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# Camel health management and pastoralists' knowledge and information on zoonoses and food safety risks in Isiolo County, Kenya

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## Abstract

Camel health management has implications for public health and camel product trade. After liberalization of the veterinary service, current camel health management in the arid and semi-arid lands (ASALS) of Kenya and its implications for public health is not known. This study investigated camel health management and its implications on zoonoses and food safety in Isiolo County, Kenya. Semi-structured questionnaires were administered to 150 households, 15 agro-veterinary shops, 15 community-based animal health workers (CBAHWs) and 10 veterinary officers to collect information on camel health management. The main occupation and source of household income for the pastoral communities is camel-keeping (45.3%). Pastoralists self-medicate camels and other livestock (45.8%), which can lead to between over-dosing, under-dosing or wrong drug use. The CBAHWs, traditional animal health service providers (TAHSPs), government veterinary officers and private veterinary officers play a minimum role. Private veterinary services have not taken root in the ASALS. The sources of knowledge and information on the veterinary drug to use are experience (57.4%), non-governmental organizations (NGO) (41.1%) or CBAHWs (32.1%). The majority of pastoralists (72.5%) do not keep camel or other livestock treatment records. The constraints in purchasing veterinary drugs are expensive drugs, accessibility to drugs and availability of money. Pastoralists refer to veterinary drugs by their brand names but not by active ingredients. As reported by pastoralists, focus group discussion and key informant interviews, antibiotics used were adamycine (33.3%), ampicilline (26.7%), penicillin (14.4%), tetracycline (12.2%), amoxylin (11.1%) and penstrip (2.2%). The common camel diseases were trypanosomiasis, brucellosis, mastitis, diarrhoea, worm infestation, camel pox and tuberculosis. The public health risk factors were the presence of veterinary drug residues in camel products and development of resistant zoonotic organisms/diseases. It was concluded that current camel health management has serious implications for public health and food safety, and hence the camel product trade.

**Keywords:** Pastoralist, Camel health management, Veterinary services, Zoonoses, Food safety concerns

## Introduction

The Kenyan livestock sector contributes about 10% of the gross domestic product (GDP), with the cattle dairy sub-sector contributing 3.8% of total GDP. However, the contribution of the camel dairy sub-sector is not quantified (GOK 2010).

In Kenya, the one-humped camel (*Camelus dromedarius*) population is estimated to be over three million heads (KNBS 2010; FAOSTAT 2015), the third largest population in Africa after Somalia and Sudan. The camels are mainly kept as mobile grazing herds under pastoral production systems in the arid and semi-arid lands (ASALS) counties of Kenya. The ASALS are characterized by high levels of poverty, poor infrastructure, extreme weather and a fragile environment. Camels require low production inputs as they have unique adaptability to these harsh environmental conditions. Camels produce more

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milk and for a longer period than other livestock under these harsh ASAL conditions (Farah and Fisher 2004). However, this comparative advantage of camels as a milk producer over other livestock has not been adequately exploited in the improvement of the ASAL community livelihoods.

One of the major constraints is poor camel health management, which does not give consumers assurance on absence or presence of zoonotic organisms/diseases and other food safety issues. Good camel health management practices are an important factor for increased milk productivity and in promoting domestic and export milk trade (Kuria et al. 2002).

However, the privatization of veterinary services in Kenya in the 1990s (Umali et al. 1992) resulted in inadequate professional veterinary service delivery in the ASALs, as most private veterinary service providers found it not economically viable to operate in these vast areas with poor infrastructure. This had a negative impact on camel/livestock health and productivity as it hampered the provision of veterinary services and dissemination of knowledge and information on good camel health management practices to pastoralists. The result effect was mushrooming of unskilled veterinary service providers (community-based animal health workers (CBAHWs)) and self-medication of livestock, including camels. The absence of professional veterinary services results in uncontrolled and unauthorized sale of veterinary drugs by agro-veterinary shops, self-medication, use of wrong veterinary drugs, injection needles and route, and overdosing of chemotherapeutic veterinary drugs (Kuria et al. 2002) leading to food safety concerns like drug residues and development of drug resistance among zoonotic organisms/diseases in milk and meat. Therefore, the liberalization of veterinary services in the camel sub-sector resulted in development of diseases that lowered productivity. The urban and export markets also developed negative attitudes towards camel milk and meat due to the likely presence of zoonotic organisms/diseases and food safety concerns, hence limiting the markets for camel products only to traditional consumers.

The frequent contact between livestock (camels) and humans and communal watering of livestock also facilitates spread of zoonotic organisms/diseases with a potentially high risk to public health among livestock and humans (Younan and Abdurahman 2004; Oliver et al. 2009; Kazoora et al. 2014).

