

## HELMINTHS AND TICKS CO-EXISTENCE IN CATTLE IN MAIDUGURI BORNO STATE, NIGERIA

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### ABSTRACT

Cattle are important livestock raised for their meat, milk and hides. They are also very important livestock animal because of their ability to convert forage, crops and household residues into meat, fiber, skins and milk. The prevalence of ticks and helminths co-infection in Maiduguri, Borno State was studied. Fecal samples and ticks were randomly collected from 312 cattle in different locations across Maiduguri metropolis. The collected samples were transported to the Veterinary Parasitology Research Laboratory, Faculty of Veterinary Medicine, University of Maiduguri, Borno State to determine the types of helminths eggs present in feces using flotation technique and also to identify the ticks using taxonomic keys. An overall prevalence of 63.78% was observed for strongyle type eggs in cattle of different breeds ( $p>0.05$ ). Wadara breed had the highest prevalence with 76.04% and Bunaji was the least ( $P=0.0119$ ). Male cattle had higher prevalence (75%) of fecal gastrointestinal helminth infection, while the female cattle had 50.69% ( $P=0.001$ ). Preputial region had the highest number of ticks collected (300) while the neck region had the lowest (80). Female cattle had the highest number of collected ticks (789) compared with the male cattle with 484 tick samples. Therefore from this, helminth infection and tick infestation do co-affect cattle in Maiduguri metropolis.

**Keywords:** Helminths, Ticks, Infestation, Cattle, Maiduguri

### INTRODUCTION

Cattle are classified as livestock which refer to farm animals but poultry being an exception, cattle are important livestock raised for their meat, milk, hides, skin and for mainly economic purpose also they are important due to their ability to convert forage crops and household residues into meat, fiber, skins and milk (Lawal-Adebolawale, 2012; Owhoeli *et al.*, 2014). However, the usefulness of cattle is truncated by helminths and ticks' infections.

Ticks are significant vectors of pathogens (bacteria, viruses, protozoa) causing diseases such as Lyme disease, anaplasmosis, babesiosis, and tick-borne encephalitis (Yu *et al.*, 2015; Rochlin & Teldo, 2020). Helminthosis has been recognized as a serious threat to cattle production worldwide (Biu *et al.*, 2009). These effects are most significant in developing countries, with gastrointestinal helminths ranked as the most important livestock disease in a global study that ranked livestock disease significance according to their impact (Perry *et al.*, 2002), with the majority of the world's

poor livestock keepers in Sub-Saharan Africa (Grace *et al.*, 2017). Tick infestations and helminths infections are the major constraints and resultant economic losses in cattle production around the world (Squire *et al.*, 2019). These findings provide insight into the prevalence of helminth and ticks co-infection. Therefore, this study will help in obtaining data that will give an insight into the prevalence, prevent or mitigate the zoonotic potential and economic impact on farmers and livestock owners.

## MATERIALS AND METHODS

### THE STUDY AREA

The study was carried out in Maiduguri, the capital and largest urban center in Borno State, Nigeria. Maiduguri lies between latitude 11°51'N and longitude 13°05'E with a human population of 521,492 based on the 2006 census (Nigerian Bureau of Statistics, 2011). It has two different seasons, the raining season which last for three-five months from early June-October with an annual rain fall of about 500-600mm and the dry season which starts from November and last up to May, therefore the climate of Maiduguri is characterized by a long period of dry season for the rest of the year (Hess *et al.*, 1995).



Source: Google map

### STUDY POPULATION AND SAMPLING METHOD

A total of 312 cattle comprising Red Bororo, Wadara, Adamawa Gudali, Abore, Bokoloji, Ndama and Bunaji breeds were randomly selected from different livestock markets and farms covering 1. Gamboru kasuwa, 2. Large Animal Clinic University of Maiduguri Veterinary Teaching Hospital (VTH), 3. Kasuwan shanu, 4. Bulumkutu kasuwa, 5. Ngomari, 6. Sabon Gari and 7. Gwange in Maiduguri,

Borno State, Nigeria were examined and feces and ticks collected within the period of June 2023 to November 2023.

