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Seasonal Prevalence of Gastrointestinal Nematodes of Dairy Goats in South Gezira, Sudan (2019-2022)

Abubakr Ammar M. A. Elsunni[1], Adam Dawood[2], Ghareeb Alla .H. Elobeid[3], and Azhari Mohammed. H. Hassan

Faculty of veterinary medicine, University of AL- Butana, Sudan[1], Department of parasitology faculty of laboratory sciences University of Gezira (Uof G) Sudan[2], Department of Animal Production, Faculty of Agriculture sciences University of Gezira (Uof G) Sudan[3]; Department of Molecular biology and biotechnology, Sudan[4]
E.mail ammarabubakr1@gmail.com
Mobile: No. 00249918005763

***Abstract**: **Background** Gastrointestinal nematodes that affect small ruminants are very important problems that affect adversely animal resources in Tropics and Sub-Saharan areas, hence increasing the margin of poverty, especially in rural communities. **Objectives:** The study was conducted to estimate the prevalence rate of gastrointestinal nematodes among dairy goats in the south Gezira locality during the period from November 2019 to April 2022.**Material and Methods:** Coprological examination was done by using flotation and culture technique methods. **Results**: 352 faecal samples were collected, and 212 samples were initiated positive for (GINs) with an overall prevalence of 60.2%. The study showed that there was a significant variation ($P \geq 0.05$) of (GINs) infections in dairy goats according to sex, age, body condition, and season. **Conclusions and Recommendations**: The study concluded that (GINs) infection is highly prevalent in the tested areas of the locality and therefore, the study abstracted that, Haemonchus spp is the most predominant parasite identified. More studies must be conducted to study the (GINs) at molecular intensity using candidate anthelmintic resistance associated with gene expression and sequence polymorphisms.*

Keywords: Gastrointestinal nematodes (GINs), the prevalence, Gezira, Sudan

Introduction:

Animal resources in Sudan are considered one of the largest wealth in the Arab and African countries. The Sudan animal assets anticipated by the Ministry of Animal Resources and Fisheries (2013) records as 162,340,000 heads including different species. In Sudan, the population of goats was estimated to be about 43 million. [1]Goats (*Capra hircus*) are important resources for poor farmers who keep their animals for cash income, savings, meat, milk, fertilizer, and employment of family members. However, it had been reported widely in the humid and sub-humid tropics. [2]Moreover, goats play a significant role in the economic cycle in both rural and urban areas. Parasites are a major cause of health problems in goats. Animals become unthrifty showing loss of weight, low birth weights, and difficulty in kidding. [3] Due to parasitism, the animals become susceptible to other health problems, which can lead to death. [4] Goats harbor a variety of gastrointestinal parasites, many of which are shared by both species. Among these, helminthes are the most important gastrointestinal tract parasites (GIT) that affect the growth as well as the production of the animal. Gastrointestinal nematodes (GINs) of the Trichostrongylidae family are perhaps the most important parasites of small ruminants worldwide, causing significant morbidity and loss of productivity. [5] Haemonchosis is primarily a disease in tropical and subtropical regions. [6] However, high humidity, at least in the microclimate of the faecal and the herbage is also essential for larval development and survival. [7] It is a serious health problem, which causes lower production due to high morbidity, mortality, and cost of treatment and control measures. The frequency and severity of the disease largely depend on the rainfall in any particular area. [8] Many surveys in different countries around the world have shown that domestic animals, sheep, and goats suffer more frequently from haemonchosis. [9]Nevertheless, Sudan's intensive and semi-intensive production systems are distributed either within aggregation sites in different locations or in small herds located in different sites around towns. Nonetheless, due to the high need for animal proteins especially milk and milk products in Gezira State. Dairy producers are oriented to import milk-high-producing breeds to meet human consumption. This procedure had been increased recently as a result of the increasing human population owing to the migration from other states caused by urbanization as well as natural disasters and conflicts. [10] The increase of crossbred animals in different areas played an important role in the dissemination of health problems due to their high susceptibility to different causative agents (particularly parasitic infections). [11] In addition, bad husbandry and poor management in the farms complicated the health status of dairy cattle. Other diseases are fairly under control by using vaccines or chemotherapeutic preparations. [12]Helminthes infections can be treated by anthelmintic chemotherapy, however, treatment is costly and drug resistance has been developed in all major parasite species. [11] However, in contrast to sheep, which develop a strong natural immunity around 12 months of age, goats acquire a lower level of immunity to (GINs) parasites. The parasitic diseases affect the milk industry with a direct effect on milk production, high cost of treatment, and financial implications for farm management to prevent parasitic infestations due to difficulty to control vectors. [13] Anthelmintics are also required for the treatment of parasitism in goats. However, there is a significant difference in their physiology, which means that the level of the active ingredient in goat blood declines more rapidly after treatment than in sheep. This has the potential to reduce the effectiveness of treatment and because of that selection of drug-resistant, strains of parasites can be much quicker in goats than in sheep. [14]

