes with specific symptoms, indicates that their knowledge of nematode ecology is relatively good.

Moreover, naming of nematode species using local vernacular could be challenging because names may differ according to culture and region, and some names can represent more than one nematode species. The finding that diarrhoea is the most common adverse effects on scavenging poultry at heavy infestation is in line with (Mwale and Masika, 2011). At heavy infestation, it could happen that nematodes are irritating the GIT leading to diarrhea. The type of diarrhoea signals symptoms of diseases facing village chickens (Gueye, 1999), such as the continuous diarrhoea indicating chickens are experiencing heavy GIN infestation. The finding that stagnant waters contributes to nematode infection agrees with Nghonjuyi *et al*. (2014), because stagnant water and deposits from drainage carry oocysts and ova of coccidia and helminthes. These waters also transfer diseases to chickens since more than one chicken can drink from the same source. Water and moist environment create good conditions for the life cycle stages of these parasites.

The findings that rural people use medicinal herbs agrees with McGaw and Eloff (2008), and this could be due to their availability, effectiveness and convenience. The findings that birds are dewormed as soon as they start showing symptoms is probably linked to that birds may take a longer period before re-infestation occurs, thus, herbalists see no necessity to deworm regularly. The finding that expert do not consider dosage agrees with Mwale and Masika (2009), could be due to that herbalist consider medicinal plants as non-toxic. Mwale *et al*. (2005) reported that there were no side effects of using *Aloe* species on treating scavenging chickens.

The finding that herbalists could combine medicinal plants with conventional medicines is in line with McGaw and Eloff (2008), probably because they believe that combining will improve effectiveness. Indigenous medicinal plants are likely to be slower than conventional drugs thus aspects probably want to speed up the healing process. The commonly used plants included those in agreement with (Mwale *et al*., 2005; McGaw and Eloff, 2008). The medicinal plants were commonly used probably because they are known to be most effective in controlling chicken nematodes.

3.5 Conclusions

Indigenous knowledge should be exploited instead of relying on anthelmintics for sustainable chicken health management. Medicinal plants need to be identified and tested for efficacy, lethal doses, standardized doses and active ingredients. Indigenous knowledge need to be put in public through media and newspapers regular studies need to be conducted to identify areas that need further intervention. Developing and creating a database on medicinal plants for chicken parasites is needed. It is, therefore, important to determine the extent of use of IK to determine the proportion farmers who are using IK.

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Chapter 4

Extent of the use of indigenous knowledge to control gastro-intestinal nematode infestations in chickens

Abstract

The objective of the study was to assess the extent of use of indigenous knowledge (IK) to control gastrointestinal nematodes (GIN) in chickens. Resource-poor farmers of Jozini local community in uMkhanyakude District Municipality in the extreme north of KwaZulu-Natal province (n = 298) were interviewed using a semi-structured questionnaire. There was no significant difference ($P > 0.05$) in the proportion of use of IK between gender and area. The challenge of GIN was significantly different ($P < 0.05$) between the dry environments and wet environments. The challenge of GIN was most important in wet environments than in dry environments. There was a significant association ($P < 0.05$) on the proportion of use of medicinal plants in wet and dry environments. The odds ratios for gender, flock size, wealth status, cattle ownership and farmers using IK showed significant difference ($P < 0.05$) for the extent of use of IK. Male farmers were 3.968 times likely to use IK than female farmers. Farmers owning larger flocks were 8.196 times more likely to use IK than farmers owning smaller flock sizes. Resource-poor farmers were 1.707 times likely to use IK than less poor farmers. Farmers owning cattle were 1.998 times likely to use IK to control GIN in chickens than farmers not owning cattle. Farmers using IK were 1.206 times likely to use IK to control GIN in chickens than farmers not using IK. It was concluded that the extent of use of IK is influenced by demographics and the availability of medicinal plants.

Keywords: medicinal plants, gastrointestinal nematodes, anthelmintics

4.1 Introduction

Chickens contributes immensely to the livelihood of resource-limited farmers as they provide meat, eggs and manure. These chickens also contribute to rural economy by providing income to the resource-limited farmers (Padhi, 2016**)**. However, chickens in resource limited area are highly vulnerable to gastrointestinal nematodes that compromise their productivity. Gastrointestinal nematodes are a major constraint on the productivity of chickens while contributing to the morbidity and mortality of chickens. Reduced chicken productivity due to GIN results in less flock sizes (Chota *et al*., 2010), this possess a detrimental challenge to resource-limited farmers as they are unable to recover their flock sizes easily. Environmental conditions contribute to the occurrence of GIN, especially during hot and wet season (Butboonchoo & Wongsawad, 2017). Abdelqader *et al*. (2012) reported that heavily infested chickens show signs of droopiness, haemorrhages and diarrhoea. In addition, gastrointestinal nematodes damage the integrity of intestinal mucosa and nutrient utilization. In severe infestation GIN causes intestinal blockage (Abdelqader *et al*., 2012).

Indigenous knowledge plays an important role to local communities through advancing livelihoods and sustainable management of natural resources (Buthelezi & Hughes, 2014). Such knowledge is locally available and shared differently among the areas, through oral communication (Tella, 2007). There is a wealth of IK in pastoralists to maintain their treasured chickens (Grade *et al*., 2009). However, due to several disadvantages such aging knowledge bearers, little effort being put to ensure that policies implementing utilization of IK are passed. There is fear that this knowledge could be lost, although it could be off value in solving challenges that farmers are facing. Use of IK to control nematodes in chickens can be determined by the availability of medicinal plants and pastorals. If there are many medicinal plants and herbalist in a particular area, there is a likelihood that they are utilizing IK more compared to those with fewer medicinal plants and herbalist. Medicinal plants of various nature are found in different agro-climatic zones (Amsalu *et al*., 2018). Dry environments dominated by trees such as *Vachelia* species and Afro alpine climatic areas are sparsely covered with grasses such as *Festuca spp* (Amsalu *et al*., 2018). In pursuit of provision of safe poultry products such as meat and eggs use of herbal remedies need to be explored.

The role of plant-derived remedies has been emphasized on a commercial level (Sunder *et al*., 2016). The last two decades have seen tremendous interest in ethno veterinary research and development (Verma, 2014; Benzie *et al*., 2011). Studies have consistently reported that resource-limited communities continually rely on medicinal plants to treat GIN in chickens (Caudell *et al*., 2017; Madibela, 2017; Mwale *et al*., 2005. However, these studies have only been focused on identifying and documenting IK methods with an end goal of preserving the information. Little if any studies have attempted to determine the extent at which indigenous knowledge is used. Identifying the extent of use of IK against chicken GIN benefit researchers and institutions to invest on projects aiming to integrate IK and conventional knowledge. There is a need to understand the extent of use of IK because it is a basis for identifying areas that need further interventions such as integrating IK with conventional knowledge. Farmers will exploit new remedies to use and have choices to either use IK, conventional knowledge or both IK and conventional knowledge. Determining the extent of use of IK is derived from the experts that highlighted that the use of IK common in Jozini, but to what extent it is not clear. Therefore, the objective of the study was to determine the extent of use of IK and the factors affecting the extent of the use of IK to control GIN in chickens. It was hypothesized that the extent of use of IK is influenced by demographics and the availability of medicinal plants.

4.2 Materials and methods

5.2.1 Study site and ethical clearance

The study was conducted in the Jozini local communities, in uMkhanyakude District Municipality located in the extreme north of KwaZulu-Natal province, South Africa. The study complied with the standards required by the Animal Ethics Committee of the University of KwaZulu-Natal (Reference No.: HSS/0852/017). Jozini municipality lies 27º 24' 06.9' S; 32º 11' 48.6 E (Gush, 2008), and covers about 3 082 km^2, with an altitude ranging from 80 to 1900 m above sea level.

