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Original Research Article

Knowledge, Attitudes and Practices of Livestock Farmers Regarding the Management of Gastrointestinal Parasitism in Small Ruminants Grazing in the Urban and Peri-Urban Areas of Ngaoundere, Cameroon

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Abstract: To contribute to the management of gastrointestinal parasites in small grazing ruminants in Cameroon, this study was conducted in the urban and peri-urban areas of three districts in Ngaoundere, a city in the Adamawa region. The objective was to evaluate farmers' knowledge, attitudes and practices regarding the management of this pathology. A total of 385 individuals were interviewed using a semi-structured questionnaire, and 259 of these were selected for the study. The results of the survey indicate that more than half of the farmers in Ngaoundere 2nd had good knowledge of gastrointestinal parasites, with an average score of 87%, whereas the lowest level of knowledge was found in Ngaoundere 3ird, with an average score of 13.4%. Attitudes were more harmful in Ngaoundere 1rst, with a score of 28.7%, than in Ngaoundere 2nd (8.7%) and Ngaoundere 3ird (6%). Ngaoundere 3ird had the most harmful practices (a score of 70.1%), followed by Ngaoundere 1rst and Ngaoundere 2nd (scores of 24.5% and 10.9%, respectively). Certain demographic parameters, such as level of education, age, and years of experience, influence farmers' levels of knowledge, attitudes, and practices. This study highlights the need for continuous training of farmers in the proper management of PGI and regular awareness-raising among farmers about disease management on their farms, as well as informing them about the silent evolution of anthelmintic resistance related to the misuse of veterinary drugs.

Keywords: Knowledge, Attitudes, Practices, Small Ruminants, Gastrointestinal Parasites, Adamawa, Ngaoundere, Cameroon.

INTRODUCTION

Gastrointestinal parasites of small ruminant's lodge in the digestive tracts of goats and sheep. These animals ae commonly bred in tropical and subtropical regions (Maiga *et al*., 2020). Gastrointestinal nematode infestations result in significant economic losses due to reduced productivity and increased treatment costs (Aumont *et al*., 2003). Gastrointestinal nematode (GIN) parasitism, which is transmitted through grazing, is one of the main causes of production loss in sheep and goats (Mahieu, 2014). This pathology manifests with symptoms such as intestinal sounds, vomiting, anal itching, irritability, fatigue, severe diarrhea with blood or phlegm, decreased production, poor overall condition, hairy coat, weight loss, brittle wool, and thinness unrelated to food intake (Mahieu, 2014).

The main gastrointestinal parasitic diseases encountered in small ruminants in Cameroon are intestinal coccidiosis and helminthiasis, which are caused by flatworms and roundworms, respectively. These diseases are associated with coccidiosis and constitute a set of complex pathogens that occur worldwide. Their severity depends on farming conditions (Mahieu, 2014). These diseases are most deadly in the northern half of the country, where animals are confronted with a long dry season and are thus less

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resistant to seasonal parasitic aggression related to the rainy season (Paolini, 2003). Coccidiosis is more prevalent in sheep than in goats among small ruminants (FR), but the infestation level remains lower than in cattle (Maiga *et al*., 2020). Generally, well tolerated among RA, it can become fatal when the animal's resistance is lowered. Among helminthiasis, strongyloidiasis sensu lato, which includes trichostrongylidiasis (*Trichostrongylus* spp., *Haemonchus contortus*, and *Cooperia* spp.), oesophagostomiasis (*Oesophagostomum columbianum*), ancylostomiasis (*Gaigeria pachyscelis*), and strongyloidiasis (*Strongyloides papillosus*), are the most prevalent conditions (Dedehou *et al*., 2014). In Cameroon, the gastrointestinal parasites that cause the most damage to small ruminants are nematodes (*Haemonchus contortus*, *Trichostrongylus* spp., and *Oesophagostomum columbianum*). These parasites are responsible for over 50% of national livestock mortality (Tchoumboue *et al*., 2000).

The management of gastrointestinal parasite infestations is based on the rational combination of several strategies, including pasture management, reasoned and selective anthelminthic treatments, the use of bioactive forages (such as tannin-rich plants), and host resistance to parasites. Genetic resistance to IGS is part of this integrated approach and plays a key role in it. Genetic resistance is a way to gradually rebalance the host-parasite relationship to the host's benefit (Dedehou *et al*., 2014).

The present work involves evaluating the knowledge of small ruminant farmers regarding the management of gastrointestinal parasitism in order to effectively combat this pathology. More specifically, the evaluation will focus on the farmers' knowledge of gastrointestinal parasites in small grazing ruminants in the peri-urban area of Ngaoundere. The evaluation will also examine the farmers' behaviors regarding infestations of their animals by these parasites, assess the practices they implement to control these infestations, and establish an effective management program for gastrointestinal parasitism in small grazing ruminants.

MATERIALS AND METHODS

Study Type and Area

Our cross-descriptive study is based on daily observations that suggest poor management of gastrointestinal parasitism. On this basis, we will explore farmers' knowledge, attitudes and practices regarding the management of gastrointestinal parasites in small grazing ruminants. Analysing the data will enable us to implement an effective management program for these parasites in the peri-urban areas of the study region.

Adamawa is one of Cameroon's ten regions. The third largest region, it is located between the 6th and 8th degrees of north latitude and the 11th and 13th degrees of east longitude. It covers an area of 63,701 km² (Boutrais & Houssou, 2018). To the north, it is bounded by the Benue basin; to the southwest, by the Western Highlands; and to the south, by the plains of southern Cameroon. The region has a predominantly rural population of over 1,015,622, accounting for 5.2% of Cameroon's population, with a density of 16 inhabitants per km². The main ethnic groups are the Foulbe, Mbororo, Hausa, Gbaya, Laka, Tikar, Konja, Vouté, Mboum and Dourou peoples. Islam is the dominant religion, and zebu breeding is the main economic activity (Mouokeu, Njinkoue *et al*., 2018).

- Climate: The high altitude results in temperatures ranging from 22 to 25 degrees. Three types of climate dominate the region: an equatorial Guinean climate in the south, an equatorial Cameroonian climate in the southwest and a Sudanese tropical climate on the high plateau.
- Hydrography and soil: the soils are mainly composed of red or brown laterites, resulting from mountain erosion caused by the alternation of dry and wet seasons (Koum, Essomba *et al*., 2018). Four major soil families can be distinguished: coarse, poorly evolved mineral soils; ferruginous soils; ferralitic soils; and hydromorphic soils (Liu *et al*., 2020).
- Vegetation: The vegetation is that of the high Guinean savannahs, with pastures suitable for raising herbivores. In the south, the Guinean savannah is a transition zone between the forest in southern Cameroon and the desert in the north. On the plateau, there is also savannah, albeit less wooded. The grass cover is consistent and thick and consists of natural grasses and woody plants. The Adamaoua is a cattle-breeding region where fodder from the genera *Sporobolus*, *Hyparrhenia*, *Setaria*, *Brachiaria*, *Andropogon* and *Pennisetum* grows naturally (Mandon, 1993).