Despite growing importance of the camel dairy sub-sector in Kenya, the effects of the post-privatization of veterinary services, current pastoralists' knowledge and information on camel health management is still limited. Most of the research conducted has documented camel husbandry practices like feeding, breeding and watering,

with very little attention given to camel health management and the implication on presence or absence of zoonotic organisms/diseases and milk safety (Wanjohi et al. 2012; Wanjohi et al. 2013; Gitao et al. 2013).

The present study was carried out to assess current camel health management and the impact of pastoralists' knowledge/information on zoonoses and food safety risks along the camel value chain in Isiolo County, Kenya, which is a major camel milk producing and marketing area in Kenya.

### **Study area**

The study was carried out along the Mlango-Ngarendare-Burat, Kambi Garba-Ngaremara-Chumvi-Gambela and Boji-Kulamawe-Baranbate camel milk clusters in Isiolo County (Figure 1).

Isiolo County is a typical ASAL area located in the northern eastern region of Kenya and covers approximately 25,000 km<sup>2</sup>. The County has a population of approximately 43,300 camels, kept under peri-urban and pastoral camel production systems. Isiolo County has a thriving camel milk production and marketing business. It supplies 90% of camel milk to the Nairobi terminal camel milk market.

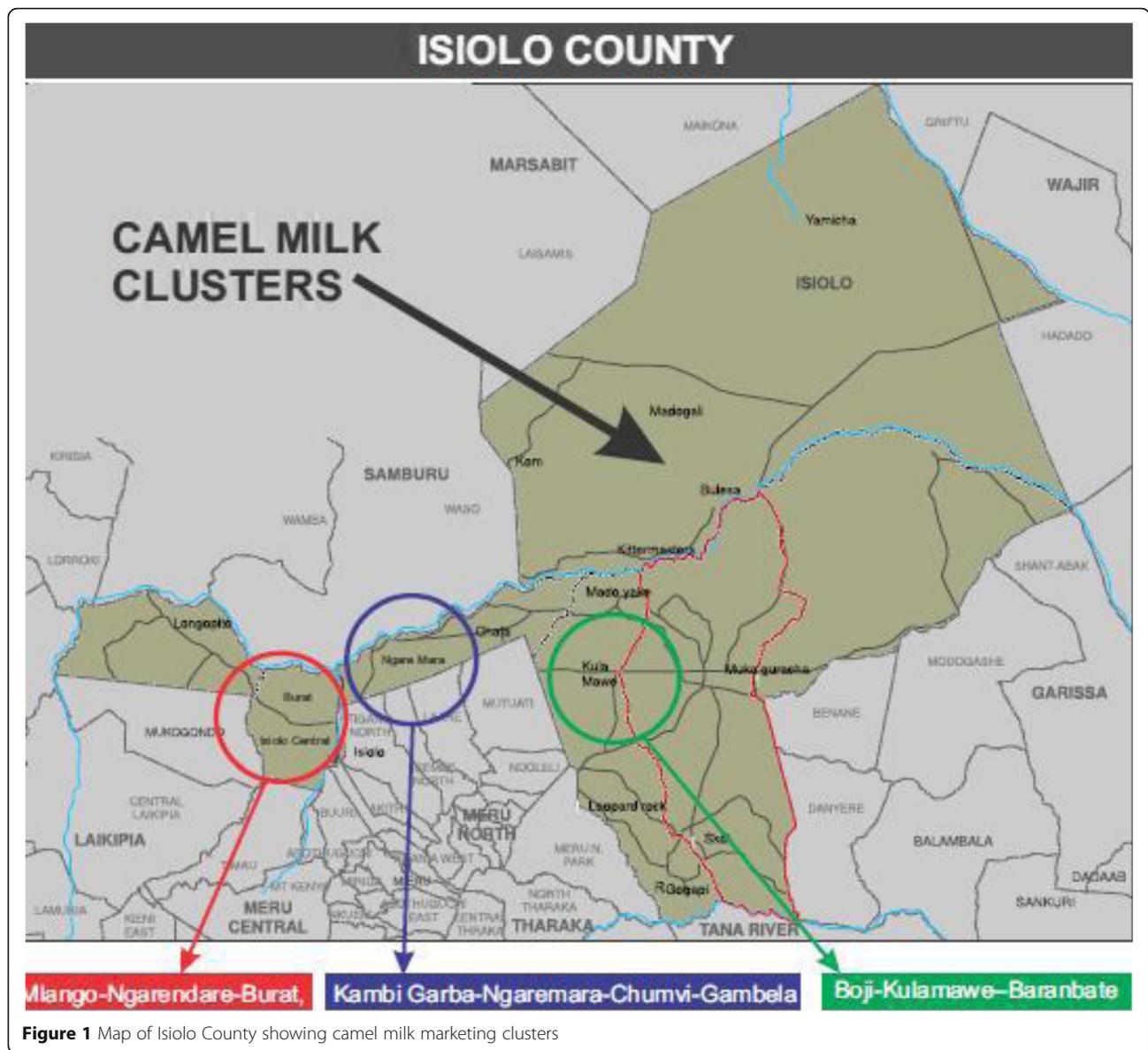
The rainfall pattern is bimodal (350 and 600 mm per year), unpredictable and erratic in distribution. Long rains occur in late March to May while short rains occur in November to December. The County experiences recurring droughts with devastating losses of livestock. The mean annual temperature is between 24 and 30 °C (Herlocker et al. 1993).