Jozini experiences subtropical climate, with an average annual rainfall of 600 mm. Average daily maximum and minimum temperatures at Jozini read 20 ºC and 10 ºC, respectively. The vegetation type is mainly coastal sand-veld, bush-veld and foothill wooded grasslands (Morgenthal *et al*., 2006). Agricultural practices of the households in the district include production of field crops, vegetables and raising livestock extensively. It was convenient to do the study in the area because almost all the households were active in poultry keeping. The study site is composed of wet and dry environments.

4.2.2 Household selection and data collection

Participants were selected based on ownership of chickens and willingness to participate in the study. Farmers who owned chickens were randomly selected to ensure equal probability of being selected for the study. A total of 300 households were interviewed. The questionnaires were administered in the isiZulu vernacular by eight trained enumerators using pre-tested questionnaires. Enumerators were obtained from the local villages to ensure that farmers are comfortable to co-operate during the study. The study was comprised of male (53.74%) and female (46.26%) participants. There was 74.39% of participants using IK and 25.61% were not using IK to control GIN in chickens.

4.2.3 Study design

Two sites were visited, wet and dry environments amongst the eight villages visited. Area was used because each area may be having different characteristics such as customs, environmental conditions and also different IK they use to control GIN in chickens. There were four villages in the wet environments and four villages in the dry environments. Wet environments were considered as areas where soils are moist having good rainfall patterns and the vegetation types included grasses and weeds of different species. In wet environments there are plenty of water sources for livestock to drink, there were even spring waters. Dry environments were areas where water supply is limited, occasional rainfall, plenty of topsoil not suitable for cropping and dry conditions were severe during dry season. The main vegetation were trees and shrubs that have thorns. In the dry environments livestock do not have consistent supply of water for drinking.

4.2.4 Data collection

Data were collected through direct observations of farmer's socio-economic status, housing structures and the availability of chicken houses. Transect walks were also made in the communities to explore resource available in the area. The questionnaire captured aspects on demographic characteristics, socio-economic status, livestock ownership, reasons for rearing chickens, challenges on chicken production, extent of use of IK, availability of medicinal plants, availability of herbalists and use of different species of medicinal plants. The characteristics of area whether it is experiencing dry or wet environments was recorded.

4.2.5 Statistical analyses

All data were analyzed using SAS (2013). The association between the use of IK and demographics in wet and dry environments were analyzed using chi-square. The association between the uses of medicinal plants with area was also analyzed using chi-square. Ranks of reasons of rearing chickens and chicken production constraints, within each area were compared using PROC GLM. An ordinal logistic regression (PROC LOGISTIC) was used to predict the odds of the extent of use of IK to control GIN in chickens. The variables fitted in the logit model included demographics, socio-economic status, access to veterinary training, flock size, livestock ownership, availability of herbalists and extent of use of IK .

4.3 Results

4.3.1 Reasons for keeping chickens and constraints in chicken production

Reasons for keeping chickens are given in Table 4.1. Ranking of keeping chickens in wet environments were mainly meat, income, ceremonies, manure and eggs in that descending order. Farmers in the dry environments ranked chickens to be kept for meat, manure, ceremonies, income and eggs, respectively. Meat and income was significantly different ($P < 0.05$) between the dry and wet environments. Manure was significantly different ($P < 0.001$) between the wet and dry environments. Ceremonies were significantly different ($P < 0.01$) between wet and dry environments.

Constraints in chicken production systems are depicted in Table 4.2. Chickens in the wet environments were mostly challenged by diseases, chick mortality, GIN and low egg production, respectively. Chickens in the dry environments were mostly challenged by chick mortalities, diseases, low egg production and GIN. The challenge of GIN was significantly different ($P < 0.05$) between the wet and dry environments. Low egg production was significantly different ($P < 0.001$) between wet and dry environments. Diseases and chick mortality was not significant different ($P > 0.05$) between wet and dry environments.

4.3.2 Demographics of households for use of indigenous knowledge as per area

Demographics of participants per area are given in Table 4.3. There was no significant difference ($P > 0.05$) in the proportion of use of IK between gender and area. There was a significant difference ($P < 0.05$) in the proportion of use of IK between age of households and area. There was a significant difference ($P < 0.05$) in the proportion of use of IK between marital status of the household and the area. The highest proportion of use of IK by marital status was in the dry lands. The proportion of use of IK was significantly different ($P < 0.05$) between education and area. There was no significant difference ($P > 0.05$) in the proportion of use of IK between farmers received training on chicken production and area. There was no significant difference ($P > 0.05$) in the proportion of farmers residing on the farm and the area.

4.3.3 Use of medicinal plants in wet and dry environments

The extent of use of medicinal plants is given in Table 4.4. There was a significant association ($P < 0.05$) on the proportion of use of medicinal plants in wet and dry environment. The most used plants were *Spirostachys Africana*, *Aloe malothii*, *Cissus quadrangularis* and *Aloe maculata*. The proportion of use of *Aloe marlothii*, *Cissus quadrangularis* and *Aloe maculata* was significantly different ($P < 0.05$) between wet and dry environments. The proportion of use of *Aloe maculata* was significantly different ($P < 0.01$) between wet and dry environments.

4.3.5 Odds ratios

The odds ratio estimates are given in Table 4.5 to determine the extent of using IK to control GIN in chickens. There was a significant difference ($P < 0.05$) on the extent of use of IK between genders (males and females). Male farmers were 3.968 times likely to use IK than female farmers. There was no significant difference on the use of IK between the farmers who are old age and those who are young. There was no significant difference between the farmers residing in the farm and those not residing in the farm for the extant of use of IK. Farmer's education showed no significant difference on the extant of use of IK between educated and not educated farmers. There was no significant difference between farmers who received and those not received training on the extent of use of IK. Farmers owning larger flocks were 8.196 times likely to use IK than farmers owning smaller flock sizes. Farmers with a poor wealth status were 1.707 times more likely to use IK when compared to their relatively wealthy counterparts. Farmers owning cattle were 1.998 times likely to use IK to control GIN in chickens than farmers not owning cattle. There was no significant difference between the extent of use of IK and the availability of herbalists in the wet and dry environments. Farmers using IK were 1.206 times likely to use IK in chickens against GIN than farmers not using IK.

Table 4.1: Reasons for keeping chickens as ranked by respondents

	Wet environments	Dry environments	Significance
Meat	1.40 (1)^{b}	1.60 (1)^{a}	*
Eggs	2.85 (4)^{a}	2.92 (5)^{a}	NS
Manure	3.95 (5)^{a}	1.86 (2)^{b}	***
Income	2.16 (2)^{b}	2.45 (4)^{a}	*
Ceremonies	2.39 (3) ^{a}	1.98 (3)^{b}	**

^{ab} Values in the same row with different superscripts are significantly different. The lower the value the more important the trait. NS: not significant ($P > 0.05$); $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$

Table 4.2: Constraints of chicken production as ranked by respondents

	Wet environments	Dry environments	Significance
GIN	2.50 (3)^{a}	2.25 (4)^{b}	*
Diseases	1.75 (1)^{a}	1.77 (2)^{a}	NS
Chick mortality	1.84 (2)^{a}	1.68 (1)^{a}	NS
Low egg production	3.00 (4)^{a}	2.08 (3)^{b}	***

^{ab} Values in the same row with different superscripts are significantly different at $P < 0.05$, and highly significant at $^{***}P < 0.001$. The lower the value the more important the trait.