The region comprises five departments, the largest and most densely populated of which is Vina. Its capital, Ngaoundere, constitutes our study area. This choice is motivated by the fact that Adamawa is an excellent breeding ground, with a humid tropical climate that favours the survival of gastrointestinal parasites for much of the year.

The region's population is cosmopolitan. It is divided into more than 11 ethnic groups of varying demographic size. The main economic activity is livestock farming, followed by secondary activities such as agriculture and trade, both of which play a dominant role in the region (Assana, 2014).

Study Population and Sampling

This cross-sectional study examined the knowledge, attitudes, and practices of small ruminant farmers regarding the management of gastrointestinal parasitism. The study population is composed of small

ruminant breeders who graze in Ngaoundere and its peri-urban areas. Participants were at least fifteen years old to ensure reliable data. According to Fuchs (2009), the reliability of data is often doubtful for individuals under 14 years of age.

Selection Criteria for the Study Population

Inclusion Criteria: All small ruminant breeders in the peri-urban area of Ngaoundere who are subject to a grazing system and who express a willingness to respond to the questionnaire.

Criteria for Non-Inclusion: Refusal to participate in the study and failure to complete the questionnaire.

Criteria for Exclusion: The present study will exclude all peri-urban Ngaoundere farmers who are not specialized in small ruminant farming, as well as those whose animals are not subjected to a grazing system.

Sampling of the survey participants was conducted in the peri-urban area of Ngaoundere. The most commonly used formula is that of Thursfield:

$N = (Z^2 \times P \times (1-P))/C^2$. N = sample size; Z = value corresponding to a given level of confidence (1.96 for a 95% confidence level, the value generally used); P = percentage of the main indicator, expressed in decimals (0.5 by default); C = standard error, expressed in decimals (0.05 or 0.10 in general). We find 384.16. Atteindre une telle taille d'échantillon dépendra des seuls critères cités plus haut. However, we had set the minimum number of respondents per arrondissement at 85. The sample size is therefore 255.

Methods

The questions were entered using Sphinx Plus 2 (version 4.0). Then, a data table was created in Microsoft Excel® (version 2013).

The survey began with information from the Regional Delegation on the various aspects of small ruminant farming and the number and dynamics of farmers. The study areas were then defined. The districts were chosen based on the high density of small ruminants. The heads of the district services helped us to contact the relevant center managers.

Study Phases

Our investigation process is based on two main approaches:

- The center leaders indicated the meeting places of the breeders and the locations of some farmers, to whom we submitted questionnaires. The other breeders were identified through previous interviews (snowball method).
- In some localities, we made direct contact with the breeders after raising awareness of the subject.

Data Collection

This took the form of individual interviews with small-scale ruminant breeders in Ngaoundere city and its surrounding areas. The questionnaires contained both closed and open questions, which were asked in either French or Fulfulde. The questions focused on the breeders' sociodemographic characteristics, general knowledge of gastrointestinal parasitism, behaviours and attitudes towards the disease, prevention methods, and the sensitivity of animals of different ages.

After data collection and statistical analysis, the results will be expressed as a percentage to provide an overall assessment, as presented in the evaluation grid by Essi and Njoya (2013).

Table 1: Shows the CAP evaluation grid (Essi and Njoya, 2013)

Dimensions	Notes	Assessments
Level of knowledge	From 85% of correct answers	Good
	From 65% to 85%	Average
	From 50% to 65%	Insufficient
	Less than 50% of correct answer	moving
Quality of attitudes	From 85% of correct answers	Just
	From 65% to 85%	Approximative
	From 50% to 65%	Low
	Less than 50% of correct answer	Harmful
Level of practices	From 85% of correct answers	Adequate
	65% to 85%	Inadequate
	From 50% to 65%	Harmful

Statistical Analyses

Descriptive statistics were used to summarise the demographic characteristics of the individuals and farms. One-way analysis of variance, combined with the post hoc Duncan test, was used to compare means. The mean standard deviation was used to represent knowledge, attitude, and practice scores. These were then converted into percentages to provide an overall assessment, as presented in the assessment grid. Data analysis was performed using Microsoft Excel 2016 (Microsoft Corporation) and IBM SPSS Statistics (version 25.0). Qualitative variables (questions) were recorded in binary, with 1 corresponding to a correct answer and 0 to an incorrect one. Missing answers and

'don't know' responses were considered incorrect and coded as 0.

For open-ended questions, code 1 was assigned to all correct answers and 0 to incorrect ones. The sum of the correct answers for each individual was divided by the number of questions in each category.

RESULTS AND DISCUSSION

Distribution of Socio-Demographic Data among Breeders

Of the 385 individuals interviewed, 259 were selected as breeders. As can be seen in Table 2, the 31–50 age group is the most represented, accounting for 46.72% of the sample. The male sex represented 79.92% of the surveyed population, compared to 20.03% for the female sex. This shows that women are also interested in this activity, representing one-fifth of the population. Breeders who have not attended school represent a significant proportion (30.12%), followed by those with secondary education (24.32%), those with higher education (23.17%), and finally those with primary education (22.39%).

Table 2: Distribution of socio-demographic data of breeders

Variables		Ngaoundere 1st	Ngaoundere 2nd	Ngaoundere 3rd	Total	P-value
		N (%)	N (%)	N (%)	N (%)	
Staff		144 (55.60%)	48 (18.53%)	67 (25.87%)	259 (100%)	
Age groups	<17 years	7 (4.87%)	0 (0.00%)	1 (1.48%)	8 (3.08%)	0.000
	17-30 years	47 (32.63%)	3 (6.25%)	15 (22.38%)	65 (25.10%)	
	31-50 years	58 (40.28%)	19 (39.58%)	44 (65.67%)	121(46.72%)	
	>50 years	32 (22.22%)	26 (54.17%)	7 (10.47%)	65 (25.10%)	
Sex	Female	38 (26.40%)	4 (8.33%)	10 (14.93%)	52 (20.08%)	0.012
	Male	106 (73.6%)	44 (91.67%)	57 (85.07%)	207(79.92%)	
Level of study	None	53 (36.80%)	13 (27.08%)	12 (17.91%)	78 (30.12%)	0.000
	Primary	20 (13.80%)	31 (64.58%)	7 (10.47%)	58 (22.39%)	
	Secondary	18 (12.50%)	4(8.34%)	41 (61.15%)	63 (24.32%)	
	Superior	53 (36.80%)	0 (0.00%)	7 (10.47%)	60 (23.17%)	

Symptoms of Gastrointestinal Parasitism in Small Ruminants, as Reported by Farmers

The most commonly reported symptom was diarrhoea (97.9%), followed by anaemia (25.2%), anorexia (24.4%), cachexia (13.7%), nasal discharge (11.1%), and itchy hair (9%). Figure 1 below shows all of this.