### **Methods**

#### **Study design and data collection**

A cross-sectional survey was conducted among 150 camel-keeping households, 15 agro-veterinary outlets/shops, 15 community-based animal health workers and 10 veterinary officers were conveniently selected along the Mlango-Ngarendare-Burat, Kambi Garba-Ngaremara-Chumvi-Gambela and Boji-Kulamawe-Baranbate camel milk clusters in Isiolo County. The households were conveniently selected from each of the above clusters based on the Kenya population census clustering system (KNBS 2010), accessibility and the willingness of pastoralists to take part in the study.

One set of semi-structured questionnaires were administered to 150 camel-keeping households to obtain information on camel health management practices and knowledge/information of pastoralists on the right veterinary practices in camel health management, zoonotic organisms/diseases and food safety risks. The practices determined were who treats camel/livestock, sources of veterinary drugs for treating the camel/livestock, source of knowledge and information on veterinary drug use, type of records kept when treating



**Figure 1** Map of Isiolo County showing camel milk marketing clusters

camel/livestock and constraints in purchasing of veterinary drugs as dependent variables. These practices if not professionally done will result in drug residues in camel milk and meat and development of drug resistant zoonotic organisms with serious implications for food safety.

Knowledge and information of pastoralists on camel husbandry practices associated with spread of zoonotic organisms/diseases was determined. Also, knowledge of pastoralists on potential food safety risk along the camel milk value chain, milk withdrawal period after treatment of camels, presence of drug residues and drug resistance was determined.

Another set of different semi-structured questionnaires were administered specifically to 15 agro-

veterinary outlets/shops, 15 community-based animal health workers and 10 veterinary officers to elicit their knowledge/information on provision of veterinary services, types of diseases commonly affecting camels, types of veterinary drugs commonly used, dosage used in treatment of camels and practices that predispose camel and pastoralists to zoonotic diseases, as dependent variables.

Focus group discussions (FGDs) and key informant interviews (KIIs) were conducted to complement the information gathered through the semi-structured questionnaires. The FGDs and KIIs comments were also used to clarify and give more insights on aspects of camel health management practices, zoonoses and food safety risk factors.

**Statistical analysis**

The frequencies of respondents’ responses were determined and corresponding proportions (percentage) of responses calculated for individual variables and histograms drawn using Excel software. The dependent variables were: who treats camel/livestock, sources of veterinary drugs for treating the camel/livestock, source of knowledge and information on veterinary drug use, type of records kept when treating camel/livestock and constraints in purchasing of veterinary drugs. The independent variables were age, gender and level of education. Correlations and Pearson’s correlation coefficient were calculated to measure the strength and direction of the relationship between dependent and independent variables.

**Results**

**Demographic and socio-economic characteristics**

Table 1 shows the gender, ethnic group, education and socio-economic characteristics of the surveyed pastoralists. The respondents consisted of 52% male and 48% female. The majority of respondents were of Somali (70%), Garri, a sub-tribe of Somali descent (16%) and Boran (10%)

**Table 1** Demographic and socio-economic characteristics of respondents

Characteristics		Frequency	Percent
Gender (n = 150)	Male	78	52.0
	Female	72	48.0
Household heads (n = 150)	Yes	98	65.3
	No	52	34.7
Relationship to household head (n = 52)	Spouse	43	82.7
	Son	6	11.5
	Others	3	5.8
Ethnic origin	Somali	105	70.0
	Garri	24	16.0
	Boran	15	10.0
	Sakuye	6	4.0
Education	No formal education	99	66.0
	Pre-primary	24	16.0
	Primary	15	10.0
	Secondary level	12	8.0
Occupation (n = 150)	Livestock keeping	100	66.7
	Self-employment	24	16.0
	Salaried-employment	20	13.3
	Others	6	4.0
Sources of income	Livestock	67	44.7
	Income from business	50	33.3
	Food aid	14	9.4
	Salary	10	6.6
	Crops	9	6.0