Table 4.3: Demographics on the use of indigenous knowledge as per area

Profile	Wet environments	Dry environments	P-value
Use of IK by gender			
Males	62	49	NS
Females	56	48	
Age distribution			
31 – 50	47	37	
More than 50 years	41	49	**
Marital status			
Single	34	44	
Married	33	24	*
Educational status			
No formal education	30	38	
Attended grade 1-7	34	25	*
Grade 8-12	23	25	
Farmers trained	15	21	NS
Farmers not trained	89	70	
Residence in farm	75	78	NS
Not residence in farm	9	9	

NS: not significant ($P > 0.05$); significant at $^{*}P < 0.05$ and highly significant at $^{**}P < 0.01$.

Table 4.4: The association on the use of medicinal plants in wet and dry environments

Name	Medicinal herb	Wet environments	Dry environments	Significance
Chromolaena odorata	Usandanezwa	0	100.00	NS
Mimusops obovata	Amasethole	10.37	89.63	*
Schotia brachypetala	Umgxamu	3.66	96.34	NS
Schkuhria pinnata	Ikhambi lesisu	13.41	86.59	NS
Agave americana	Halibhoma	1.22	98.78	NS
Stapelia gigantaea	Uzililo	1.83	98.17	NS
Euphorbia ingens	Umhlonhlo	8.54	91.46	*
Spirostachys africana	Umthombothi	25.00	75.00	*
Aloe malothii	Inhlaba	70.73	29.27	*
Cissus quadrangularis	Nhlashwana	69.51	30.49	*
Aloe maculata	Icena	69.94	30.06	**
Schotia afra	Umnala	15.85	84.15	NS

NS: not significant ($P > 0.05$), significant at $^{*}P < 0.05$ and highly significant at $^{**}P < 0.01$

Table 4.5: Odds ratio estimates, lower and upper confidence interval (CI) of the extent of use indigenous knowledge to control gastro-intestinal nematodes in chickens

Parameters	Odds ratio	Lower CI	Upper CI	Significance
Gender (males vs females)	3.968	1.262	1.2487	*
Age (old vs young)	0.335	0.106	1.053	NS
Resident in farm (yes vs no)	0.639	0.081	5.050	NS
Education (not educated vs educated)	0.706	0.264	1.889	NS
Training (yes vs no)	4.349	0.405	33.543	NS
Wealth status (poor vs less poor)	1.707	0.591	4.926	*
Flock size (small<24 vs large>24)	0.122	0.405	3.114	*
Cattle ownership (yes vs no)	1.998	1.220	3.271	*
Availability of herbalists (yes vs no)	1.761	0.892	3.477	NS
Extent of use of IK (use vs not use)	1.206	0.705	2.061`	*

NS: not significant (P > 0.05), *P < 0.05

4.4 Discussion

The finding that farmers raise chickens for meat and eggs indicates that meat is the primary source for protein. Chickens were the main food source to farmers especially during the dry season where harvest is limited. These results were expected based on Melesse (2014) who stated chicken products provides health benefits to consumers. These includes lower fats, proteins, vitamins and micronutrients. Finding that chickens were raised for income indicates that rural people are more likely unemployed so they are subsidising their needs such as groceries, school fees and medical services by income coming from chickens. These results were also reported by Dana *et al*. (2010) that chickens contributes to income to rural people.

The results that farmers keep chickens for manure is due to that farmers were practicing integrated livestock-crop system they then use chicken excreta as manure to their crops. Dry environment may require manure to support soil fertility, since these areas were experiencing water shortages that affect agriculture agrees with Turner *et al*. (2011). As a result, farmers would be using manure for their crops and vegetable gardens. Muchadeyi *et al*. (2004) also reported that chickens are kept for manure. Raising chickens for ceremonies indicates that chickens are important since they serve traditional events. Traditional events such as ancestral sacrifices were important events to farmers as they are able to communicate with their ancestors. It was important to understand the reasons for rearing chickens in the study so that it will be known how farmers value their chickens.

The results that gastro-intestinal nematodes were significantly different indicate that GIN prevalence vary with climatic conditions. The reason to GIN infestation could be due to that chickens in a free-range production system scavenge everywhere and attain feed in deeper soil layers leading to GIN infestation. In the wet environments there are possibly favorable conditions for the development of nematode eggs due to moisture. Sreedevi *et al*. (2016) reported the similar findings that in the wet environment GIN is a challenge. The other reason to this is poor chicken management such as disposing waste in the backyard which agrees with (Meskerem, 2017). These findings contradict Slimane (2016) who observed that GIN prevalence is highest in dry environments. The differences from these findings could be due to that there were different environmental conditions. It is fundamental to understand the occurrence of GIN in chickens with respect to environmental conditions so that the management practices suitable for the environment will be used.

The observation that diseases was not significant different and ranked similar across areas indicates that diseases are important constraints in both environments. The type of diseases was probably not similar in each environment due to that some diseases may be more prevalent in wet environment and others in dry environment. Effort therefore to determine the prevalent diseases in each environment is needed to help in managing these diseases effectively in chickens. According to Illango *et al*. (2002) diseases are environmental independent. The results that chick mortality was not significantly different between wet and dry environments indicates that there was no difference in on chick mortality in both areas. Chick mortality is due to mismanagement, malnutrition, diseases and predation. These are the factors that can be present in both areas. Awuni (2002) reported that chick mortality is a challenge in chicken production. The finding that low egg production was significantly different within the areas indicates that egg production entirely depends on climatic conditions of the area. The extreme temperatures are most likely to reduce egg production because the chickens will be panting realising too much carbon dioxide needed for egg formation. In the present study it was noted that in the dry environments there were hot temperatures leading to low egg production. Jacobs *et al*. (2003) reported that temperatures affect the egg production. Management of chickens such as provision of supplements could affect egg productions agrees with Yemane *et al*. (2013).

The finding that there was no association on the use of IK between gender and area indicates that IK is used similar between genders in both areas. The results were expected because in the study males and females were both participating in chicken production. Thus, they are likely to be making decision on when and how to treat chicken GIN. It was important to find the relationship between the IK in different areas with gender because it would have given an insight of how gender utilize IK in different areas. These results would have helped to understand if in the different areas gender equality is practiced in terms of sharing IK amongst genders. However, little literature instigating how demographics in different areas affect the use of IK for chicken GIN. More work is needed to investigate how area is associated with the use of IK and gender to find out gender participation on IK in different areas.

The results that there was association of use of IK between age and area indicates that the use of IK differs with age in different areas. The significant difference was expected due to that in the present study there were areas that was populated with youth while others with elders. Therefore, the use of indigenous knowledge will differ according to area. There is limited literature on how area affect the use of IK in controlling GIN in chickens. To find a relationship on the use of IK between age and area was important. It would have help to understand how to distribute IK amongst all age group in different areas to keep IK sustainable in all areas.

The findings that there was an association between education and area highlights that use of indigenous knowledge in different areas is affected by education. These results were expected that education affect the use of IK, because farmers in most rural areas especially those not educated were found to have more knowledge and uses IK more than educated farmers. There were little farmers using conventional medicines since education status in the present study was poor, due to that even schools were recently constructed. It gave impression that in the older times where schools were not available farmers were using IK more than present time. There is little literature that explains the association between the use of indigenous knowledge between education and area in chicken production. It was therefore important to determine the association of the use of IK between education and areas so that IK will be included even in schools of all areas.

The results that there was an association of the use of indigenous knowledge between marital status and area indicates that the use of indigenous knowledge was different between married and single. The results were not expected because factors that were most likely to affect use of IK in the areas were gender, age and education. Wassie *et al*. (2015) reported that there was no association between use of IK and marital status in the area. The results that there was no association on the proportion of use of IK between training and area indicates that training does not influence the use of IK in different areas. The results were not expected because most farmers in the present study were not trained for chicken production, while only a few received training. It is thus expected that farmers in the area where training was not received to be relying more on IK for control of GIN because they have been using it for some time.