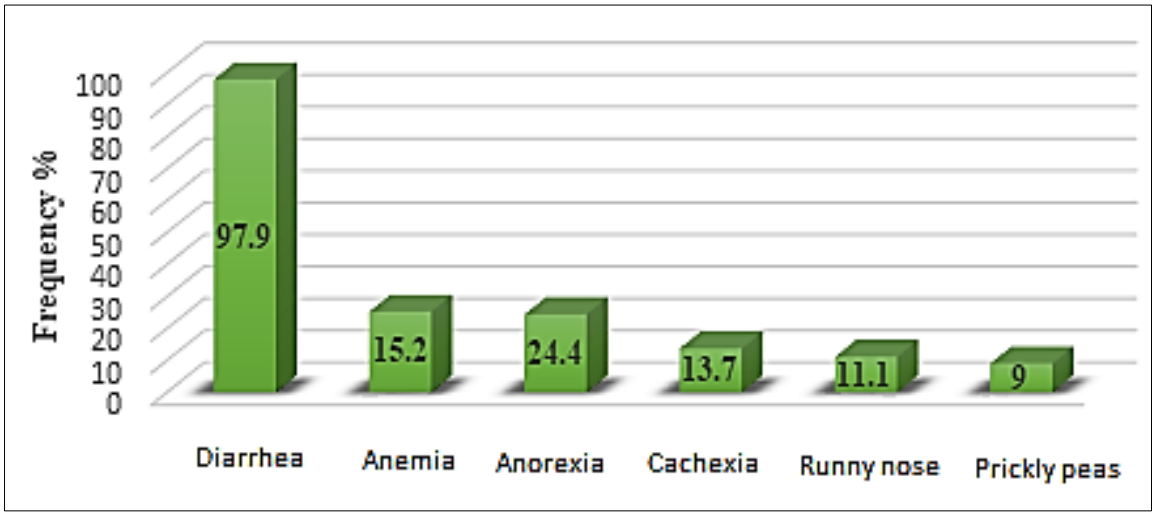

Figure 1: Percentage breakdown of symptoms according to breeders

The Mode of Transmission of Gastrointestinal Parasitism in Small Ruminants, according to the Respondents

Figure 2 shows the results of the survey on the transmission of gastrointestinal parasitism of small ruminants. It is clear that the majority of respondents (66%) do not know the mode of transmission of endoparasitosis. Conversely, 21% of breeders reported that ingestion of larvae via water is the cause, while 13% stated that ingestion of infesting larvae via pasture is the cause.

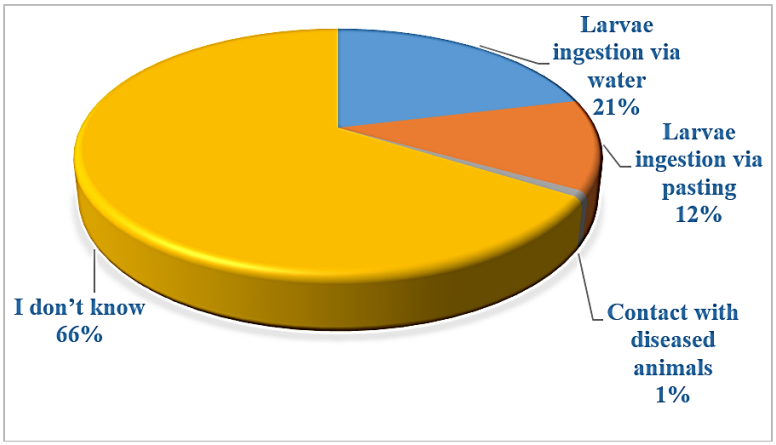

Figure 2: Mode of transmission, as reported by respondents

Respondents' Reactions in the Event of an Infestation

Although 52% of farmers in the peri-urban area of Ngaoundere use pharmaceutical products (mostly fraudulent medicines), 37% consult a veterinarian for a more accurate diagnosis and effective treatment. A small proportion do nothing, while others use traditional medicine involving bark or slaughter sick animals. These results are shown in Figure 3 below.

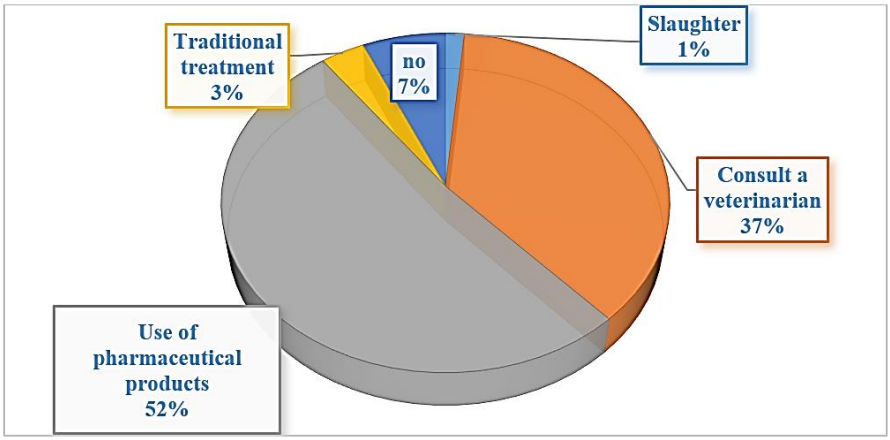

Figure 3: Shows the reaction of breeders in the event of a herd being infected by the disease

Molecules Used

Pharmaceuticals

Of the drugs used by the respondents, the most well-known and widely used molecule is albendazole, at 37.5%. This is followed by tetramisole (20.5%), oxfendazole (14.7%), oxyclosanide (14.7%), levamisole (11.2%), ivermectin (6.9%) and mebendazole (0.4%).