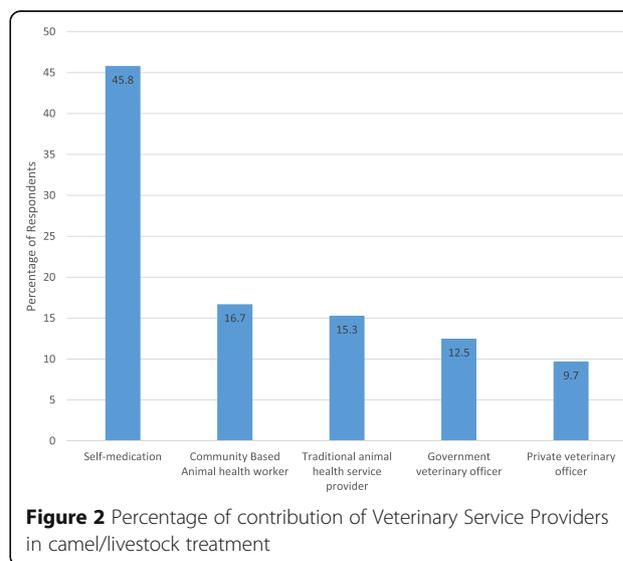
ethnic groups. A high percentage of respondents (66%) had no formal education. The main occupation of the household heads was livestock-keeping (70%), with self-employment (16%) and salaried-employment (12.7%) as other occupations. Livestock-keeping contributes about 44.7% towards households’ income on average, of which camels contributed 45.3%, goats and sheep contributed 32.7% and income from business contributing 33.3% towards households’ income. Drought (34.6%), livestock diseases (33.4%) and insecurity (32%) have nearly equal implications for household income generation, due to either death of livestock or loss of livestock due to livestock theft.

**Treatment of camels and other livestock**

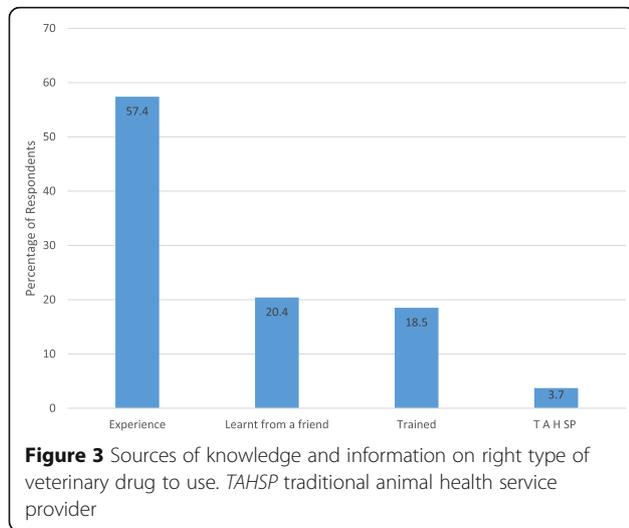
The treatment of camels and other livestock is mostly done by pastoralists themselves, (45.8%) (self-medication), and also by CBAHWs (16.7%) or traditional animal health service providers (TAHSP) (15.3%) but very few remaining government veterinary officers (12.5%) (Figure 2). Provision of veterinary clinical services from private professional veterinary officers is minimal (9.7%), indicating that private veterinary practice has not taken root in the ASALs.

**Knowledge and information on the right veterinary drugs to use**

Most of the pastoralists (57.4%) acquired knowledge/information on veterinary drug use through experience and previous conduct with past professional government veterinary officers (Figure 3). There was highly significant ( $p < 0.001$ ) difference and negative correlation ( $r = -0.309$ ) between age and sources of knowledge and information on treating camels. Only 18.5% of pastoralists had some knowledge/information on the right veterinary drug to use, which they acquired through informal training



**Figure 2** Percentage of contribution of Veterinary Service Providers in camel/livestock treatment

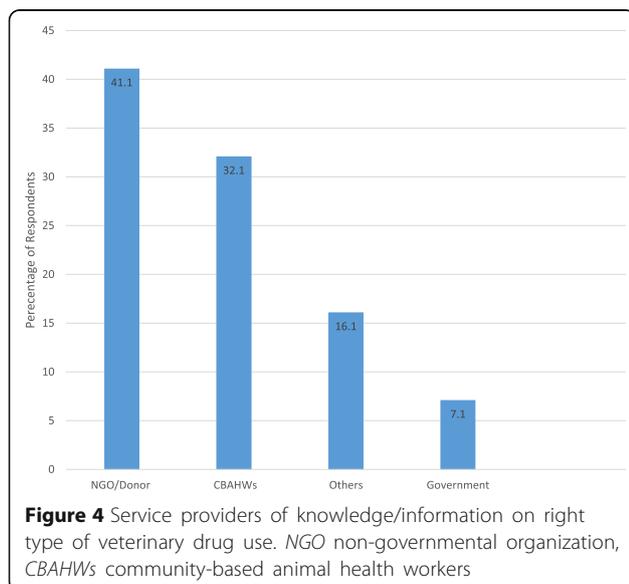


(Figure 3) provided by either non-governmental organization (NGO) (41.1%) or CBAHWs (32.1%) (Figure 4). There was significant ( $p < 0.05$ ) difference and negative correlation ( $r = -0.387$ ) between level of education and knowledge and information on the right veterinary drug to use.