The results that there was no association on the use of IK between residency and area indicates that use of IK is similar for farmers residing and not. The possibility that farmers residing and not in the region use indigenous knowledge similar could be due to that they had similar background knowledge about use of IK against chickens gastro-intestinal nematodes. These results contradicts Eyssartier *et al*. (2008) who reported that IK is used more by inhabitants.

The inhabitants have vast experience about the use of IK as they have lived in the region for a long time (Eyssartier *et al*., 2008).

The finding that there was as association between the use of use of medicinal plants and areas indicates that farmers use medicinal plants available to their area. The two areas in the present study had different types of medicinal plant species but these plants were performing the same role of deworming the birds. Therefore, farmers will not have a reason to harvest the plants available in the wet environments leaving the plants in the dry environment. The plants in both areas perform the similar activity against chicken GIN unless the plants are needed for other chicken diseases or other livestock ailments. Amsalu *et al*. (2018) reported that availability of medicinal plants vary with area.

The finding that there was a significant difference on the extent of use of IK between males and females indicates that the use of indigenous knowledge between genders is not similar. The likelihood for the differences could be that males culturally believe in IK more than females. They normally take care of livestock as they treat all livestock (chickens, cattle, goats, sheep and pigs) similar. Therefore, they use IK in chickens against GIN. These findings were expected based on Eyssartier *et al*. (2008) who reported that use of IK is affected by gender. However, our results that males were most users of IK contrary to Masimba *et al*. (2011) who stated that females use IK in chicken more than males as they are the owners and managers of chickens.

The findings that there was no significant difference between age and extent of use of IK indicates that the extent of use of IK does not vary with age. The results gives impression that even youth have now gained interest on the use of indigenous knowledge. Majority of youth people who are educated could have realised that conventional remedies have developed resistance to ailments. These results contradicts Amsalu *et al*. (2018) who reported that modernisation and advancement of technology makes youth to lose interest on using IK. Masimba *et al*. (2011) observed that 61.5% of IK of treating chicken ailments was sourced from elders. It was important that the effect of age on the extent of use of IK is determined so that all age group will be knowledgeable through lessons from elders.

The finding that there was no significance between the extant of use of IK and residency of the farmer indicates that use of IK is similar with a farmer residing and not residing in farm. Farmers not residing in the area would have been trained by the residency and that in the present study majority of farmers were residing in the farm. It would have made easier to train the farmers not residing in the area about medicinal plants for medical use in the livestock including chickens GIN. The extent use of IK with farmer residing in the area was important to understand, it will help mitigate the issue of new resident farmers on misusing the resources such as medicinal plants. These farmers will be taught how to utilize the medicinal plants sustainable by other farmers who are long staying in the area, this could be done through meetings and gatherings.

The results that there was no significant different between education and extent of use of IK indicates that using IK is similar for those educated and not educated. An explanation to these findings is that IK to uneducated farmers is likely to be their existence because they had never attended school. They are most relying on indigenous methods, even if conventional medicines are given. Farmers will not likely to be using these medicines correctly, leading to errors because they will not follow instructions correctly if they are illiterate. These results were not expected based on the study by Parthiban *et al*. (2016) who stated that uneducated or poorly educated farmers were mostly the users of IK. It was important to identify the extent of use of IK and education so that IK will be put in school syllabuses if it is poorly understood by those who are educated.

Our findings that there was no significant difference between the extent of use of IK and training indicates that IK does not vary with training. It is likely that farmers who received training about chicken production could have not adopted new teachings from training experts. They could have continued with indigenous knowledge or the other reasons could be that training experts were encouraging the use of IK because there have realized that anthelmintics leads to resistance of gastro-intestinal nematodes in chickens. Eyssartier *et al*. (2008) reported that training experts introduce new practices and technology that are different from IK. It is relevant, therefore to determine the impact of training on the extent of use of IK since training experts may be lacking IK. Indigenous knowledge expert will be organised to teach them if there is a lack of this knowledge to them. It will also help the training experts that they to realize how they can integrate IK with conventional knowledge.

The results that there was a significant difference between the extent of use of indigenous knowledge and flock size indicates that use of IK vary with flock size. The reason to that farmers with larger flock sizes use IK more than farmers with smaller flock size indicates that IK is effective. It also indicates that using IK helps in improving the productivity of chickens as the farmer using IK were mostly those having larger flock sizes. Majority of farmers having smaller flock sizes were not using both IK and conventional medicines, they leave their chickens to grow. Although there is little literature determining the extent of use of IK for farmers who possess flocks of different sizes these findings were expected. Effort to determine the effect of flock size of the extent of use of IK is needed to understand the effectiveness of IK in relation to flock size.

The results that there was a significant difference between the extent of use of IK and wealth status indicated that IK use varies with wealth status of the farmer. Resource-poor farmers were using IK because it is probably accessible to them. These farmers would prefer IK because they have successfully used it for some time and it is working for them. Sanhokwe *et al*. (2016) also reported similar findings that resource-poor farmers uses IK.

The observation that there was a significant difference between the extent of use of indigenous knowledge and cattle ownership indicates that the extent of use of IK is affected by cattle ownership. Farmers owning cattle in the present study use same medicinal plants they use in cattle GIN to chicken GIN. The extent of use of IK by cattle owners need to be investigated because Syakalima *et al*. (2018) observed that cattle owners use both IK and conventional methods.

The results that there was no significance between the extent of use of IK and availability of herbalist indicates that availability of herbalists does not affect the use of IK. It could be due to that farmers were knowledgeable about medicinal plants to use for chicken GIN. Consulting or relying on herbalists to them was now not a necessity. These results were not expected based on Luseba and Tshisikhawe (2013) who observed that the availability of herbalists affect the use of IK. The results was the benefit for the utilization of IK that majority of farmers are knowledgeable about indigenous knowledge.

The findings that there was a significant difference on the extent of use of IK on farmers indicates that the extent of use of IK is different amongst farmers. Majority of farmers were using IK for chicken GIN in the present study because veterinary services focusing on chickens was not provided. The other reasons was that majority of farmers in the present study were growing these medicinal plants into their home gardens indicating that they prefer using IK instead of anthelmintics. It was important to determine the extent of use of indigenous knowledge to control GIN in chickens because this knowledge has not yet been fully integrated with conventional knowledge. Therefore, development programmes will be implemented which is the integration of IK with conventional knowledge.

4.5 Conclusions

Medicinal plant species were used based on their availability in both areas. The extent of use of IK was determined by demographics, males were using IK more than females. Resource-poor farmers were mostly using IK more than farmers who are less poor. Farmers owning large flock were using IK to control GIN in chickens more than farmers having smaller flock sizes. Cattle owners were using IK more than the farmers not owning cattle. In the extent of use of medicinal plants majority were farmers that were using IK that those reported that they do not use IK to control gastro-intestinal nematodes in chickens. It was concluded that availability of medicinal plants and the demographics influence the extent of use of medicinal plants. Research is needed to determine other factors that influence the extent of use of IK to get more acceptable results. Determining the efficacy of commonly used medicinal plants is important to affirm their usefulness and expand opportunities for farmers.