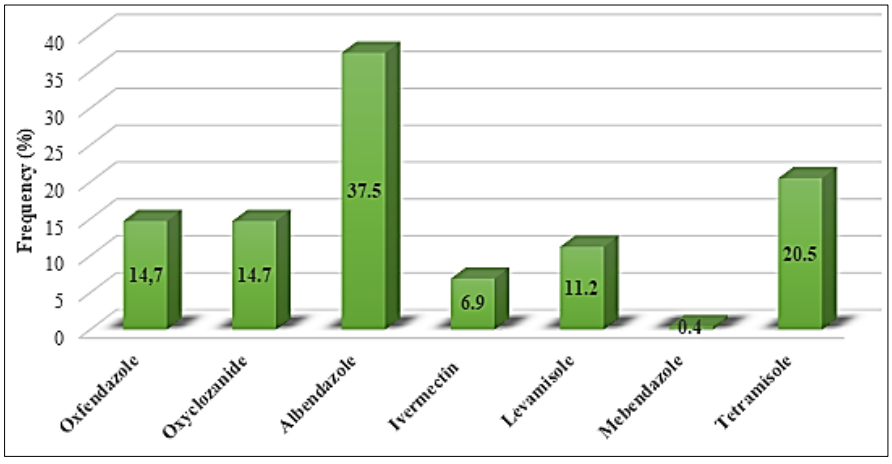

Figure 4: Frequencies of use of molecules by farmers

Traditional Products

As shown in Figure 5, other farmers use non-pharmaceutical products to treat their animals. However, more than half of the farmers (52.9%) do not use traditional products. Of these, 15.8% claim to use natron; 12%, *Azadirachta indica* oil (commonly known as neem); 10%, *Azadirachta indica* seeds and *Citrus lemon* (lemon); 0.8%, *Azadirachta indica* seed only; 3.9%, *Adansonia digitata* leaves (baobab, still called the "pharmacist's tree" by breeders); and 3.1%, *Aloe vera*.

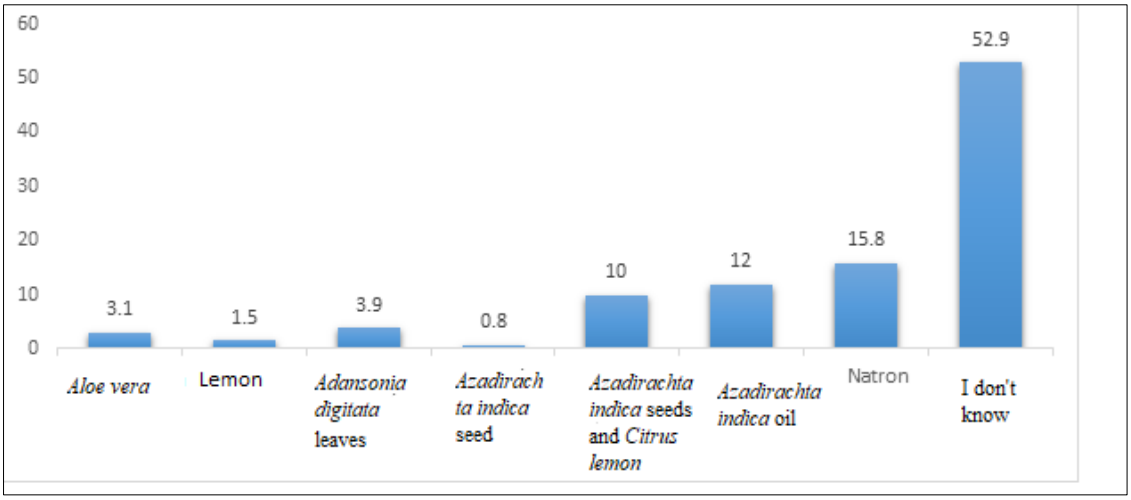

Figure 5: Traditional products used by farmers

Mortality Rate

According to some farmers, this disease is one of the main causes of mortality. The mortality diagram shows that 39.4% of breeders said endoparasitosis would account for 26–50% of deaths. Others estimate that the disease would cause losses of more than 50% in sheep and goats, affecting 51–75% of the herd.

Breeders' Knowledge of Gastrointestinal Parasitism

Table 3 clearly shows that 91.12% of respondents have at least heard of GI in small ruminants, with more than half recognising an animal with the disease (74.52%). The age groups most affected are adults (59.07%), followed by young animals (31.07%). According to farmers, the disease mainly occurs at the beginning of the rainy season (38.61%), remaining high throughout this period. However, a small minority mentioned that the disease occurs at the end of the rainy season (7.72%), at the beginning of the dry season (3.86%), and at the end of the dry season (3.47%).

Table 3: Farmers' knowledge of gastrointestinal parasites

PGI in small ruminants		Ngaoundere 1st	Ngaoundere 2nd	Ngaoundere 3rd	Total	p-value
Heard about	Yes	132 (50.96%)	42 (17%)	60 (23.16%)	236 (91.12%)	0.000
	No	12 (4.63%)	4 (1.55%)	7 (2.70%)	23 (8.88%)	
Animal recognition reached	Yes	132 (50.96%)	44 (17%)	17 (6.56%)	193 (74.52%))	0.000
	No	2 (0.77%)	4 (1.55%)	60 (23.16%)	66 (25.48%)	
Affected age class	Young	42 (16.21%)	29 (11.20%)	11 (4.25%)	82 (31.66)	0.000
	Adults	89 (34.36%)	15 (5.80%)	49 (18.91%)	153 (59.07%)	
	I don't know	12 (4.63%)	4 (1.55%)	8 (3.09%)	24 (9.26%)	
Season during which the disease occurs	End of dry season	1 (0.39%)	5 (1.93%)	3 (1.15%)	9 (3.47%)	0.000
	End of the rainy season	17 (6.56%)	2 (0.77%)	1 (0.39%)	20 (7.72%)	
	Beginning of the rainy season	49 (18.92%)	2 (0.77%)	49 (18.92%)	100 (38.61%)	
	Beginning of the dry season	6 (2.31%)	4 (1.55%)	0 (0.00%)	10(3.86%)	
	Rainy season	57 (22.0%)	35 (13.52%)	8 (3.09%)	100 (38.61%)	
	I don't know	12 (4.63%)	2 (0.77%)	6 (2.32)	20 (7.72%)	

Average Knowledge Scores of Breeders Based on Demographic Factors

Regarding knowledge of endoparasitoses, breeders in Ngaoundere 1 and 3 have a medium level, according to the Essi and Njoya appreciation grid, with an average score of 76%. Those in Ngaoundere 2 have a good level, with an average score of 88%. As the P-value (0.001) is less than 0.005, there is a significant difference in knowledge regarding endoparasitosis between respondents from peri-urban and urban areas of Ngaoundere.

Level of study also influences knowledge: The P-value (0.000) being less than 0.005, there is therefore

a highly significant difference between levels of study. Those with higher levels of education had a good level of knowledge, followed by those with no education. This could be explained by their permanent contact with the animals.

Similarly, age and years of experience positively influence knowledge; the oldest people and those with the most experience had the best knowledge scores. This result is summarised in Table 4.