## SAMPLE COLLECTION AND ANALYSIS

### TICK COLLECTION

Apparently healthy cattle of various breeds and sexes were sampled with consent from the cattle owners. During sample collection, every effort was made to reduce the animals' level of suffering. With the assistance of the herdsman, the sampled cattle were securely restrained which made it simpler to reach all of the cattle's body parts. To prevent mutilation, ticks were plucked with gloved hands and then carefully twisted 180 degrees. Samples were collected and properly labeled and categorized on the basis of breed, sex, age of the cattle, as well as the date and location of sample collection. Collected tick samples were put into clean, properly labeled and well-capped glass vials containing 70% alcohol and 5% glycerol for preservation. The vials were then transported to the Parasitology Research Laboratory, Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine University of Maiduguri, Borno State for further identification and analysis.

### FECAL SAMPLE COLLECTION

Fecal samples were collected from cattle using disposable hand gloves from the rectum via careful stimulation of the rectum with the fingers. Collected samples were properly labelled, data pertaining to the species and consistency of the feces were recorded. The collected fecal samples were preserved in an ice-packed (flask) plastic container. Samples were transported directly to the Parasitology Research Laboratory, Department of Veterinary Parasitology and Entomology, Faculty of Veterinary Medicine, University of Maiduguri Borno State, for analysis on the same day of sampling.

### LABORATORY PROCEDURE

Flotation method of fecal analysis was used. Fecal sample weighing 3g was suspended in 30 ml of saturated salt solution using spatula. It was thoroughly mix with pestle and mortar. The mixture was sieved and collected in a beaker and used to fill the sample bottle. The bottle was then covered with a cover slip for 4 to 5 minutes. The cover slip was placed on clean glass slide under a light microscope for examination. The slides were viewed using 10x objective lens following standardized procedures (Hayat *et al.*, 1996). The results were appropriately recorded.

Additionally, the ticks were viewed, identified and recorded accordingly, using stereo-microscope. Identification of the different species of the ticks was accomplished with the help of the anatomical and morphological characteristics as described by Soulsby (1982).

**RESULTS**

In Table I the total of 1585 samples for ticks and feces, consisting of 312 fecal (19.7%) and 1273 (80.3%) tick samples were collected from 312 cattle from various locations in Maiduguri metropolis.

**TABLE I: SAMPLE TYPES AND NUMBER OF SAMPLES COLLECTED**

Sample	Frequency	Percentage (%)
Fecal	312	19.7
Tick	1273	80.3
Total	1585	100

Table II shows the various locations within Maiduguri metropolis that 312 fecal samples were collected. Almost half the total samples were collected from Kasuwan Shanu (49.03%) and the rest of the 59.97% was collected from the other six locations.

Table III shows the prevalence of Gastro-intestinal helminth infections of cattle by breed, this result showed that all the breeds of cattle tested positive to different parasitic stages of various gastrointestinal helminths at varying percentages that ranges between 30.0% - 76.0%. The result showed that 63.7% of the total samples collected test positive.

Table IV shows the prevalence of gastrointestinal helminth infection of cattle by age. This table shows the infection rates in cattle ranging from 0>24 months of age. The table shows that 0<12 Months had a higher percentage of infection 67.57% compared to 12months>24 months.

Table V shows the prevalence of gastrointestinal helminth infection of cattle by sex. This table showed the prevalence of gastrointestinal helminths in male and female as 75.0% and 59.6% respectively.

Table VI shows prevalence of gastrointestinal helminth infection of cattle by their fecal consistency, the prevalence of gastrointestinal helminth infection is seen to decrease from watery (81.5%) to firm (42.2%).

**TABLE IV: PREVALENCE OF GASTROINTESTINAL HELMINTH INFECTION OF CATTLE BY AGE**

Ages	Positive samples	Total	Prevalence (%)
0<12 Months	50	74	67.57
12-24 months	79	120	65.83
>24 months	70	118	59.32

**TABLE II: LOCATION AND NUMBER OF FECAL SAMPLES COLLECTED PER SITE**

Locations	Number of samples collected	Percentage (%)
Kasuwan shanu	153	49.03
Bulumkutu	35	11.22
Unimaid	5	1.60
Gwange	29	9.29
Gamboru	44	14.1
Ngomari	25	8.01
Sabon gari	21	6.73

Incidence of gastrointestinal helminth infection is seen to be lowest under the intensive management (45.0%) and highest under the extensive system (69.43%).