MATERIALS AND METHODS:

Study area Gezira state is located between latitudes (13- 32 ˚S-15-30˚W) and longitudes (22-32˚W-20-42˚S. The entire area is approximately 23373) square kilometers. The state area covers around 2.5% of the country's area and comprises seven localities. Their populations are about (2.796.330) consistent with the latest population census held in (2013). A percentage of 19.1% of the total population lives in rural areas while 80.4% lives in urban districts. In general, many agricultural Projects were established in the state. Gezira irrigated scheme is the prime scheme in Africa and the Middle East for the cotton industry and other crops. The state is located within the belt of the dry climate, which is characterized by seasonal rains that fall between (July and September). The annual rainfall was estimated at 272.1 ml reaching the peak in August and declining to zero in the dry seasons. Humidity ranges from 70 – 180 % in falls and declines to 18 – 32 % in dry seasons. The land platform is flat plains that run from northern to southern state borders forming a sharp sliding stage for rivers and streams. The current study was conducted at the South Gezira locality. Data was collected for Barakat, Elhoush, Elmadena Arab, and Wadelhadad veterinary units. Target animals: Goats (Capra *aegagrus hircus*) Target Parasite: gastrointestinal nematode (with more focus on strong nematodes especially *Haemonchus contortus).* Target drugs Albendazole, Ivermectin, Levamisol and Tetramizol

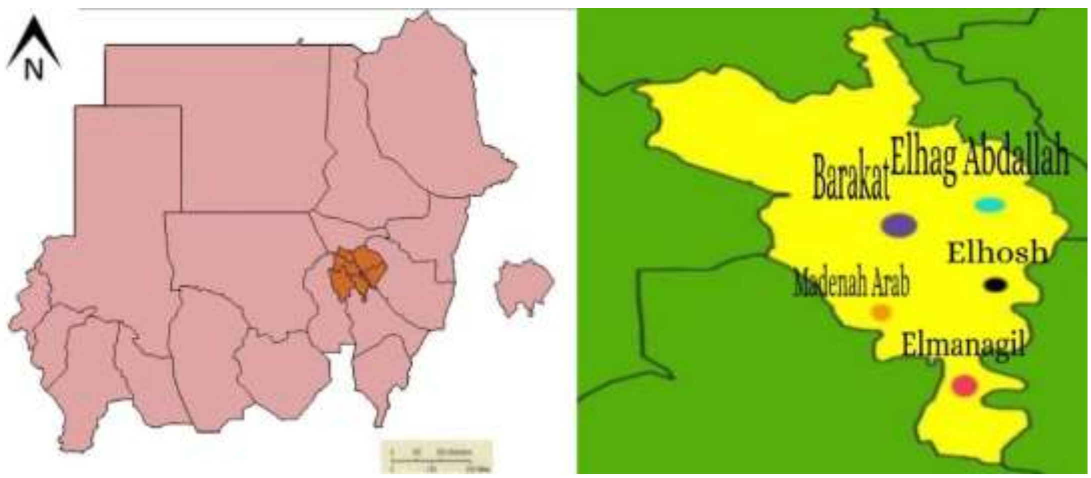

Fig.3.1. The map of Sudan shows the Gezira state map of the study area (south Gezira locality).