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Chapter 5

Efficacy of selected medicinal plants used by resource-limited farmers to control gastro-intestinal nematodes in chickens

Abstract

The objective of the current study was to affirm the efficacy of medicinal plants used to control gastro-intestinal nematodes (GIN) in chickens. *Cissus quadrangularis*, *Aloe maculata* and *Gomphocarpus physocarpus* plants were chosen amongst the commonly plants in Jozini. The control treatments were birds that were not treated. Nematode egg counts were used to compare the efficacy of ethno veterinary remedies. Forty mature hens were purchased from farmers in the study area and slaughtered. Egg production, body condition score, severity of anaemia, alertness, feather appearance and comb colour were assessed before slaughter. After slaughter, visual observations were made to determine carcass colour, condition of intestines and faeces (presence of blood, soil or clear), colour and texture of faeces. There was a positive association ($P < 0.05$) between anaemia and whether the birds were treated or not. The body condition of the chickens was higher where the medicinal plants were used. The alertness, feather appearance and comb colour were not associated ($P > 0.05$) with use of the medicinal plants. There was no association between the use of medicinal plants and meat colour, intestine condition and faeces condition ($P > 0.05$). Nematode egg counts in the control birds were higher ($P < 0.05$) than those from treated birds. *Cissus quadrangularis* and *Aloe maculata* were significantly more effective in reducing faecal egg counts than ($P < 0.05$) *Gomphocarpus physocarpus*. *Aloe maculata* treated chickens had a faecal egg count of 155 compared to 270 for those treated with *Gomphocarpus physocarpus*. There is, however, still need to determine the mechanism of action of the different plant extractions.

Key words: Faecal egg count, medicinal herbs, hens

5.1 Introduction

Gastro-intestinal nematodes are a major cause of ill-health and low productivity in chickens in developing countries (Mekibib *et al*., 2014). Multiple infestation are experienced in chickens due to the production system they are raised under for example, deep liter or free-range production systems have higher infestation rate (Nalubamba *et al*., 2015). Gastrointestinal nematodes infesting chickens include *Ascaridia galli*, *Heterakis gallinae* and *Capillaria* spp (Alam *et al*., 2014). Other important GIN species affecting chicken health include species such as *Subulura strongylina*, *Strongyloides avium*, *Syngamus trachea* and *Hymenolepis* and *Raillietina* among others (Dube *et al*., 2010; Nalubamba *et al*., 2015). Heavy GIN infestations inhibit the growth of chickens, egg production and reduce the quality of the meat (Dar and Tanveer *et al*., 2013). Although anthelmintics are effective in controlling nematodes, they normally target adult parasite (Tarbiat *et al*., 2016), are expensive and often unavailable to resource-poor farmers. The disadvantages of using anthelmintics such as drug resistance, food residues and environmental pollution has resulted to more interest on the use of IK in controlling parasites. Other important aspects such as body condition, feather appearance, bird alertness, comb colour, gut morphology may be affected and leading to anaemia. Dullness increases susceptibility of the chickens to predators. Therefore, to combat the challenges of nematodes farmers in most of rural Africa use medicinal plants to control nematodes (Githiori *et al*., 2005) and other parasites.

Aloe species, *Solanum nodiflorum*, *Terminali avicennoides*, *Agave sisalana* and *Gunnera perpensa* are commonly used to control GIN in chickens (Adjeji *et al*., 2013; Mwale and Masika, 2015). Medicinal plants are widely known for their reduced health hazards and easy accessibility compared to synthetic anthelmintics (Feroza *et al*., 2017). Medicinal plant species used to control GIN in chickens are found in regions with varying climatic conditions, such as dry and wet environments. For example, *Aloe* species are widely distributed in wet environments of Africa (Grace *et al*., 2015).

Poultry farmers have been using IK for centuries to control nematodes. As discussed in Chapter 4, households use a variety of medicinal plants to control GIN in chickens. Choice of plant material to use is influenced by local availability, ease of use, efficacy and perceived safety of the chicken products, among other factors. Very few studies have yet been conducted to assess efficacy of medicinal plants in an on-farm where chickens are free to scavenge for feed. The efficacy of the plants used needs to be estimated, so as to determine whether these medicinal plants needs to be complemented with conventional anthelmintic drugs. Therefore, the present study was designed to affirm and compare the efficacy of *Cissus quadrangularis*, *Aloe maculata* and *Gomphocarpus physocarpus* on the control of nematode eggs. It was hypothesized that these medicinal plants are equally effective in control of GIN in chickens.

5.2 Materials and Methods

5.2.1 Study site

The study was conducted at Jozini local communities, in uMkhanyakude District Municipality located in the extreme north of KwaZulu-Natal province, South Africa. The study complied with the standards required by the Animal Ethics Committee of the University of KwaZulu-Natal (Protocol reference No.: AREC/043/017).

Jozini municipality lies 27º 24' 06.9' S; 32º 11' 48.6 E (Gush, 2008), and covers about 3 082 km^2, with an altitude ranging from 80 to 1900 m above sea level. Jozini experiences subtropical climate, with an average annual rainfall of 600 mm. Average daily maximum and minimum temperatures at Jozini read 20 ºC and 10 ºC, respectively. The vegetation type is mainly coastal sand-veld, bush-veld and foothill wooded grasslands (Morgenthal *et al*., 2006). Agricultural practices of the households in the district include production of field crops, vegetables and raising livestock extensively. It was feasible to do the study in the area because almost all the households were active in poultry keeping and are using medicinal plants to control livestock ailments.

5.2.2 Experimental design

Pre-survey visits were made for identifying willing households and the agreement on the sampling dates. The selection was based on the ownership of chickens and willingness to participate. The households that are using medicinal plants and those that are not using were separated in order to compare the faecal nematode egg counts. Nematode egg counts were used to compare the efficacy of ethno veterinary remedies. The households were chosen according to the herb they are using to treat nematodes in chickens.

Three medicinal herbs were chosen based on their popularity and local availability, namely, *Aloe maculata* (icena), *Cissus quadrangalaris* (nhlashwana) and *Gomphocarpus physocarpus* (uphehlacwathi). Four households were sampled randomly based on the type of plant the household used to treat against GIN in chickens. Three households using each of the medicinal herb were identified from the survey reported in Chapter 4. Three households were considered to be the control since they were not using any form of GIN control in chickens. In each household, 10 hens were selected from the flock and purchased for slaughter. The hens were aged between 12 and 18 months. All the hens were slaughtered by the household member who usually slaughter chickens. The gastrointestinal tracts were removed for assessment. The digesta from the intestines were also recovered and placed in sample bottles.

5.2.3 Data collection

Data were collected both before and after slaughter.

5.2.3.1 Data collection before slaughter

Aspects on chicken production status, such as egg production was captured, where farmers were requested to recall the number of eggs the hen last laid. Data were collected from more than one household member and, in some cases, discussions among household members were held to ascertain the data for each bird. Data on parameters such as anaemia, body condition score, age of chicken, alertness, feather appearance and comb colour were captured. The anaemia status was assessed through opening of the eyelids of the chicken to see the paleness or redness. Chickens that were anaemic had pale color in their inner parts of the mucous membrane, as opposed to the expected reddish mucous membrane.

Body condition score of the chicken was assessed through physical assessment of the chicken body. Hens were scored into four categories by palpating the keel and breast muscles. The four categories were ranging from zero to three (Gregory and Robins, 1998), as follows:

0: a protruding keel bone and depressed contour to breast muscles;

1: a prominent keel bone with poorly developed breast muscles;

2: less prominent keel bone and moderate breast muscle development; and

3: plump breast muscles which provide a smooth contour with the keel.

The age of a chicken was also obtained from the household members, based on recall. Alertness, feather appearance and comb colour was recorded to identify the symptoms of nematode infestation in chickens through physical observation.

5.2.3.2 Data collection after chicken slaughter

Within one hour after slaughter, the meat condition that was physically assessed for its colour appearance (yellow or pale), the condition of intestines (red spots or white) and size (big or small). The faeces were assessed through physical observation using colour, whether they were watery or thick. The presence or absence of blood clots or soil particles was also recorded.