Table VIII shows the ticks collected on the various breeds of cattle with the Red Bororo having the highest (336/26.3%) while the Bunaji had no tick on it during the course of the study. Table IX shows the sex of the cattle and the total number of ticks collected on them.

Table X shows the sex of the tick; total number of male (484/38.0%) ticks were less than females (789/61.9%) ticks.

**TABLE V: PREVALENCE OF GASTROINTESTINAL HELMINTH INFECTION OF CATTLE BY SEX**

Sex	Positive samples	Total samples	Prevalence (%)
Males	126	168	75.00
Females	73	144	50.69

**TABLE VI: PREVALENCE OF GASTROINTESTINAL HELMINTH INFECTION OF CATTLE BY FECAL CONSISTENCY**

Fecal consistency	Positive samples	Total samples	Prevalence (%)
Watery	93	114	81.58
Pasty	61	92	66.30
Firm	45	106	42.45

**TABLE III: SHOWING THE PREVALENCE OF GASTROINTESTINAL HELMINTH SPECIES INFECTION OF CATTLE BY BREED**

S/n	Breed of cattle	PS	TS	Types of Fecal Eggs				Monie	Prevalence (%)
				Strg	Taeni	Strdes	Dicroc		
1.	Red Bororo	23	40	15	03	02	01	02	57.50
2.	Wadara	73	96	40	05	28	00	00	76.04
3.	Adamawa Gudali	13	23	05	02	02	00	04	56.52
4.	Abore	29	45	08	06	00	05	10	64.44
5.	Bokoloji	39	59	21	00	11	00	07	66.10
6.	Ndama	19	39	19	00	00	00	00	48.72
7.	Bunaji	03	10	03	03	00	00	00	30.00
	Total	199	312	111	19	43	06	23	63.78

P.S- Positive samples; T.S- Total sample; Strg- Strongylus; Taen- Taenia; Strdes- Strongyloides; Dicro- Dicrocelium; Monie- Monienza

**TABLE VII: SHOWING PREVALENCE OF GASTROINTESTINAL HELMINTH INFECTION BY THE TYPE OF MANAGEMENT OF THE CATTLE**

Type of management	Positive samples	Total samples	Prevalence (%)
Intensive	27	60	45.00
Semi intensive	63	95	66.32
Extensive	109	157	69.43

**TABLE VIII: TYPES OF TICKS RECORDED BY SEX AND BREED OF ANIMALS**

Breed	Types of ticks						Total
	Hyalomma		Boophilus		Amblayo.		
	M	F	M	F	M	F	
Red Bororo	91	173	21	25	07	19	336
Wadara	44	101	30	13	04	15	207
Adam. G.	68	93	21	19	00	21	222
Abore	76	81	21	21	00	15	214
Bokoloji	77	97	20	09	02	12	217
Ndama	22	38	03	06	00	08	77
Bunaji	00	00	00	00	00	00	00
Total	378	583	116	93	13	90	1273

**TABLE IX: SEX OF ANIMALS AND NUMBER OF TICKS COLLECTED**

S/n	Sex of animal	Number of ticks collected
1	Male cattle	484
2	Female cattle	789
3	Total	1273

**TICKS**

A total of 1,273 ticks were collected from the same 312 cattle. The ticks were viewed, identified and recorded using stereo microscope. The breed of cattle from which ticks were collected are as follows:

Red Bororo, Wadara, Red Adamawa Gudali (Rahaji), Abore, Bokoloji, Ndama, Bunaji

**TABLE X: TYPES OF TICKS RECORDED BY SEX**

Type of ticks	Hyalomma		Boophilus		Amblyo ma		Total
	M	F	M	F	M	F	
Ticks collected	378	583	93	116	13	90	1273
Total	961		209		103		1273

## DISCUSSION

This study revealed a total prevalence of 63.78% in cattle of different breeds. Wadara breed had the highest prevalence of gastrointestinal helminth (76.04%). The least prevalence was seen in Bunaji breed (30%). The higher prevalence seen in wadara breeds in this study could be as a result of more exposure of this breed to the parasites or it could be as a result of less resistance of the breeds to gastro intestinal helminths. Our findings contradict the findings by Adedipe *et al.* (2014) and Yuguda *et al.* (2018) who both reported higher prevalence rates of 46% and 74.8% respectively in White Fulani breed as compared to wadara.