Study Design:

A longitudinal cross-sectional herd-based study was adopted to survey the GINS over 48 months. (350) dairy goats were selected by simple random sampling method with discrimination of their age, and sex and represent dairy goats at South Gezira locality. The sampling includes all seasons between 2019 and 2022, throughout the years' seasons (summer, autumn, and winter). Fecal samples were collected during the same period to determine nematode eggs and then positive samples were cultured for nematode larvae identification

Study Population:

Dairy goats are raised in the South Gezira locality, they are a local breed of Nubain goat. The Parasitological survey was prepared by a cross-sectional to detect the common (GINs) in infected goats in the south Gezira locality to determine the prevalence of these parasites. Risk factors associated with GIT infection in goats were also investigated. In each collection, 352 faecal samples obtained by rectal collection will be examined by floatation technique. EPG was performed by the modified McMaster technique. Baemann Technique was performed for larval culture and consequently, identification of recovered parasite was accomplished using morphometric studies**.** Fecal samples were collected from 352 Goats. The duration of the study was from the period of 2019 to 2022. Samples were examined for parasite identification, counting eggs (FEC) (EPG). Faecal samples were collected directly from the rectum of the tested animals. Samples were also kept in sterile plastic bags and marked along with the animal's age, sex and location. These samples were preserved in an ice bag and transported to the laboratory at a veterinary hospital in Barkat for faecal examinations. FEC, Faecal cultures for larvae were dispatched to the parasitology laboratory College of Medical and laboratory Sciences, University of Gezira (Uof G) for parasitic identification. Microscopic Faecal Examination for parasitic ova

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by flotation techniques. Two gram of faeces was in use in a beaker with a sufficient amount of water to make a fluid mixture. The faeces were thoroughly dissociated and the eggs were entirely separated from the faees. The suspension was poured into a test tube. Saturate NaCl was added to meet the tube volume. A cover slip was then placed on the surface of the liquid and left standing for 10-50 minutes. It was then removed vertically and placed on a slide. Microscopically examination was applied under low and high-power magnification.

Method for faecal egg counts, faecal culture , and Identification of the infective larvae

The number of eggs per gram of faeces (FPG) was determined by using the modified McMaster technique (FAO, 2004). Three grams of faeces were mixed with 42 ml of tap water. The faeces suspension was then passed through an 80 µm/a square inch sieve to remove debris. The filtrated liquid was collected in a clean dry bowl. A volume of 15 ml of filtrated solution was taken into a centrifuge tube and then centrifuged for 2 minutes at 1500 rpm. The supernatant was discarded. The sediment was emulsified by gentle agitation by adding saturated NaCl until the volume becomes equal to the initial aliquot of the filtrated solution. Two chambers of McMaster slide were filled using a clean Pasteur pipette. The average number of eggs present in these chambers was multiplied by 100 to obtain the number of eggs per gram of faeces (EPG). Some samples of collected faecal were cultured for the sake of confirmation of counted eggs by recognizing *H.Contortus* larvae (L3) by using the method was said by Litchenfels, [15] The culture of the faecal was prepared according to Urquhart, et al. (1996). [16] Sterilized egg-free goat faeces were crushed into small particles. A small amount of water was added to the faecal mass to form a moist crumbly material. The pure eggs were then added to the faeces and well mixed. The faecal mass was then wrapped in a piece of gauze and suspended on the cover of a closed marmalade jar containing water at the bottom to sustain the moisture levels. The jar was then incubated in the dark at room temperature for 12 days. Harvesting of infective larvae was done by the standard Baermann technique. [17]This application was used to recover *H contortus* larvae from the faecal culture. A tubing piece closed at one end was fitted with a clamp to the funnel's stem. The faecal culture was placed on a piece of double-layered gauze. The gauze was formed as a pouch around the faecal culture and then the pouch was closed with a rubber band. A supporting stick under the rubber band was fixed and the pouch containing faecal culture materials was placed in the funnel. The latter was filled with water and the apparatus was left for about 3 hours. The larvae actively moved out of the faecal material and collected by gravitation in the funnel's stem. The fluid from the stem of the funnel was then collected into a large container. Recovered larvae were then identified and stored at 4º c until used. The identification of the infective larvae was performed by drawing 10-15 ml of the fluid from the stem of the funnel into the test tube and then left to stand for 30 minutes. The supernatant was removed with a clean Pasteur pipette. A small aliquot of the remaining fluid was transferred by using a clean Pasteur pipette to a microscope slide. A drop of iodine was added and a cover slip was placed. The microscopic examination of larvae was achieved under 10× 10 magnification and the Identification was achieved according to Anon 1977. [17]