Table 4: Average knowledge scores

Factors	Variables	Knowledge Mean ± SD	p-value
Boroughs	Ngaoundere 1st	0.76 ± 0.25[a]	0.001
	Ngaoundere 2nd	0.88 ± 0.24[b]	
	Ngaoundere 3rd	0.69 ± 0,27[a]	
Level of study	None	0.72 ± 0.18[a]	0.000
	Primary	0.70 ± 0.40[a]	
	Secondary	0.71 ± 0.23[a]	
	Superior	0.94 ± 0.07[b]	
Age	< 17 years	0.78 ± 0.33[ab]	0.001
	[17 – 30]	0.65 ± 0.37[a]	
	[31 – 50]	0.80 ± 0.17[b]	
	>50 years	0.81 ± 0.23[b]	
year of experience	< 5	0.66 ± 0.38[a]	0.002
	[5 – 10]	0.71 ± 0.29[a]	
	> 10	0.80 ± 0.20[b]	
Gender	Male	0.77 ± 0.24	0.308
	Female	0.73 ± 0.33	

The values bearing the different letters (a, b, c and d) are significantly different (P < 0.05).

Farmers' Attitudes towards Gastrointestinal Parasitism in Small Ruminants

Table 5 summarises breeders' attitudes according to district. Most farmers (51.74% of respondents) appear to use pharmaceutical products of their choice, which they administer to the animals themselves, while 36.68% consult a veterinarian to achieve better results. A minority use traditional products.

The most common method used to limit infestation is deworming (mentioned by 46.34% of respondents), followed by rotational grazing (10.04%) and combined rotational and mixed grazing (10.04%).

Table 5: Attitudes of breeders

		Ngaoundere 1st	Ngaoundere 2nd	Ngaoundere 3rd	Total	p-value
Effective		N = 144	N = 48	N = 67	N= 259	
Reaction in case of infestation	Contact the veterinarian	49 (18.92%)	40 (15.44%)	6 (2.32)	95 (36.68%)	0.000
	Do a traditional treatment	4 (1.54%)	2 (0.77%)	3 (1.16%)	9(3.47%)	
	Resort to pharmaceutical products	76 (29.35%)	4 (1.54%)	54 (20.85%)	134 (51.74%)	
	Slaughter	0 (0.0%)	2 (0.77%%)	4 (1.54%)	6 (2.31%)	
	I don't know	13 (5.03%)	2 (0.77%)	0 (0.0%)	15(5.80%)	
Means used to avoid infestation	Deworming	50 (19.30%)	17 (6.57%)	53 (20.47%)	120 (46.34%)	0.000
	Mixed grazing	11 (4.25%)	0 (0.0%)	4 (1.54%)	15 (5.79%)	
	Rotating pasture	25 (9.65%)	0 (0.0%)	1 (0.39%)	26 (10.04%)	
	Rotating and mixed grazing	0 (0.0%)	26 (10.04%)	0 (0.0%)	26 (10.04%)	
	Rotating grazing and deworming	2 (0.77%)	0 (0.0%)	0 (0.0%)	2 (0.77%)	
	I don't know	56 (21.62%)	5 (1.92%)	9 (3.47%)	70 (27.04%)	

Average Scores of Breeders' Attitudes

It should be noted here that rounding has a significant influence on practices. Breeders from Ngaoundere 2 had a fair attitude (score of 89%), whereas breeders from Ngaoundere 1 and 3 had poor practices (scores of 48% and 53% respectively). As the P-value is less than 0.005, there is a significant difference in the attitudes of breeders from different districts.

Level of education and age also positively influence the practices of breeders. Breeders with a higher level of education had a fair attitude, followed by those with a primary level of education, whose attitude was average. Regarding age, only the 31–50 age group had an average attitude. Years of experience and age do not influence breeders' attitudes. These results are presented in Table 7.

Breeders' Practices in the Face of Gastrointestinal Parasitism in Small Ruminants

Of those surveyed, 93.05% use dewormers to control endoparasitosis, while 6.95% do not. Of those

who use dewormers, 69.11% claim to achieve satisfactory results, while 16.99% claim to achieve passable results. However, some farmers use bark or traditional products to treat their animals, as shown in Table 6.

Table 6: Breeders' practices

		Ngaoundere 1st	Ngaoundere 2nd	Ngaoundere 3rd	Total	p-value
Vermifugation	Yes	135 (51.12)	46 (17.76%)	60 (23.16%)	241 (93.05%)	
	No	9 (3.47%)	2 (0.77%)	7 (2.70%)	18 (6.95%)	0.402
Results in case of use of pharmaceutical products	Satisfactory	112 (43.24)	44 (17.0%)	20 (7.72%)	179 (69.11%)	
	Unsatisfactory	3 (1.15%)	0 (0.0%)	0 (0.0%)	3 (1.15%)	
	Fair	15 (5.79%)	0 (0.0%)	29(11,20%)	44 (16,99%)	
	I don't know	7 (2.70)	4 (1.55%)	7 (2.70%)	18 (6.95%)	0,00
Results in case of use of traditional products	Satisfactory	26 (10.04%)	14 (5.41%)	5 (1.93%)	45 (17.38%)	
	Unsatisfactory	9 (3.47%)	4 (1.54%)	5 (1.93%)	18(6.94%)	
	Fair	59 (22.78%)	0 (0.0%)	0 (0.0%)	59 (22.8%)	0.000
	I don't know	49 (18.92%)	30 (11.59%)	58 (22.39%)	137 (2.90%)	

Average Scores of Breeders' Practices

The practices of breeders in Ngaoundere 2 are the only ones that are adequate (with a rate of 86%). The practices of breeders in Ngaoundere 1 are inadequate (with a rate of 71%), while the practices of breeders in Ngaoundere 3 are harmful (with a rate of 56%). Rounding significantly influences the practices of breeders. Analysis of variation shows that there are significant differences in the practices of breeders in these three districts. Breeders with higher education are the only ones with adequate practices.

Years of experience and gender have no influence on practices, with p-values (0.350 and 0.317) greater than 0.005. These results are presented in Table 7.

Table 7: Shows the average scores of breeders' attitudes and practices according to demographic parameters

Factors Variables		Attitudes		Practical	
		Mean ± SD	P-value	Mean ± SD	P-value
Districts	Ngaoundere1st	0.48 ±0.36[a]	0.000	0.71 ± 0.21[b]	
	Ngaoundere 2 nd	0.89 ±0.30[b]		0.86 ± 0.23[c]	0.000
	Ngaoundere 3 rd	0.53 ±0.21[a]		0.56 ± 0.26[a]	
Level of study	None	0.37 ±0.34[a]	0.000	0.66 ± 0.20[b]	
	Primary	0.73 ±0.40[b]		0.76 ± 0.34[b]	0.000
	Secondary	0.44 ±0.18[a]		0.54 ± 0.18[a]	
	Superior	0.78 ±0.25[b]		0.85 ± 0.13[c]	
Age	< 17 years	0.38± 0.23[a]	0.000	0.50 ± 0.23[a]	
	[17 – 30]	0.52± 0.31[a]		0.75 ± 0.30[b]	0.000
	[31 – 50]	0.67± 0.25[b]		0.63 ± 0.15[a]	
	>50 years	0.44± 0.48[a]		0.79 ± 0.29[c]	
Years of experience	< 5	0.55 ± 0.31		0.65 ± 0.30	
	[5 – 10]	0.57 ± 0.32	0.989	0.70 ± 0.21	0.350
	> 10]	0.57 ± 0.27		0.71 ± 0.24	
Gender	Male	0.56 ± 0.38	0.988	0.69 ± 0.21	0.317
	Female	0.52 ± 0.22		0.72 ± 0.37	

The values bearing the different letters (a, b, c and d) are significantly different (P < 0.05).