5.2.4 Faecal egg counts

The faecal samples were collected from the intestines of individual chickens immediately after slaughter and stored at 4 °C before processing, to prevent the eggs of parasites from hatching. The modified quantitative McMaster floatation technique was used to examine faecal samples (Maff, 1986).

5.2.5 Statistical analyses

Chi-square of SAS (2013) was used to analyze chicken parameters before slaughter and after slaughter. Indigenous methods used by farmers to control GIN infestation in chickens was analysed using GLM for means and PDIFF to compare means of medicinal plants and FEC.

5.3 Results

5.3.1 Chicken parameters measured before slaughter

The results for chicken parameters before slaughter as per treatment are depicted in Table 3.1. There was no association ($P > 0.05$) between treatments and egg production for a chicken producing less than 8 eggs and the one producing more than eight eggs. The level of anaemia, comb colour and condition score were significantly different ($P < 0.05$) among treatments. The body condition scores are given in Table 3.2. The type of medicinal plant used had no influence on chicken alertness and feather appearance.

5.3.2 Chicken parameters observed after slaughter

Results of chicken parameters observed after slaughter as per treatments are given in Table 3.3. Meat colour and condition of faeces was significantly different ($P < 0.05$) in relation to treatments. There was no significant different ($P > 0.05$) on colour of intestines, size of intestines, colour and state of faeces with treatments.

5.3.3 Medicinal plants used to control chicken GIN and faecal nematode egg counts

Table 3.4 shows the faecal egg counts (FEC) from the birds that were given each of the medicinal plants. Faecal egg counts in hens that were on the control treatment was significantly different ($P<0.05$) from those where *Aloe maculata* and *Cissus quadrangularis* were used. The faecal egg count in chickens managed on *Gomphocarpus physocarpus* was the same those on the control treatment. *Aloe maculata* and *Cissus quadrangularis* had similar ($P < 0.05$) efficacy levels, but significantly differently lower ($P < 0.05$) than those on the control treatment.

Table 5.1: Proportion of chickens in relation to medicinal plants used by farmers observed before slaughter

Treatment	Egg production		Anaemia		Alertness		Feather appearance		Comb colour	
	< 8	≥ 8	Yes	No	Yes	No	Ruffled	Smooth	Reddish	Pale
Gomphocarpus physocarpus	40	60	20	80	60	40	60	40	40	60
Cissus quadrangalaris	40	60	0	100	60	40	0	100	0	100
Aloe maculata	60	40	0	100	100	0	20	80	60	40
Control	40	60	20	80	40	60	80	20	40	60
Significance	NS		*		NS		NS		*	

NS: not significant (P>0.05); *P<0.05

Table 5.2: Body conditions scores of the chickens

Treatment	**Proportions (%)**			
	Protruding keel bone	Prominent keel bone	Less prominent keel bone	Plump breast muscle
Gomphocarpus physocarpus	20	40	40	0
Cissus quadrangalaris	0	0	60	40
Aloe maculata	0	0	20	80
Control	60	40	0	0
Significance	*			

Significant *P < 0.05

Table 5.3: Chicken characteristics in relation to medicinal plants used by farmers observed after slaughter

Treatment	Meat colour		Condition of intestines		Size of intestines		Condition of faeces			Colour of faeces		Texture of faeces	
	Yellow	Pale	Red spot	White	Tinny	Big	Soil	Blood	None	Whitish	Darker	Thick	Watery
G. physocarpus	40	60	40	60	60	40	30	30	40	50	50	50	50
Cissus quandrangalaris	100	0	60	40	40	60	40	30	30	50	50	50	50
Aloe maculata	100	0	60	40	20	80	20	30	50	20	80	30	70
Control	20	80	40	60	60	40	50	40	10	30	70	30	70
significance	*		NS		NS		*			NS		NS	

NS: not significant ($P > 0.05$) and significant at $*P < 0.05$

Table 5.4: Evaluation of medicinal plants to nematode loads in chickens

Medicinal plant	Faecal egg count
Control	321.33[a]
Gomphocarpus physocarpus	138.5[ab]
Cissus quadrangalaris	190.0[b]
Aloe maculata	162.5[b]
SEM	44.83

[ab] Values with different superscripts are significant ($P < 0.05$).

5.4 Discussion

The present study evaluated the use of medicinal plants on the treatment of GIN in chickens while focusing on understanding the other benefits of these medicinal plants in chicken health. The findings that there was no association between treatments and egg production indicates that different treatments did not have an influence in egg production of the chicken. It could be due to that the chickens were deficient of nutrients for egg production and the medicinal plants cannot provide such nutrients. Nematodes were probably feeding on such nutrients such as lipids and the medicinal plants cannot replace such nutrients. The improvement of egg production was expected to increase based on Bennett *et al*. (2011). Reported the improvement of egg production after hens were treated with diatomaceous earth from 60-70 into 80-90%.

The findings that there was no association between feather appearances, colour and state of faeces and treatments used by farmers indicated that the medicinal herbs did not affect feathers and condition of faeces. Gastrointestinal nematodes leads to poor feathers and condition of faeces becomes watery, therefore after treated with medicinal plants these parameters need to improve. These expectations were based on Mathiyazhagan *et al*. (2018) who used

Trichosanthes dioica on faeces condition and freshness of feathers for chickens infested with GIN. It was reported that the faeces and feathers were recovered. There is limited literature investigating the effect of using *Aloe maculata*, *Cissus quandragalaris* and *Gomphocarpus physocarpus* on feather appearance, faeces colour and state. Therefore, it is recommended that such studies are conducted for a variety of medicinal plants as well. To find the other medicinal plants benefits that are not only targeting GIN in chickens but other parameters.

The finding that there was association between body condition scores of birds and medicinal plants indicates that medicinal plants are effective in improving condition score of chickens. It can happen that the treatments (*Gomphocarpus physocarpus*, *Cissus quadrangalaris* and *Aloe maculata*) had an effect on tissue and muscle development of the chicken, thus leads to muscle and fat deposition.

The findings that there was an association between meat colour and treatments (*Gomphocarpus physocarpus*, *Cissus quadrangalaris* and *Aloe maculata*) indicates that treatments had an influence on the meat colour of chickens. The treatments (*Gomphocarpus physocarpus*, *Cissus quadrangalaris* and *Aloe maculata*) are most likely to be having antioxidant activity that can improve quality of meat in chickens such as meat colour. It could not be expected that medicinal plants can influence meat colour because meat colour can be affected by many factors. Such factors include haem pigments (myoglobin), genetics, feed, hauling, handling and stress (Fletcher, 2002). Others are stunning techniques, muscle pH changes and further processing.

The findings that there was no association between condition of intestines and treatments (*Gomphocarpus physocarpus*, *Cissus quadrangalaris* and *Aloe maculata*) suggest that treatments had no influence on the condition intestines. It may be due to that the treatments (*Gomphocarpus physocarpus*, *Cissus quadrangalaris* and *Aloe maculata*) only eradicates the GIN found in the gut without speeding the process of healing in the intestines. It could also indicates that the anti-inflammatory properties of the herbs were not yet active to speed up the recovery in the intestines that are damaged by gastro-intestinal nematodes. Plants with anti-inflammatory properties are could also help in wound recoveries, such as *Aloe maculata* (McGaw and Eloff, 2008). Belete *et al*. (2016) stated that GIN lead to unhealthy gut such as smaller size of intestines and red spots in the intestines. The GIN in intestines utilize nutrients from the feed that enters the gut, thereby damaging the wall of the intestines leading to the internal bleeding. Since the primary function of intestines are to digest and absorb nutrients from the ingested feed (Yamauchi, 2007).