Statistical analysis:

Statistical analysis was performed using Statistical software besides individual descriptive measures. The Chi-square tests(x2) and one-way (ANOVA) were used by Gomes and Gomez, (1984). [18] The final negative binomial regression model was used for analyzing the EPG of (GINs) nematodes in different seasons. Comparative data were also subjected to descriptive statistical analysis. Student-independent T-test was also used to compare differences between the means of the observations. The least significant difference (LSD) was used to cope with differences among means. Tests for equal proportion have been applied to explore the dependencies between the count variables where these were significant, they were reported along the corresponding p-value. The comparative survey was entered into Ms. Excel and analyzed using SPSS version 21. Differences among studied parameters were explored under probability levels of 5% and 1%.

Results:

The prevalence of faecal intestinal parasite eggs and species spectrum was studied about host and management variables in goats in four districts of south Gezira locality Barakat, Elhoush, Elmadena Arab, and Wadelhadad. The prevalence and the frequency of infection with (GINs) in goats in the study areas were studied in 352 goats of both gender at certain age classes were examined from the first of November 2019 to the last of April 2022. The second part of the study was concerned with the culture of infected faecal samples of dairy goats. From each culture, at least 100 L3 third-stage larvae were morphologically differentiated. The collected faecal samples were processed, based on sedimentation and flotation methods, and then examined for helminthes eggs. Coprological examinations revealed that the overall prevalence was 60.2% (n= 212; Table: 4.1). The infection rates of parasitic (GINs) among dairy goats by seasons are shown in (Table: 1; Fig:.1 C). The prevalence of (GINs) parasites among dairy goats consistent with the gender is shown in (Table: 4.2; Fig: 4.1.D). The infection rate parasites) parasite among males was (17/352 =4.8 %.). Whereas, (195/352= 55.3%) among females. The statistical analysis of host factors showed significant variations such as gender and age. The classes on transversely (GINs) invasion have been publicized in (Table: .3; .4; and Fig: 4. 1 A. C and D). In general, the magnitude of the worm's burden, measured by egg per gram of faces (EPG), was also variable throughout the season with the highest egg count in the dry season and the lowest count by the end of winter. The results exposed that a higher infection rate was recorded in autumn (20.4%) in the age class ranging from (2-4) years (Fig: 4.2.C). The study highlights the rate of simultaneous co-infection with all different helminthes groups was very low. Sequentially to identify risk factors with significant effects on the odds of animals included in the study being positive for nematodes or on the eggs per gram EPG, multivariate logistic and negative binomial regression models were fitted, respectively. As potential risk factors, the variables area, season, age group, sex, and an interaction between sex and age group were initially considered and step-wise eliminated to optimize the Akaike information criterion (AIC) as practiced since 1974. The final negative binomial regression model showed that the EPG of (GINs) was significantly lower in winter than in autumn (rate ratio 0.18; P<0.0001). Moreover, the EPGS were significantly higher in all the units of the south Gezira locality. The odds assumed positive have also differed from one unit to another. P values were only slightly above 0.05 but 95% confidence intervals (CIs) did not include an odds ratio of 1%. The current study also demonstrated that only (11.9, 24.7, 18, .1, 5.1, and 0.3 %) EPG positive cases were registered for age class less than 2 years, (2-4 years), (4-6years), (6-8 years) and above 8 years of age correspondingly (Table:4.6). The study has shown that 80% of the positive cases have low EPG of less than 250. These outcomes reflect the dominance of chronic infection. However, only 4% of positive cases partake more than 600 EPG parasitic load (Table: 4.7). The dispersal occurrence of the EPG among the positive cases in males (88%) and females (80%) in dairy goats. (Table: 4.7). Moreover, 5% of males and 3% of females' positive cases have EPG of more than 600 EPG. (Fig: 4.3, 4.4, 4.5A, B, C and D) illustrate. The different species of GINs

Table. 1. Prevalence of (GINs) parasites among dairy goats in accordance with and gender

Parameters	Studied Variable	No. of Examined Anima	No. of Positive	Positive%	No. of Negative	Negative %
	Summer	121	86	24.43%	35	9.90%
	Winter	111	52	14.70%	59	16.76%
Season	Autumn	120	74	21.02%	46	13%
	Overall	352	212	60.20%	140	39.77%
	Male	26	17	9.00%	4.80%	2.50%
Gender	Female	326	195	131.00%	55%	37.20%
	Overall	352	212	140.00%	60%	37.70%