There was very little involvement of either the national or the County government in provision of information on the right veterinary drug to use (7.1%) to pastoralists (Figure 4). The veterinary drug stores/agro-veterinary shops are mostly staffed by personnel with nil or minimum knowledge on clinical veterinary services.

**Sources of drugs for treating camels and other livestock**

Eighty percent (80%) of pastoralists reported that they purchase veterinary drugs from agro-veterinary shops, while else received from NGO/donor projects (11.4%) or



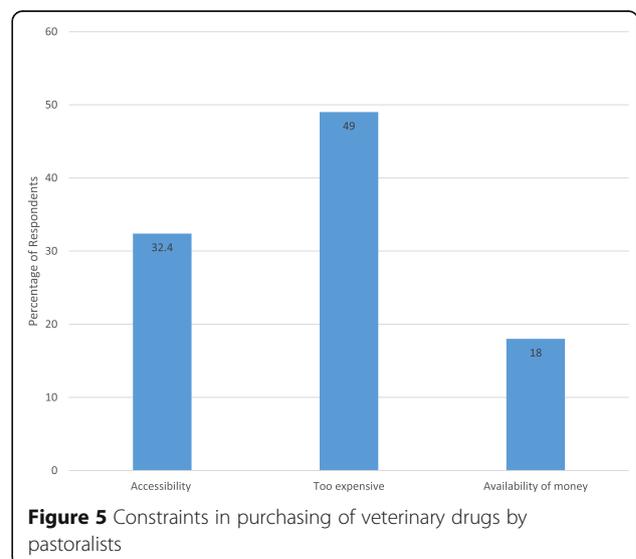
other sources (8.6%) such as friends/neighbours with previous leftover stock. There was significant ( $p < 0.05$ ) difference and negative correlation ( $r = -0.300$ ) between age and sources of veterinary drugs for treating camels, indicating that youth and elderly herders get veterinary drugs from several sources.

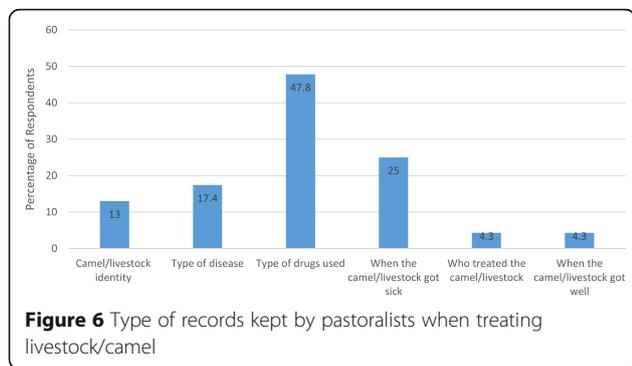
**Constraints in purchasing veterinary drugs**

The distance on average to the nearest veterinary drug stores was more than 20 km (43.2%), with 20.3% and 21.6% of respondents being 1 to 5 km and 11 to 20 km away from veterinary drug stores, respectively. There was no significant ( $p > 0.05$ ) difference and negative correlation between level of education and accessibility to veterinary drug store ( $r = -0.263$ ) or in constraints of getting veterinary drugs ( $r = -0.347$ ). Despite the long distances to the nearest drug store, the high cost of veterinary drugs (49%) was the main constraint faced by pastoralists when purchasing veterinary drugs, compared to accessibility to veterinary drugs (32.4%) or availability of money to purchase the veterinary drugs (18%) (Figure 5).

**Type of records kept when treating camels and other livestock**

Most of the pastoralists (72.5%) do not keep records on treatment of camels and other livestock. There was no significant ( $p > 0.05$ ) difference and negative correlation ( $r = -1.000$ ) between level of education and types of record kept when treating camel. Of the 25.5% who kept records, 17.4, 47.8 and 25% kept records on type of diseases, type of veterinary drugs used and when the camel got sick, respectively (Figure 6).