Squire *et al.* (2013) also found N'Dama breeds to have highest prevalence in Southern Ghana. The variations in breed prevalence could be credited to varying geographical locations, management systems and availability of suitable micro-environment for sustained survival and development of infective stage of most parasites. The differences in breed prevalence in the current study, revealed that breed may play a role in the prevalence of gastrointestinal helminth parasites. This finding agrees with the reports of Bisimwa *et al.* (2014) of exotic cattle breeds being 4.6 times more likely to be infected with gastrointestinal helminth parasites in Congo.

The fecal infection rate (67.57%) by gastrointestinal helminth is highest among cattle less than 12 months old. The least gastrointestinal helminth fecal infection prevalence (59.32%) was seen in the cattle above 24 months old. But there is no any statistically significant association among the ages of the cattle as  $P=0.4288$ . The findings agree with Ahmed *et al.* (2017), it was stated by these authors that the younger cattle are more susceptible than adult animals. The higher prevalence in younger cattle maybe due to undeveloped immune system, and regular exposure to infected cattle, but these findings contradict with the study by Khan *et al.*, (2021) who reported that adult cattle were highly affected by gastrointestinal parasites.

Based on sex, the overall prevalence of gastrointestinal helminth parasites was higher in males (75%) as compared to the females (50.69%). This finding is consistent with those of Bisimwa *et al.* (2014) in South Kivu Province of Congo and Yuguda *et al.* (2018) in Bauchi State of Nigeria. However, the findings were in contrast to Regassa *et al.* (2006) in Western Oromia, Ethiopia; Squire *et al.* (2013) in Southern Ghana. The high prevalence rates observed in males could be attributed to the fact that male cattle have aggressive habit of feeding as compared to female, it may also be as a result of contact of male animals to different females due to mating as males can have more than five contact with different females just for mating purpose. The studies carried out by Bisimwa *et al.* (2014) in South Kivu Province of Congo and Yuguda *et al.* (2018) in Bauchi state of Nigeria, is consistent with our findings. But, Adedipe *et*

*al.* (2014) revealed that both female and male cattle could have the same chances of being infected with gastrointestinal parasites.

Prevalence in treated cattle was 36.71% and untreated cattle was 83.12%, while in cattle with unknown history the prevalence was 65.15%. Our finding is closely similar with the result of Gunathilaka *et al.* (2018) who reported prevalence of 46.67% in untreated and 15% treated cattle. The higher prevalence of these parasites in the untreated is justifiable because the treated cattle might have been infected but when treated are either totally free from the helminth or have a reduced burden of the parasites which the immune system of the cattle can handled there by leading to low prevalence in such category of cattle.

Cattle with watery feces had the highest prevalence (81.58%) of gastrointestinal helminth infection. While the cattle with normal firm feces had the lower prevalence gastrointestinal helminth infection (42.45%) as compared with those with watery feces. Statistically  $P<0.05$  which showed that there is very a high significant statistical association of the prevalence of these helminthes to the fecal consistency of the cattle. This finding disagrees with Bisimwa *et al.* (2018) who observed that not all parasitic helminths of cattle were associated with diarrhea and anemia.

Base on management system, higher prevalence (45.00%) of gastrointestinal helminth infection was seen in cattle under extensive management system as compared to those cattle under intensive system of management (42.45%).

The result of this study shows a high tick infestation among the cattle sampled. However, our finding shows a higher tick burden on female animals as compared to males which is consistent with previous studies carried out in ruminants (Iqbal *et al.*, 2014) but in contrast to Musa *et al.* (2014) who worked in Maiduguri. The result from this study may be because male animals receive more care mainly due to their use for draught and breeding purposes throughout the year, like frequent grooming including the manual removal of ticks, which would result in low tick burdens.

The findings in this study identified Hyalomma, Boophilus and Amblyomma species of hard ticks infesting cattle is in line with the work of Musa *et al.* (2014) who had similar findings in Maiduguri, These ticks are vectors of livestock and haemoparasitic diseases. Soulsby (1990) reported that the cuticle of hard ticks is key to survival in areas of high temperature, these hard ticks were predominant on cattle this could be as a result of the high ambient temperature which makes survival of soft ticks unfavourable in the region (Opara & Ezech, 2011). The distribution of the ticks among the breeds Red Bororo, Wadara, Red Adamawa Gudali (Rahaji), Abore, Bokoloji, Ndama with exception of Bunaji shows that these ticks are not host specific in cattle and needs blood meal for survival. The exception of Bunaji is