The Level of Knowledge among Farmers Regarding Gastrointestinal Parasitism of Small Ruminants, according to the Three Districts

The majority of breeders in Ngaoundere 2nd have a good level of knowledge of PGI (87%), while 8.7% have an insufficient level of knowledge. In Ngaoundere 3rd, the average knowledge score is 65.7%, with 20.9% having a good level of knowledge. In Ngaoundere 1st (ER), 44.8% of farmers had a good knowledge of the disease, 33.6% had an average knowledge, 14% had an insufficient knowledge, and 7.7% had a poor knowledge. These results are shown in Figure 6 below.

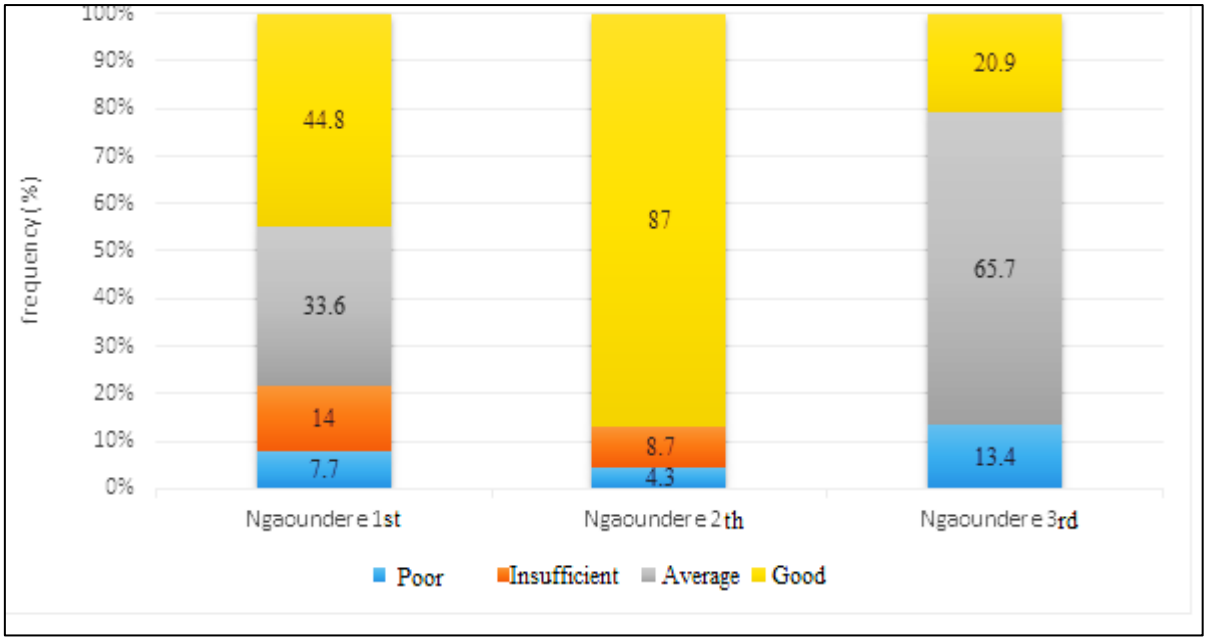

Figure 6: Breeders' knowledge levels according to the three districts

Quality of Breeders' Attitudes According to the Three Districts

Figure 7 below shows the quality of breeders' attitudes in the three districts. Moreover, Ngaoundere 2nd remains in the lead, with 87% of respondents having a fair attitude. Meanwhile, Ngaoundere 3rd has 82.1% of respondents with a weak attitude, while Ngaoundere 1st presented the most harmful practices, with a rate of 28.7%.

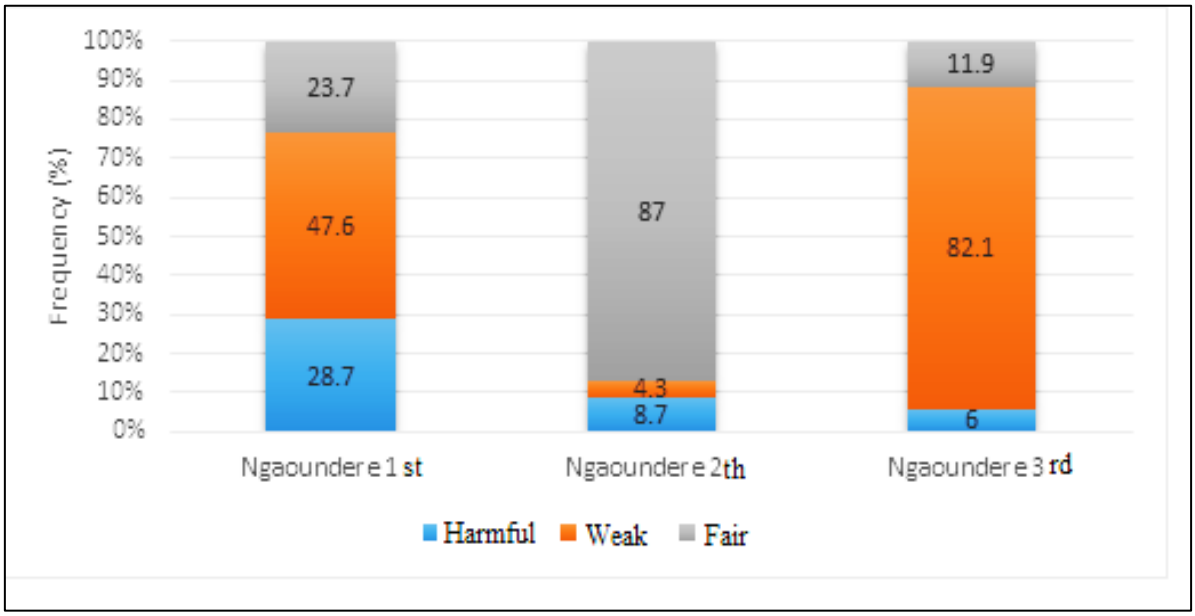

Figure 7: The quality of attitudes exhibited by breeders is distributed across the three districts

The Following Analysis is concerned with the Practices of Breeders within the Three Districts

As illustrated in Figure 8, the levels of practice among breeders are distributed across the three districts. The results of this study indicate concerning practices among a majority of interviewees in Ngaoundere 3rd, with a rate of 70.1%. Furthermore, the data reveal that 58.7% of individuals interviewed in Ngaoundere 1st adopted practices that were deemed inadequate, while those of Ngaoundere 2nd are distinguished by a higher proportion of adequate practices, with a rate of 65.2%.