**Diseases commonly affecting camels in the study area**

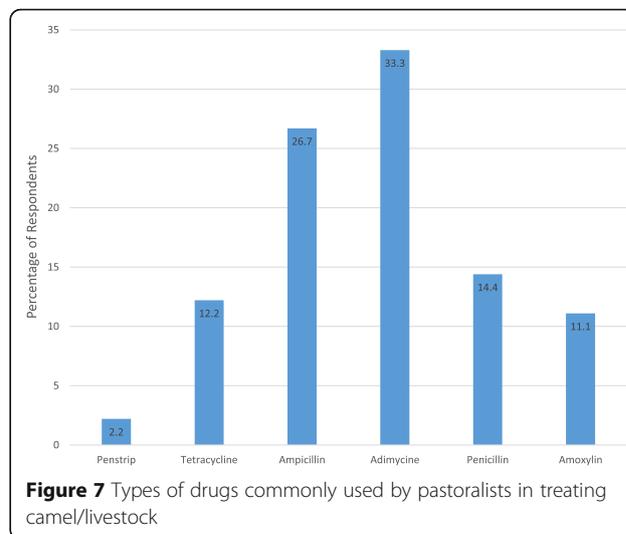
The common diseases that infect camels in the study area were listed by pastoralists as trypanosomiasis (39%), brucellosis (14%), mastitis (10%), diarrhoea (10%), worm infestation (9%), camel pox (4%) and tuberculosis (3%). Most of the respondents were not aware of incidences of bovine tuberculosis in camels. There was no significant ( $p > 0.05$ ) difference and negative correlation between level of education and pastoralists knowing diseases that affect camels in the study area ( $r = -0.312$ ) or knowing whether brucella, tuberculosis (TB) and mastitis affect camels in the study area ( $r = -0.352$ ).

**Types of drug used**

There was no significant ( $p > 0.05$ ) difference and negative correlation between level of education and the pastoralists knowing types of drugs used to treat camels ( $r = -0.447$ ) and whether antibiotics ( $r = -0.254$ ) are used to treat camels. Ninety percent (90%) of pastoralists reported to have used veterinary drugs during treatment of their camels or other livestock. However, the respondents could only refer to the veterinary drugs by their brand names. The active ingredients on the brand were determined by cross-checking on packages at agrovet shops and consultation with veterinary professionals at the Department of Clinical Studies, University of Nairobi. Apart from triquin (11.9%), which is used in treatment of trypanosomiasis, the penstrip (2.2%), tetracycline (12.2%), ampicilline (26.7%), adamycine (33.3%), penicillin (14.4%) and amoxylin (11.1%) were common antibiotics used in treatment of camels or other livestock (Figure 7). This information was complemented by agro-veterinary shop attendants who also reported selling the same veterinary drugs in nearly the same proportion (Figure 8).

**Risk factors associated with residual veterinary drugs and spread of zoonotic organisms/diseases**

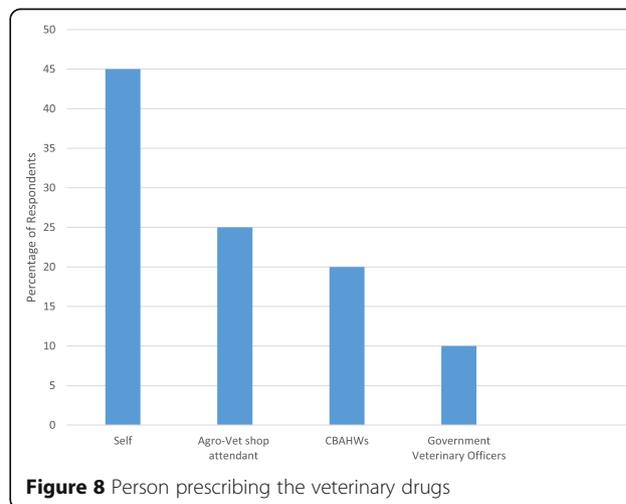
Thirty-six percent (36.2%) of respondents reported that presence of veterinary drug residues in camel milk and meat was a health risk to human and camels (Figure 9).



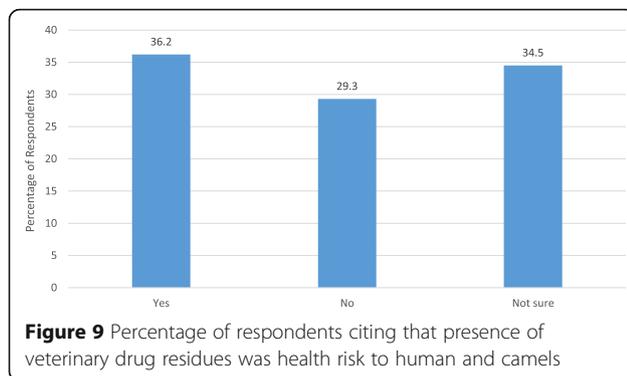
About 34.5% were not sure of the impact of veterinary drug residues on human and camel health. There was no significant ( $p > 0.05$ ) difference but there was negative correlation ( $r = -0.312$ ) between level of education and likely presence of residual veterinary drugs in camel milk ( $r = -0.447$ ) knowing that presence of residual veterinary drugs in camel milk is a risk ( $r = -0.339$ ). The health risks cited were diarrhoea/vomiting (44.7%), allergic reaction (31.6%) resistance to human and veterinary drugs (15.8%) and cancer (7.9%).