attributed to the number, the management system and care under which was reared. The highest quantity of ticks found on Red Bororo which is in contrast to (Opara & Ezeh, 2011) findings is attributed to probably the management system (pastoralist) and the number sampled, because these breeds are common in this region. The ticks were highest around the preputial area (genitalia), then udder, flank and legs were the most tick infested area on cattle agreeing with Musa *et al.*, 2014. Asmaa *et al.* (2014) also reported that the preputial area and udders were the highly infested areas in cattle. These findings could be attributed to the fact that external genitals, udder, perineum and inguinal/groin region of the body are highly supplied with blood and this region is usually warmer as compared to the other areas of the body and also ticks usually prefer thinner and short hair skin for infestation.

There was higher infestation in the younger cattle than the older ones in this study and this is consistent with the work of Manan *et al.* (2007) and Musa *et al.* (2014), this could be attributed to the resistances against tick infestation as the animal gets older. Sajid *et al.* (2007) attributed it to lower immunity and softer and thinner skin of young animals that could aid in the penetration of mouthparts of ticks for feeding.

## CONCLUSION

The result of this study shows that helminth and tick co-infection is a serious problem to livestock owners in Maiduguri, Borno state. Therefore, helminthosis and tick infestation co-infesting cattle in Borno state presents a serious challenge to the livestock health and food security in the state, thus appropriate and adequate control strategies should be put in place to mitigate losses and enhance the quantity and quality of meat to Borno and its Nigeria in general.

## CONFLICT OF INTEREST

No conflict of interest was interest was involved.

## REFERENCES

- Adedipe, O. D., Uwalaka, E. C., Akinseye, V. O., Adediran, O. A. & Cadmus, S. I. B. (2014). Gastrointestinal helminths in slaughtered cattle in Ibadan, South-Western Nigeria. *Journal of Veterinary Medicine*,
- Ahmed, J., Duguma, A., Regassa, D., Belina, D. & Jilo, R. (2017). Gastrointestinal nematode parasites of small ruminants and anthelmintics efficacy test in sheep of Haramaya district, Eastern Ethiopia. *Animal and Veterinary Sciences*, 5(3), 39-44.
- Asmaa, N.M., Elbably, M.A. & Shokier, K. A (2014). Studies on prevalence, risk indicators and control options for tick infestation in ruminants. *Beni – Seuf University Journal of Basic and Applied Sciences*, 68 – 73. 5
- Bisimwa, N. P., Lugano, R. M., Bwihangane, B. A., Wasso, S. D., Kinimi, E., Banswe, G. & Bajope, B. (2018). Prevalence of gastrointestinal helminths in slaughtered cattle in Walungu territory, South Kivu province, Eastern Democratic Republic of Congo. *Austin Journal of Veterinary Science and Animal Husbandry*, 5(1), 1039-1046.
- Biu, A. A., Maimunatu, A., Salamatu, A. F. & Agbadu, E. T. (2009). A faecal survey of gastrointestinal parasites of ruminants on University of Maiduguri Research Farm. *International Journal of Biomedical and Health Sciences*, 5(4), 175-179.
- Grace, D., Lindahl, J., Wanyoike, F., Bett B., Randolph, T. & Rich, K. M. (2017). Poor livestock keepers: ecosystem–poverty–health interactions. *Philosophical Transactions of the Royal Society B. Biological Sciences*, 372(1725), 20160166.
- Gunathilaka, N., Niroshana, D., Amarasinghe, D. & Udayanga, L. (2018). Prevalence of gastrointestinal parasitic infections and assessment of deworming program among cattle and buffaloes in Gampaha District, Sri Lanka. *BioMed Research International*, 2018, 3048373.
- Hayat, C. S., Hussain, S. M., Iqbal, Z., Hayat, B. & Akhtar, M. (1996). Effect of parasitic nematodes on haematology and productivity of sheep. *Pakistan Veterinary Journal*, 16, 81–83.
- Hess, J E., Njoku, D. E., & Okechukwu, R.I. (1995). Ecological studies of ticks in the Sahelian zone of Northern Nigeria: The climate of Maiduguri and its influence on tick populations. *Journal of Tropical Veterinary Science*, 9(2), 115–123.
- Iqbal, A., Sajid, M. S., Khan, M. N. & Khan, M. K. (2013). Frequency distribution of hard ticks (Acari: Ixodidae) infesting bubaline population of district Toba Tek Singh-Punjab, Pakistan. *Parasitology Research*, 112, 535–541.
- Khan, T., Nasreen, N., Shater, A. F., Khan, A., Kamal, M., Vinueza, R. & Al-Jabr, O. A. (2021). Risk factor analysis for the prevalence of gastrointestinal parasites found in large ruminants in Lower Dir Khyber Pakhtunkhwa Pakistan. *Saudi Journal of Biological Sciences*, 28(12), 7022-7026.
- Lawal-Adebawale, O. A. (2012) Dynamics of ruminant livestock management in the context of the Nigerian Agricultural System. *Livestock Production*, 4, 61–80.
- Musa, H.I., Jajere, S.M., Adamu, N B., Atsanda, N.N., Lawal, J. R., Adamu, S. G. & Lawal, E. K. (2014). Prevalence of Tick Infestation in different Breeds of