The finding that there was no association between comb colour and alertness in relation to treatments (*Gomphocarpus physocarpus, Cissus quadrangalaris* and *Aloe maculata*) indicates that medicinal plants does not affect comb colour and alertness of the bird. It could happen that the poor comb colour and poor alertness was not caused by GIN infestation but rather nutrient deficiency in chickens and the herbs could not provide such nutrients.

The finding that there was a significant difference between the control treatment and faecal egg count in chickens indicates that chickens that are not dewormed are more prone to infestation. There is a likelihood that chickens in the control treatment had higher nematode infestation due to climatic conditions in the area that favours nematode larval development and quick production of nematode eggs. These findings were expected based on the findings by (Khokon *et al*., 2014) who reported that the control treatment (where birds were not treated with neem leaves extract) had increased FEC than chickens treated with neem leaves extract. Farmers are likely not to deworm their chickens because they may be convinced that their flocks are not heavily infested with GIN, while chickens are infested. The major contributing factor to the high prevalence of GIN infestations is the type of production system. For example, free-range allows chickens to scavenge in the contaminated environment (Molla *et al*., 2012).

The findings that *Gomphocarpus physocarpus* had FEC similar to control indicates the least efficacy of the herb. These could be attributed to factors such as chickens were last treated at least three months prior and nematode infestation might have inclined. It could also due to that chickens have been in an environment that is highly exposed to infective eggs of nematodes. It could be possible that the chickens were in an unhealthy state thereby increasing their chances to susceptibility to infestation. The anthelmintic properties might be lacking or found in smaller amounts such as tannins and alkaloids as these properties plays role in eradicating GIN (Fomum and Nsahlai, 2017)

The finding that chickens treated with *Cissus quandragalaris* and *Aloe maculata* plant showed significant decrease in FEC indicates that these medicinal plants have anthelmintic potential (Koiko *et al*., 2015). It could happen that during the preparation of these medicinal plants they were given enough time to release its anthelmintic properties to eradicate gastro-intestinal nematodes faster. These results were expected based on (Kaingu *et al*., 2017) who reported that *Aloe* species showed a significant decrease of GIN in chickens. However, these results contrary Scholtz *et al*. (2010) who reported no reduction on faecal egg count counts as *Aloe* was used by farmers. The difference in the findings between the two studies could be due preparation methods of *Aloe* it differed.

The tannins in Aloe species prevents the eggs of certain parasites from developing into larvae (Masamha *et al*., 2010). Zenebe *et al*., 2017 stated that extract of *Cissus quadrangularis* showed 100% efficacy against GIN. Ghouse (2015) stated that *Cissus quadrangularis* can be used as a commercial anthelmintics. There was little literature on the use of Cissus quadrangularis on chicken GIN, thus, studies focusing on chicken use of *Cissus quadrangularis* on chickens GIN is worth conducting. However, there are many factors that could have affected the results of the study on assessing the efficacy of medicinal plants such as chicken breed, sex, age, contamination, site, temperature, treating time amongst others. Hence, the variation for nematode egg counts should be expected to be different for all the treatments. It is not only due to the anthelmintic properties of medicinal herbs, but these factors could affect the accuracy of affirming the efficacy of using these medicinal plants.

5.5 Conclusions

Gastrointestinal nematode infestation cause anaemia, poor condition score, meat quality and poor faecal condition. The use of medicinal plants is useful in mitigating these negative factors. The medicinal plants showed efficacy of the FEC in chickens. It is still needed to conduct further studies that will affirm the use of these medicinal plants in an in vitro.

5.6 References

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Chapter 6

General discussion, conclusions and recommendations

6.1 General discussion

The main hypothesis tested was that IK is used to control chicken GIN in communal areas. Indigenous knowledge plays an important role to local communities through advancing livelihoods and sustainable management of natural resources. The IK is shared differently, through word of mouth, activities, rituals, amongst other methods. Indigenous knowledge is deteriorating due to lack of interest by people especially youth as they becoming more urbanised. Indigenous knowledge should be widely accessible and available in addressing challenges facing communities and societies, livestock in particular. Chickens are challenged by GIN, lot of work has been done based on the use of IK to control GIN in chickens but they are not fully exploited. It is regarded as backyard or old-fashioned. Chickens either in a backyard or deep litter systems, are highly exposed to GIN infestation.

In Objective 1 (chapter 3), face-to face interviews with herbalists were conducted to document indigenous methods used to control GIN in chickens. Other than GIN in chicken production other challenges were diseases, chick mortality, low egg production, low productivity and predation. The results identified that GIN prevalence is higher during dry season due to that there are limited feed resources. These findings were not expected since chickens especially in a free-range production system can scavenge for feed to meet their feed requirements. Farmers use indigenous methods to mitigate GIN challenge in chickens which is the use of medicinal plants. Indigenous knowledge was sourced from knowledgeable community members, parents and grandparents and passed to children through oral communication. Farmers identify GIN using their indigenous customs, they use width, shape and colour to formulate a local names of GIN different species. Medicinal plants were used to control GIN in chickens. The medicinal plants are prepared and administered differently. The two common methods were to boil or soak the plant part in drinking water, the most medicinal plant parts used were leaves. A total of 17 medicinal plant species were used to control GIN in chickens, 12 being used to treat and five to prevent against chicken GIN. Challenges to the use of medicinal plants included that of seasonal availability, drought, overharvesting and unsustainable harvesting methods by untrained people. It was suggested that more work need to be done in order to exploit methods used to control GIN infestation in chickens. The study about investigating to what extent do IK is used was conducted to find the possible interventions that can be made to integrate IK with conventional knowledge

The second objective (Chapter 4) was to determine the extent of use of indigenous knowledge to control GIN infestation in chickens. The extent of use of IK varied with demographics, availability of medicinal plants, cattle ownership and the extent of use of IK. The results showed that chickens plays a significant role in farmers. Chickens ensures food security through provision of readily available protein source in the form of meat and eggs. Diseases, chick mortalities, GIN infestation and low egg production were the main challenges affecting chicken production. The results showed that in wet environments GIN infestations were greater than in dry environments. The conditions in wet environments experience moisture that favours the development of nematode eggs. The results showed that more males were using IK than females because males were the decision makers on livestock management which also includes chickens. The extent of use of IK showed that majority of farmers were using IK than those who were not using IK. The hypothesis that the extent of use of IK is influenced by demographics and availability of medicinal plants was accepted since the use of IK varied with demographics and the availability of medicinal plants.

The third objective (chapter 5) was to evaluate the effectiveness of medicinal plants to control GIN in chickens through assessment of chicken parameters and FEC. Results revealed that chickens that medicinal plants were not used to control GIN were unhealthier than those treated. The symptoms of chickens with GIN that were not treated for GIN were anaemic, poor body conditions score, pale comb, ruffled feathers and poor artlessness. Low egg production, pale meat colour, bloody faeces and red spots in the intestines was observed. These chickens were having higher nematode egg counts as compared to the chickens found in the households using medicinal plants to control GIN infestation. These results highlighted that IK is effective in controlling GIN in chickens. The hypothesis that IK is effective in controlling GIN in chickens was therefore accepted since chicken parameters and FEC of chickens treated using medicinal plants were found better.

6.2 Conclusions

Indigenous knowledge should be exploited instead of relying on anthelmintics for sustainable chicken health management. Data on useful plant species is unavailable thus, effort to record data such data is therefore needed. Different areas are using different medicinal plant species depending on their availability, it is important that these plants are identified. Gastrointestinal nematodes infestation is associated with many factors that negatively affect chicken health such as lower egg production, alertness, body condition and leading to anaemia. The medicinal plants that will treat for these factors while targeting GIN in chickens need to be identified.