**Health risk to human and camels**

Forty-eight percent (48%) of pastoralists reported having received advice from veterinary service providers on milk withdrawal period after treatment of camels or other livestock. Of the 48% who had received this advice, about 53% of pastoralists reported to have been advised not to consume or sell camel milk one day



**Figure 8** Person prescribing the veterinary drugs



(15.2%), three days (51.5%) and five days (30.3%) after treatment of camels with antibiotics.

#### Common foodborne diseases encountered in the study area

Twenty-three percent of pastoralists reported that one of their family members or person from the study area had a health problem associated with camels. (Figure 9). Out of these 23% of pastoralists, 72.7, 81.8, 26.4, 45.4 and 27.3% of respondents reported incidences of bloody diarrhoea, brucellosis, tuberculosis, septic sore throat and kidney failure, respectively, among either family members or any other persons in the study area. There was no significant ( $p > 0.05$ ) difference and negative correlation ( $r = -0.312$ ) between level of education knowing whether brucellosis, TB and kidney failure affect humans. According to key informants at the county health office, there are high incidences of brucellosis and tuberculosis in the County (read Kenya as most Kenyans commonly referred to brucellosis as “milk disease”).

#### Focus group discussion and key informant interview

During focus group discussions (FGD) and key informant interviews (KIIs), gross misuse and abuse of veterinary drugs by pastoralists was reported. The noted cases were administering veterinary drugs through a wrong route and using a wrong injection needle size. The pastoralists, CBAHWs and veterinary officers complained that most of the veterinary drug packages in agro-veterinary shops did not have instructions on dosage for camels, and they extrapolate the camel dosage based on cattle or horse dosage on the package, which can lead to over-dosing or under-dosing of camels.

During FGD and KIIs, the respondents cited several barriers to availability and appropriate prescription of veterinary drugs by agro-veterinary outlets. These include unavailability of veterinary drugs, price competition among agro-veterinary outlets, economic constraints and limited pastoralists’ knowledge on drug use and camel diseases. The veterinary officers expressed mistrust towards competency of non-professional practitioners. The agro-veterinary

drug outlets reported that professional veterinarians and para-veterinarians were important players in promoting the pastoralists’ management of camel and other livestock health.

The risk factors associated with spread of zoonotic organisms/diseases between human and camel/livestock were identified by veterinary service providers and KIIs as: livestock and wildlife common grazing and watering points, mixing of infected and healthy camels and other livestock herds at grazing and watering points, humans sharing water sources for personal hygiene and domestic use with camels and other livestock, aerogenic transmission due to close contact of camels and herders in the night housing “boma”, herders assisting camels during delivery and training young camels how to take water and suckle the mother.

## Discussion

#### Demographic and socio-economic characteristics

There is equal and highly significant ( $p = <0.001$ ,  $p = -0.359$ ) participation of male, women and youth in camel-keeping activities. However, according to traditions of Somali and Boran pastoral communities, daughters should play limited roles in camel and other livestock management. Therefore, for development of commercially viable camel product system, women should be considered seriously in the transformation of the camel value chain. The predominant camel keepers are the Somali ethnic group, but due to recurrent drought and adaptability of camels to the ASAL conditions, the Boran ethnic group, although traditionally cattle-keepers, are slowly adapting to camel keeping (Noor et al. 2013).

There was highly significant ( $p < 0.001$ ,  $r = -0.309$ ) correlation between age and pastoralists knowledge and information on treating camels. Lack of formal education or low level of education among pastoralists affects their ability to acquire, comprehend and disseminate knowledge and information on camel health management and food safety awareness. It also hampers their ability to interact with professional veterinary staff.

The results of this study are in agreement with studies by Kaufmann (1998), Musinga et al. (2008), Wayua et al. (2012) and Watete et al. (2016), who reported that livestock-keeping, especially camel-keeping, is the main occupation and source of household income for the pastoral communities. Camels are adapted to harsh ASAL conditions; therefore, interventions aimed at improving the camel value chain need to consider the promotion of camel health management as an option for building pastoralists’ resilience against climate change.

#### Treatment of camels and other livestock

The results are in agreement with the findings of Onono et al. (2015) who reported that treatment of cattle in

Narok County was done by male pastoralists. The pastoralists' self-medication of their camel and other livestock poses serious public health risks due to use of the wrong veterinary drugs, over-dosing and under-dosing. The over- or under-dosing of camels is complicated by lack of camel dosage information on most drug packages, hence extrapolation of camel dosages based on cattle or horse dosage, which can lead to over-dosing and under-dosing. The presence of veterinary drug residues in camels and camel milk and meat can lead to development of drug resistant organisms in both the camels and the humans consuming camel products. This can result in development of drug-resistant zoonotic organisms in the camel. When camel products are consumed, the drug-resistant foodborne organisms are then transmitted to human consumers, thus posing a food safety and public health issue. Inappropriate and inefficient use of veterinary drugs has been reported to have devastating effects on animal disease management (Redding et al. 2013).