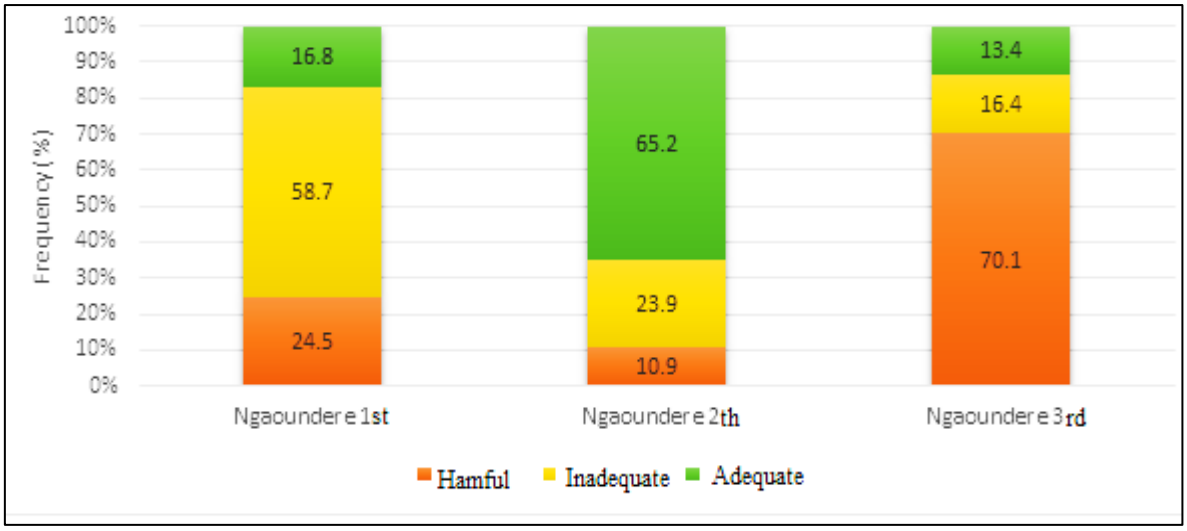

Figure 8: The levels of breeders' practices are distributed across the three districts

Pearson's Correlation Coefficient was Utilised to Analyse the Relationship between the CAP Parameters

The analysis yielded a substantial correlation between the respondents' knowledge and their attitudes. Furthermore, a significant correlation was identified between the attitudes and practices of these individuals. As demonstrated in Table 8, a high degree of correlation was observed between knowledge and attitude (r = 0.608), knowledge and practice (r = 0.557), and attitude and practice (r = 0.353), with a p-value of less than 0.01.

Table 8: Demonstrates a Pearson correlation between CAP parameters

Pearson correlation	Knowledge	Attitudes	Practice
knowledge	1		
Attitudes	0.608**	1	
Practice	0.557**	0.353**	1

**. The Correlation is significant at 0.01.

Linear Regression Analysis Was Conducted on the CAP Parameters, Incorporating the Sociodemographic Characteristics of the Respondents Residing in the Three Districts under Consideration

Table 9 presents the outcomes of linear regressions of knowledge, attitudes and practices parameters, stratified by the sociodemographic characteristics of respondents in the three districts. The analysis of the data reveals significant disparities between districts, depending on age, level of study, gender and year of experience. The findings of this study indicate that the district exerts a substantial and favorable influence on attitudes, as demonstrated by the observed increase of 4.3%. Conversely, the level of education exhibited a significant positive correlation with the variable of 'knowledge', which demonstrated an increase of 11%. A 13.7% increase in attitudes has been observed, while a 6.1% increase has been recorded in practices. The findings of this study demonstrate that age exerts a significantly positive influence on both the level of knowledge and practices, with an increase of 10.8% and 8.2%, respectively. Statistical analysis reveals a correlation between level of knowledge and year of experience, with an increase of 2.6% in the latter.

Table 9: Linear regression analysis of CAP parameters is contingent on the sociodemographic characteristics of respondents in the three districts

Factors	Knowledge [95%CI]	Attitudes [95%CI]	Practice [95%CI]
Districts	-0.043* [-0.077;-0.009]	0.043 [-0.005; 0.090]	-0.066** [-0.101;-0.032]
Age	0.108** [0.049; 0.167]	0.050 [-0.033; 0.133]	0.082** [0.022; 0.142]
Level of study	0.110** [0.081; 0.140]	0.137 ** [0.096; 0.179]	0.061** [0.030;0.091]
Gender	-0.059 [-0.145; 0.026]	-0.178** [-0.298;-0.058]	0.010 [-0.077; 0.096]
Year of experience	0.026 [-0.029; 0.081]	-0.034 [-0.111; 0.044]	0.001 [-0.055;0.057]
Constant	0.259* [0.036; 0.481]	0.311 [-0.402; 0.155]	0.409** [0.184; 0.635]
N = 256	R^2 = 0.230	R^2 = 0.171	R^2 = 0.121

**p< 0.01; *p< 0.05; CI: Confidence interval

DISCUSSION

The present study was conducted in the region of Adamawa, more precisely in the urban and peri-urban area of Ngaoundere. As a component of the research endeavour, an investigative process will be initiated with the objective of evaluating the extent of knowledge, attitudes, and practices exhibited by farmers with regard to the management of gastrointestinal parasitism in grazing small ruminants.

In the course of this study, a number of groups of people were identified who have expressed an interest in small ruminant farming. The groups in question include farmers, breeders, veterinarians, hairdressers, traders, pupils, teachers, students, civil servants and workmates. This phenomenon can be attributed to the fact that this activity generates income and occupies a predominant place in the economy of the area. The breeding of these animals has been shown to have several advantages. It is evident that the subjects' diminutive stature confers a distinct advantage in terms of ease of handling. Conversely, they exhibit minimal discernment with regard to the quality of their foraging environment. Furthermore, the meat yield from a single animal is sufficient to meet the consumption requirements of a family unit. These results are in agreement with those reported by Anim-Jnr *et al*., (2023) in their work, which states that small ruminants play an important role in the livestock production sector and the entire economy of many developing countries.

The findings of the study indicate that 91.12% of respondents had been exposed at least once to PGI in small ruminants. This observation can be interpreted as an illustration of the prevalence of the disease in the local community. Furthermore, the majority of respondents are owner-shepherds, a profession which involves permanent contact with animals. This result stands in contradistinction to the conclusions of Remi BEH's thesis work, published in 2020, which focuses on bovine herpesviroses in northern Cameroon. The study revealed that 96.7% of the farmers surveyed were not informed about the disease.