Table: 2.The effects of seasonal dynamics and gender on (GINs) invasions among dairy goats

Gender		Male			Female		
			Positive	Negative		Positive	Negative
Season	Summer	9	7	2	112	79(40.5%)	33
	Winter	2	0	2	`109	52(26.7%)	57
	Autumn	15	10(58.8%)	5	105	64(32.8%)	41
	Total	26	17	9	326	195	13`1

N.B: Negative binomial regression model showed that the EPG of (GINs) nematodes was significantly lower in winter than in autumn (rate ratio 0.18; P<0.0001).

Table. 3. The effects of age classes and seasonal dynamics on the prevalence rate of (GINs) among goats in the south Gezira locality.

Age Class Years	No. of Examined Animals	Positive(+)	Negative(-)	Percent (+Ve)	Summer	Winter	Autumn
≤2	96(27.2%)	42	54	11.90%	30(8.5%)	44(12.5%)	22(6.25%)
2 to 4	128(36.4%)	87	41	24.7	61(17.3%)	49(13.9%)	72(20.40%)
4 to6	92(26.1%)	64	28	18.10%	29(8.2%)	27(7.6%)	17(4.8%)
6 to 8	35(9.9%)	18	17	5.10%	1(8.5%)	0(0%)	0(0%)
≥8	1(0.30%)	1	0	0.30%			
Total	352	212	140				

N.B: Negative binomial regression model showed that the EPG of (GINs) nematodes was significantly lower in winter than in autumn (rate ratio 0.15; P<0.05).

Table.4. The frequency distribution of EPG of infected male and female dairy goats in infected dairy goats in the south Gezira locality.

FEC	Summer	Winter	Autumn	Total	Male	Rate	Female	rate
50-250	67(77.9)%	42(80.76)%	62(83.78)%	171	15	88.20%	156	80%
251-450	15(17.44)%	10(19.23)%	9(12.16)%	34	1	5%	33	16.90%
451-650	4(4.65)%	0%	3(40,05.)%	7	1	5%	6	3%
Total	86(40.6)%	52(24.5)%	74(34.9)%	212	17	8%	195	92%

N.B: The final negative binomial regression model showed that the EPG of (GINs) nematodes was significantly lower in winter than in autumn (rate ratio 0.18; P<0.0001)

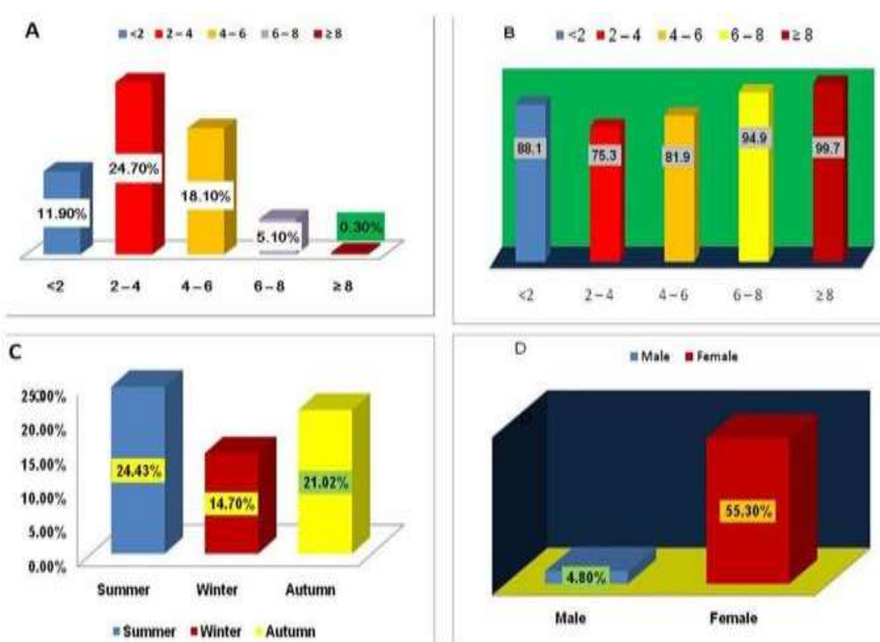

Fig.4.1:A. Illustrated the effect of age class on the frequency distribution of infection rate (GINs) among infected dairy goats in the south Gezira locality (2019-2022). **C:** The influence of season on the infection rate of (GINs) parasites among dairy goats (in the south Gezira locality (2019-2022).**D:** The consequences of prevalence rate of (GINs) parasites among dairy goats in relation to the south Gezira locality during (2017-2019).