This study shows that CBAHWs are the main providers of animal health services, apart from the pastoralists themselves. The private clinical veterinary practices are unsustainable in the ASALs. This is due to the nomadic nature of the pastoral systems and disproportionately high expenses involved in transport and time involved in tracing the camels and other livestock animal (FAO 2001; Chema and Gathuma 2004; Woodford 2004; Onono et al. 2015). CBAHWs have been reported as an alternative animal health service providers in smallholder farming sectors in Zimbabwe (Matambara et al. 2013) and reported to be technically competent in Mwingi County, Kenya (The IDL Group and McCorkle C 2002; Rubyogo et al. 2005).

Recognition of CBAHWs as Para-Veterinary Professionals is not defined in the Veterinary Surgeons and Veterinary Para-Professionals Regulations, Legal Notice no. 48 (GOK 2013), making their services illegal. The statutory bodies like the Kenya Veterinary Board (KVB) and Kenya Veterinary Association (KVA) also state that the CBAHW approach does not fit within the existing technical, legal and policy framework of animal health delivery (Mugunieri et al. 2004a). Therefore, there is a need for policy change to integrate CBAHWs in the existing formal animal health service delivery in pastoral areas of Kenya (Mugunieri et al. 2004b; Ahuja 2004).

#### **Knowledge and information on the right veterinary drug to use**

In the ASALs, there is limited dissemination of knowledge and information on camel health management. Pastoralists obtain knowledge and information on veterinary drug use through experience (the elders have more information on veterinary drugs than the youth).

Pastoralists also get knowledge/information on veterinary drug use through informal training conducted by either NGOs or CBAHWs recruited as facilitators by NGOs. This demonstrates the significant role played by the CBAHWs in animal health management in the ASALs. There is limited involvement of the government in provision of knowledge and information on the right veterinary drugs to use.

#### **Sources of veterinary drugs for treating the camel/ livestock and constraints in purchasing veterinary drugs**

There was no significant differences in different ways of accessibility ( $p > 0.05$ ,  $r = -0.263$ ) to veterinary drug stores or constraints ( $p > 0.05$ ,  $r = -0.347$ ) involved in getting veterinary drugs. The high cost of drugs is the main constraint compared to accessibility to veterinary stores. Pastoralists do not factor transport into overall costs, due to daily delivery of milk to urban centres located in the same urban and peri-urban centres where the veterinary drug stores are located. Key informant interviews revealed that camel-keepers spend more money on camel health care and watering of camel than on feeds. This corroborates the findings of Heffernan (2004) who reported that livestock owners have increased household expenditures for animal healthcare, feed and water. Heffernan and Misturelli (2000) reported that expenditure on livestock drugs was ranked fourth after food, school fees and human health in the tier of pastoralists' expenditure.

The regulations on provision and sale of livestock drugs in Kenya are very weak, allowing for unqualified persons to establish and manage outlets selling veterinary pharmaceuticals. This leads to extensive misuse and abuse of veterinary drugs due to lack of dissemination of knowledge and information to pastoralists when administering the veterinary drugs.

#### **Treatment records and diseases commonly affecting camels in the study area**

Lack of records on treatment of livestock/camels may be attributed to lack of education and low education level of pastoralist communities. The lack of records has serious implications on traceability of diseases and veterinary drug use, thus affecting international safety requirements.

The study findings indicate that the pastoralists are more familiar with the common diseases like mastitis, brucellosis and diarrhoea than with the rare diseases like bovine tuberculosis and listeriosis in animals/camels. Woldearegay et al. (2015) reported that in Ethiopia, pastoralists apply prophylactic treatments (49.4%) and deworming (89.8%) to control bacterial infection and parasitic diseases of camels, respectively.

### Health risk factors and food safety concerns

The health risk factors were veterinary drug residues in camel milk and meat, diarrhoea/vomiting, allergic reaction, resistance to human and veterinary drugs and cancer. The presence of these public health and food safety risk factors demonstrates the likelihood of spreading zoonotic diseases between animals and human. The presence of veterinary drug residuals may lead to development of resistance in the common diseases affecting the livestock and humans in the study area.

### Conclusions

Pastoralists self-medicate camels despite having limited knowledge and information on camel health management. Pastoralists also do not receive any government or private professional veterinary services in management of camel health. These pose serious public health risk and food safety concerns in the camel value chain. Therefore, to support the development of camel value chain, effective strategies that support improved management of camel health should be promoted.

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### Authors' contributions

All authors read and approved the final manuscript.

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### Competing interests

The authors declare that they have no competing interests.

### Ethics approval and consent to participate

Ethical clearance for the study was approved by the Biosafety, Animal Use and Ethics Committee of the Faculty of Veterinary Medicine, University of Nairobi, Kenya.

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