A thorough investigation into the distribution of the disease indicates that the adult demographic constitutes the most affected group, representing 59.07% of the documented cases, while the category of young adults exhibits a lower prevalence, with 31.66%. A recent study revealed that 91.12% of respondents reported familiarity with PGI (high-quality protein) in small ruminants. Furthermore, 8.88% of the subjects interviewed stated that they did not have an opinion on PGIs. A recent study revealed that 74.52% of the breeders surveyed expressed confidence in their ability to recognise an animal affected by the disease. Conversely, 25.48% of respondents expressed a divergent viewpoint. According to breeders, the disease has a significant impact on adults, with a percentage of 59.07%. These results appear to be at odds with those reported by Mahieu in 2009 in the French Antilles. Indeed, the present study observed that young children, aged less than six months, demonstrated heightened sensitivity to the disease.

Indeed, statistical analyses reveal that the infestation rate peaks at the commencement of the rainy season, with 35.52% of the specimens infested, and experiences a significant increase during the rainy season, reaching 41.70%. The present situation can be attributed to several factors. Initial rainfall creates conditions conducive to the development of larval habitats, such as stagnant waters, which in turn serve as an environment favourable for the development of disease vectors. Secondly, the presence of moisture and water contamination can create a conducive environment for the proliferation of bacteria and viruses, thereby increasing the risk of pathogen spread. These results are in perfect agreement with the work reported by Aumont *et al*., (2001), which demonstrates that the infestation rate is high at the beginning of the rainy season and increases throughout the season.

Within the domain of livestock farming, the disease is recognised as a primary cause of animal mortality. According to breeders, pathogens (PGI) are responsible for a significant proportion of these losses, with a mortality rate ranging from 26 to 50%. Furthermore, some farmers claim that the disease causes additional losses of more than 50% in sheep and goats, which corresponds precisely to the 51-75% margin of livestock. This phenomenon can be attributed to the fact that the majority of breeders do not implement prophylaxis programs.

In the event of a livestock infestation, 134 of the 258 individuals surveyed (51.74%) resort to the medication of their choice for treatment. An in-depth analysis of the data reveals that 95 individuals use a veterinary practitioner to treat their pet. This proportion represents 36.68% of the sample studied. A recent study revealed that systematic deworming was the most widespread method among farmers to limit infestation of their livestock by the disease. This approach was followed by rotational grazing, accounting for 10.04% of practices employed. However, this result seems to contradict the conclusions of research conducted by Soulsby (2014) on the management of gastrointestinal parasitism in small grazing ruminants in the French West Indies, as well as the principles of the Famacha method (selective treatment). This approach specifically targets the animals most affected by the disease and is considered the most effective way to optimally manage the parasitic population.

In the sample studied, 93.05% of respondents reported using dewormers as part of the fight against endoparasitosis. Furthermore, 6.95% of these subjects indicated that they did not proceed with the aforementioned treatment. Within the sample

considered, 69.11% of subjects who used dewormers reported having obtained a satisfactory result, while 16.99% indicated having obtained a fair result. Nevertheless, the scientific literature reports the existence of other farmers who use bark or traditional products for their treatment. This study emphasises the predominant utilisation of anthelmintic by breeders in the region. With regard to the drugs used by the subjects of the survey, albendazole (37.5%) is distinguished as the most well-known and widely used molecule, followed by tetramisole (20.5%), oxfendazole (14.7%), oxyclosanide (14.7%), levamisole, ivermectin and mebendazole. Nevertheless, alternative approaches exist that utilise bark and other traditional products to achieve similar outcomes. This observation has the potential to provide an explanation for the ineffectiveness of certain anthelmintic drugs, as highlighted by breeders. These results contradict the conclusions of the study conducted by Mahieu in 2009. As asserted by the latter, it is of paramount importance to impose restrictions on the utilisation of anthelminthic, with a view to ensuring the preservation of their efficacy in the future.

In terms of knowledge relating to endoparasitosis, breeders in Ngaoundere 1st and 3rd have an average level of knowledge, with an average score of 76%, whereas breeders in Ngaoundere 2nd have a high level of knowledge, with an average score of 88%. As the p-value (0.001) is less than 0.005, there is a significant difference in the knowledge of endoparasitosis between respondents from peri-urban and urban areas of Ngaoundere. This could be because Ngaoundere 2nd is the city center, with the largest number of clinics providing access to the right information.

Similarly, age, level of education and years of experience positively affect knowledge. Level of study also influences knowledge; the p-value (0.000) is less than 0.005, indicating a highly significant difference between levels of study. Those with higher levels of education and experience had a higher level of knowledge, followed by those with no education. The level of study also influences knowledge, with a p-value of 0.000 less than 0.005 indicating a very significant difference between levels of study. Those with higher education had a good level of knowledge (94%), showing that knowledge depends on both the level of education of farmers and their relationship with animals. Those with no education had an average level of knowledge (72%). This could be explained by their permanent contact with the animals. This finding aligns with Halimatou Mamoudou's 2022 study on the perceptions, attitudes, and practices of Ngaoundere city dwellers (Cameroon) regarding zoonoses. Mamoudou concluded that individuals with higher education exhibited a superior level of knowledge.

The level of education and age had a positive influence on breeders' attitudes. Those with higher education had a fair attitude, followed by those with primary education, whose attitude was similar. This is because educated people are more open to communication and are more likely to follow the advice of technicians or veterinary staff.

It should be noted here that rounding has a significant influence on attitudes. Only the breeders from Ngaoundere 2nd had a fair attitude, with a score of 89%, while those from Ngaoundere 1st and 3rd had a weak attitude. As the p-value is less than 0.005, there is a significant difference in attitude between breeders in different districts, with those in Ngaoundere 2nd having the best attitude. This may be because the Ngaoundere 2nd respondents are more highly educated and have easier access to clinics and veterinary advice.

In the event of a herd infestation, 52% of peri-urban farmers in Ngaoundere use pharmaceutical products (mostly fraudulent medicines) on their animals. However, 37% of farmers consult a veterinarian (mostly in Ngaoundere 2nd) for a better diagnosis and effective treatment. A minority do nothing (7%), some resort to bark (3%), and some prefer to slaughter sick animals. This is because Ngaoundere 2nd is close to most of the region's veterinary clinics, giving farmers easy access.

Of those interviewed in Ngaoundere 3rd, the majority had a harmful practice (70.1%), while in Ngaoundere 1, the majority had an inappropriate practice (58.7%), and in Ngaoundere 2nd, the majority had an adapted practice (65.2%). This difference in results between the three districts could be explained by the fact that the breeders in Ngaoundere 2 have easy access to useful information and veterinary clinics, as it is the metropolis of the city. These results are consistent with the work of Rémy Loïc BEH on the knowledge, attitudes and practices of farmers and veterinary staff regarding bovine herpesvirus infections in northern Cameroon, where farmers had harmful practices.

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