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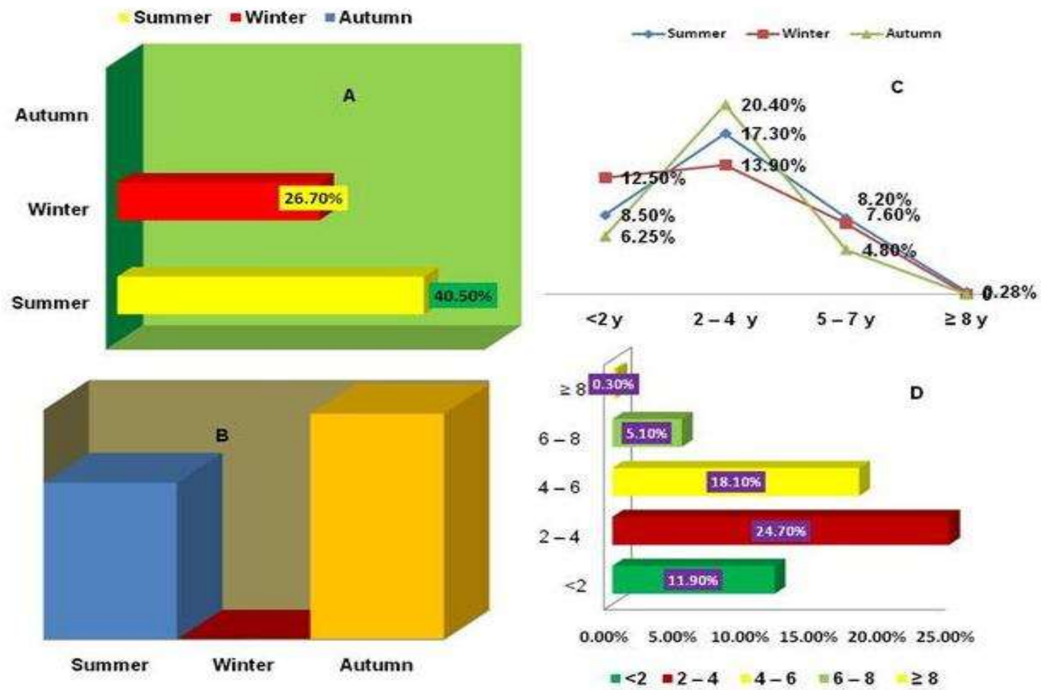

Fig: 4.2. Displays: A The effects of seasonal dynamic and gender on the infection rate of GINs parasites among dairy goats in (in south Gezira locality during (2017-2019).**B:** The impacts of season and gender on the infection rate of (GINS) among dairy goats in (in south Gezira locality during (2019-2022).**C:** The effects of age classes and dynamics on the prevalence rate of (GINs) among dairy goats in the south Gezira locality. **D:** The consequences of a Frequency distribution of infection among positive animals according to age class) among dairy goats in (terms of egg count), according to the standard range of (EPG) in the south Gezira locality during (2019-2022).