5.3 Recommendations and further research

It is recommended that IK be integrated with conventional knowledge to get better results in controlling GIN of chickens. Indigenous knowledge need to be put in public through media and newspapers. Regular studies need to be conducted to identify areas that need further intervention. Developing and creating a database on medicinal plants for chicken parasites is needed. It is important that livestock farmers share ideas on traditional knowledge with modern veterinarians in order to optimize productive capacity of flock sizes and enhance sustainable rural livelihoods.

Aspects that require further research includes the following;

1. Active ingredients that contribute in health of chickens such as immunity and nutritional benefits.
2. Efficacy, lethal doses, standardized doses and active ingredients of medicinal plants.
3. More research is needed to gather more IK from farmers and herbalists so that it can be integrated into extension service provision.

Appendix 1: Structured questionnaire

Objective: Farmer perceptions on the extent of use of indigenous knowledge to control gastrointestinal nematodes in scavenging chickens

Questionnaire Number……Village name………………………Numerator name………………..Ward Number……

SECTION A: Household demography

A1. Sex of household: 1. M □ 2. F □

A2. Marital status: 1. Married □ 2. Single □ 3. Divorced □ 4. Widowed □

A3. Age: 1. 18-30 □ 2. 31-50 □ 3. >50 □

A4. Is the head of the household resident on the farm? 1. Yes □ 2. No □

A5. Highest education level: 1. No formal education □ 2. Grade 1-7 □ 3. Grade 8-12 □ 4. Tertiary □

A6. Have you ever received any training on livestock production? 1. Yes □ 2. No □

A7. What are major sources of income? 1. Crops □ 2. Livestock sales □ 3. Livestock products □ 4. Salary □

5. Government grant □ 6. Other □, specify ………

A8. Types of livestock species kept

	Cattle	Goats	Sheep	Chickens	Pigs	Other (specify)
Number						
Rank						

A10. What is the reason of using indigenous knowledge?

1. Effectiveness □ 2. Availability □ 3. Affordability □ 4. Quick solution □ 5. Works the same as conventional ways □ 6. Other □, specify ……….

A11. What is the source of indigenous knowledge?

1. Oral tradition from the family □ 2. Other farmers □ 3. Local elders □ 4. Own experience □ 5. Myths □ 6. Other □, specify ………………

A12. Do agricultural institutions promote and support the use of indigenous knowledge to treat animal diseases?

1. Yes □ 2. No □

A13. Which groups within the community uses traditional knowledge more?

1. Males □ 2. Females □ 3. Wealthy □ 4. Poor □ 5. Young □ 6. Educated □ 7. Non-educated □ 8. Other □, specify

A14. Do you see yourself using indigenous knowledge in future?

1. Yes □ 2. No □

A15. Which method would you recommend for preservation of indigenous knowledge?

1. Workshop □ 2. Educate young generation □ 3. Include in syllabus at school □ 4. Other, specify □ …

SECTION B: Chicken health

D1. Why do you keep chickens? (Please tick the first column for the purpose and the second column for ranking)

Purpose	Meat	Eggs	Manure	Income	Traditional ceremonies
Tick					
Rank					

D2. What chicken production system do you use?

1. Extensive □ 2. Semi-intensive □ 3. Intensive □ 4. Other □, specify ……….

D3. What are the challenges facing chicken production?

Challenges	Nematodes	Diseases	Mortality	Low egg production
Rank				

D4. What is the chicken flock size and composition?

Range	**Hens**	**Chicks**	**Cocks**
≤ 10			
10 - 30			
30 – 50			
50+			

D5. What method do you use to feed chickens?

1. Broadcast □ 2. Local made feeders □ 3. Commercial feeders □ 4. Other □, specify ……….

D6. How often do you clean chicken houses?

1. Once a week □ 2. Once a season □ 3. Once a year □ 4. When remembered □ 5. None □ 6. Other □ (specify) ………………

D7. What are problematic parasites in your chickens?

1. Internal parasites □ 2. Ecto-parasites □

D8. How do you diagnose chickens with nematodes?

1. Diarrhoea □ 2. Loss of body weight □ 3. Low egg production □ 4. Anaemia □ 5. Feather drop □ 6. Reduced appetite □ 7. Coughing □ 8. Saliva excretion □ 9. Swollen comb □ 10. Closed eyes □ 11. Dirty cloacal region □ 12. Increased thirst 13. Head nodding down 14 Other □, specify ……….

D9. How do you select cocks for mating?

1. Health □ Colour □ Size □ Other □, specify ……….

D10. Do you use traditional medicines to treat nematodes or parasites in chickens?

1. Yes □ 2. No □

D11. If yes, how long have you been using medicinal herbs to treat nematodes in chickens?

1. < 5 years □ 2. 5 – 10 years □ 3. >10 years □

D12. Which medicinal plants do you use to treat nematodes in chickens?

1. Isithezi □ 2. Umnala □ 3. Icena □ 4. Inhlashwana □ 5. Inhlaba □ 6. Umdlandlatho □ 7. Umthombothi □ 8. Umhlonhlo □ 9. Ulilo □ 10. Umgwadla □ 11. Uhalibhomu □ 12. Ikhambi lesisu □ 13. Umtshovane □ 14. Umgxamo □ 15. Amasethole □ 16. Isibiba samakula □ 17. Umanyazini □ 18. Isnemfu □ 19. Ushibhoshi □ 20. Other □, specify ……….

D13. Which type of chickens flock is mostly affected by nematodes?

1. Chicks □ 2. Hens □ 3. Cockerels □

Appendix 2: Ethical approval document for the survey study

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

23 January 2018

Professor Michael Chimonyo (28007)
Scool of Agricultural, Earth & Environmental Sc
Pietermaritzburg Campus

Dear Professor Chimonyo,

Protocol reference number: HSS/0852/017
Project Title: Indigenous knowledge of controlling nematodes and ticks in chickens and goats

HSSREC Approval – Expedited Application

In response to your application received 21 June 2017, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **APPROVAL** for Trial 2 and Trial 3.

NOTE:
AREC approval needs to be obtained for Trial 1 and Trial 4

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Dr Shenuka Singh (Chair)

/ms

Cc Academic Leader Research: Professor Hussain Shimelis
Cc School Administrator: Ms Marsha Manjoo

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001 Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

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Appendix 3: Ethical approval for the scavenging chicken trial

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

14 August 2018

Professor Michael Chimonyo (28007)
School of Agricultural, Earth & Environmental Sciences
Pietermaritzburg Campus

Dear Professor Chimonyo,

Protocol reference number: AREC/043/017
Project title: Indigenous Knowledge of controlling nematodes and ticks in chickens and goats

Full Approval – Research Application

With regards to your revised application received on 29 June 2018. The documents submitted have been accepted by the Animal Research Ethics Committee and **FULL APPROVAL** for the protocol has been granted.

Please note: Any Veterinary and Para-Veterinary procedures must be conducted by a SAVC registered VET or SAVC authorized person.

Any alteration/s to the approved research protocol, i.e Title of Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of one year from the date of issue. Renewal for the study must be applied for before 14 August 2019.

Attached to the Approval letter is a template of the Progress Report that is required at the end of the study, or when applying for Renewal (whichever comes first). An Adverse Event Reporting form has also been attached in the event of any unanticipated event involving the animals' health / wellbeing.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Prof S Islam, PhD
Chair: Animal Research Ethics Committee

/ms

Cc: Academic Leader Research: Professor Hussein Shimelis
Cc: Registrar: Mr Simon Mokoena
Cc: NSPCA: Ms Anita Engelbrecht

Animal Research Ethics Committee (AREC)
Ms Marielle Snyman (Administrator)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 8350 Facsimile: +27 (0) 31 260 4609 Email: animalethics@ukzn.ac.za
Website: http://research.ukzn.ac.za/Research-Ethics/Animal-Ethics.aspx

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