- Cattle in Maiduguri, Northeastern Nigeria. *Bangladesh Journal of Veterinary Medicine*, 12 (2), 161-166.
- Nigerian Bureau of Statistics (2011). Population distribution by sex, state, LGA and senatorial district: 2006 census priority tables (Vol. 3). Abuja, Nigeria: National Population Commission
- Opara, M.N. & Ezech, N.O. (2011). Ixodid ticks of cattle in Borno and Yobe states of North-Eastern Nigeria: Breed and coat color preference. *Animal Research International*, 8(1), 1359-1365.
- Owhoeli, O., Elele, K. E. & Gboeloh, L. B. (2014). Prevalence of gastrointestinal helminths in indigenous and exotic goats slaughtered in selected abattoirs in Port Harcourt, South-South, Nigeria. *Chinese Journal of Biology*, 2014, Article ID 435913, 8 pages.
- Perry, B. D., Randolph, T.F., McDermott, J. J., Sones, K. R. & Thornton, P. K. (2002). Investing in Animal Health Research to Alleviate Poverty. Accessed 24 May 2014. International Livestock Research Institute, Nairobi. <https://cgspace.cgiar.org/handle/10568/2308>.
- Rajput, Z. I., Hu, S., Chen, W., Arijo, A. G. & Xiao, C. (2006). Importance of ticks and their chemical and immunological control in livestock. *Journal of Zhejiang University Science B*. 7(11), 912-921.
- Regassa, F., Sori, T., Dhuguma, R. & Kiros, Y. (2006). Epidemiology of gastrointestinal parasites of ruminants in western Oromia, Ethiopia. *International Journal for Applied Research in Veterinary Medicine*, 4 (1), 51-57.
- Rochlin, I. & Toledo, A. (2020). Emerging tick-borne pathogens of public health importance: A mini-review. *Journal of Medical Microbiology*, 69, 781-791.
- Sajid, M. S. (2007). Epidemiology, acaricidal resistance of tick population infesting domestic ruminants. Ph.D Thesis, Faisalabad, Pakistan: University of Agriculture, P: 47.
- Soulsby, E. J. I (1982). Helminths, Arthropod and Protozoa of Domesticated Animals. 7th edn, Bailliere, Tindall and Cassell Ltd, P.136-778.
- Squire, S. A., Amafu-Dey, H. & Beyuo, J. (2013). Epidemiology of gastrointestinal parasites of cattle from selected locations in Southern Ghana. *Livesock Research for Rural Development*, 25(7), 14-18.
- Squire, S. A., Robertson, I. D., Yang, R., Ayi, I. & Ryan, U. (2019). Prevalence and risk factors associated with gastrointestinal parasites in ruminant livestock in the Coastal Savannah zone of Ghana. *ActaTropica*, 199, 105126.
- Yu, Z., Wang, H., Wang, T., Sun, W., Yang & X., Liu, J. (2015). Tick-borne pathogens and the vector potential of ticks in China. *Parasites & Vectors*, 8, 24.
- Yuguda, A. U., Samaila, A. B. & Panda S. M. (2018). Gastrointestinal helminths of slaughtered cattle in Bauchi Central Abattoir, Bauchi State, Nigeria. *GSC Biological and Pharmaceutical Sciences*, 04(02), 058-065.