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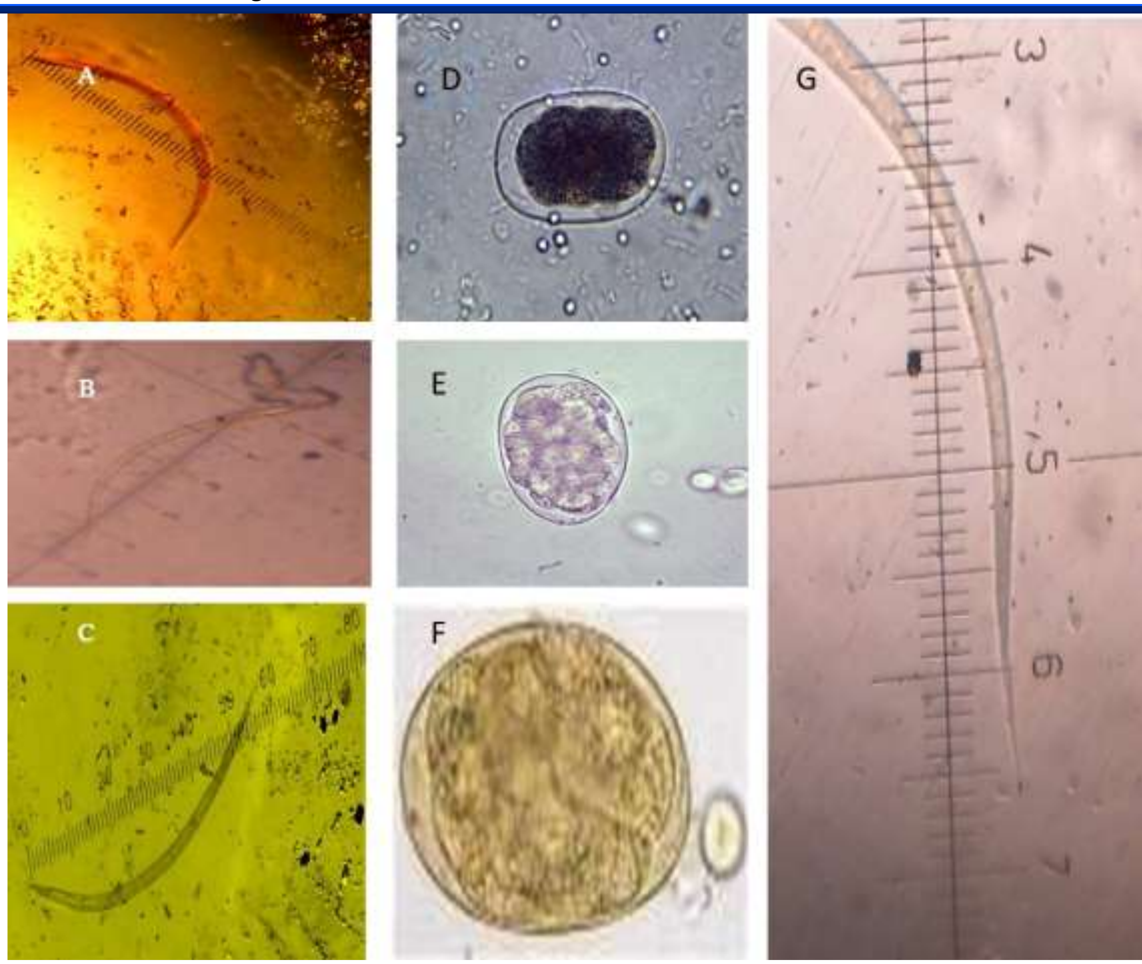

Figure: 4.3 Identification of the infective larvae A *Copperia spp* B**:** *Trichostrongylus spp* **C:** *Haemonchus spp while* **D, E,** *and* **F:** *show different Trichostroglids types of Nematode* eggs G*: exhibits SPP.infective Larvae sheath tail with medium length and usually kinked pointed tail*

DISCUSSION

Parasites are the major cause of health problems in goats. They cause the animals to be unthrifty; this may include loss of weight, low birth weights, and difficulty in kidding. Due to parasitism, the animals become susceptible to other health problems that can lead to death. [19] Goats harbor a variety of gastrointestinal parasites (GINs) of the theTrichostrongylidae family these are perhaps the most important parasite of small ruminants worldwide causing significant morbidity and reduction of production. [20] Goats in the south Gezira locality were heavily infected by GINs of various species of helminthes. *Haemonchus Contortus*, *Cooperia*, and *Trichostrongylus* were the most isolated helminthes in this study. These findings agree with similar studies reported by [21, 1] in Darfur, Sudan.

The outcomes of this study have shared the same identity with previous studies determining the Prevalence of gastrointestinal roundworms in goats [3, 22, 23] in cattle in Nigeria and Ethiopia correspondingly. The high prevalence of *Trichostrongylus* and *Haemonchus* species evident in this study also agrees with similar findings by [1, 24,25]. This result supports the previous finding, which verified the nematodes findings is the most common helminthes in cattle [26, 27] in camels, goats, and ewes. The contemporary study revealed that there are more adult goats in the locality brought for slaughter than young ones. The results publicized that; t ones adult females are more infected than their male counterparts. This could be a factor in the market price or culling the effect. Also, they had shown a high level of worm infestation in adult goats than in young ones. These consequences agree with preceding studies tackled by [29, 3, 28] in Afghanistan, Nigeria, and Ethiopia respectively. Successive retrospective studies bared that the delayed exposure of camel calves and small ruminants to grazing fields can reduce early field exposure of calves to parasites [30, 31] The prevalence of (GINs) infection among dairy goats in the south Gezira locality based on fecal examinations(EPG) and the effect of seasonal dynamic for exam dynamic, sex, and to identify different species of parasite. The current study is concerned with the investigation of nematode parasites affecting the dairy goats in South Gezira the locality. The prevalence rate was found to be

60.2% in proportion to (EPG) samples. This outcome goes in the same line with the recent study in the western Darfur state, Sudan. [1]The seasonal dynamic of the infection revealed that the highest prevalence rates occur in the dry season and score 24.4%in summer. Whereas, a prevalence of 21.02% was recorded in autumn and the lowest prevalence in winter at 14.8 %.These results might likely be attributed due to the mixing of goat flocks with other ruminant animal**s** in small grazing pastures (over stocking). This action was happening due to grazing the residues of harvested crops in the Gezira scheme.

The plausible interpretations regarding the flux occurring in prevalence rates across the seasonal vibrant could be caused by the high population of animals in small grazing areas. In addition to a lack of accessible, clean sources of water. This situation may aggravate the occurrence of contaminated pastures, and may perhaps enhance the outbreak of disease incidences. Interestingly the infective larva of nematodes is very sensitive to winter conditions. Thereupon, larvae undergo an arrested form (hypobiosis) and complete their growth. The present study disclosed that the high-frequency EEG was initiate24.7% among animals aged classed from (2 to≤4 years). Whereas, the lowest rate was registered at 0.28 % for old the age-classes ≥8 years. These results show similar conformity with the study piloted by [1, 32] in Sudan, China, and Ghana respectively. These findings might refer to the immune system. The young animals have had low immunity reservoirs that do not allow them to fight against diseases and therefore, possibly susceptible to disease. While the old age classes have had a sturdy makeup immunity pool that implements a system to clash against a wide range of parasitic incursion. The contemporary study demonstrated that the prevalence of GINs in accordance with gender was 4.8 % in males and 55.3 % in females. The result of the standing study goes in line with [33,34,35]. These outcomes could be attributable due to the low number of males in the flocks and might also be due to the physiological changes that may probably face females during gestation and lactation periods. Thereinafter, females were suffering from stumpy or feeble immunity, which causes an increase in the probability of a high burden of parasitic invasion. In this, study the prevalence of GINs regarding gender and season shows 2.8% in males in the autumn and 22.4% in females in the summer. This might reflect the role of the physiological us and its impact on hormonal balance during different seasons. The prevailing study verified that summer originates 80.6% for low recurrence of infection rate and showed 50-250 EPG for males and females. The study on intestinal parasitic infections of goats in pastoral Belgium areas by [34] found that drenched goats prior to the sampling for the study for the study were associated with low levels of helminthes Potential health-associated risks could be arising from consuming meat or milk from severely ill slaughtered animals and drug resistance from consuming products of animals with the drug in the milk of goats in the Gezira state is mainly sold for commercial purposes. The lack of proper structural outlay and the hygiene standard may set up the main problems encountered by the dairy industry in the state. Although the state is compromised by, largely inhabited people of nomadic background who believe goat products are precious and even linked to medicinal myth and legend. The study concluded that GINs infections are highly prevalent in the tested areas of the locality; therefore, the study abstracted that *Haemonchus spp*. being the most predominant parasite identified. More research work for longer periods involving more goats to focus on the possibility of achieving the total worm counts and identification. The current study recommended further studies that must be carried out immediately to study GINs at molecular levels using candidate anthelmintic resistance associated with gene expression and sequence polymorphisms in a triple-resistant field isolate of *Haemonchus contortus.* Moreover, the detection of quantitative trait loci (QTL) for resistance to (GINs) infections in goats is of assessment for detection of (GINs) or by using Single nucleotide polymorphisms in candidate genes associated with (GINs) infection in goats

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