v. 4, n. 4, 2024

Journal of Agricultural Sciences Research

ANNUAL MONITORING OF GASTROINTESTINAL PARASITOSIS OF THE COLLARED PECCARY (PECARI TAJACU) IN CAPTIVITY

Rubén Cornelio Montes-Pérez
Universidad Autónoma de Yucatán
Mérida, Yucatán, Mexico
https://orcid.org/0000-0003-4251-7342

María del Rosario Zapata-Escobedo
Universidad Autónoma de Yucatán
Mérida, Yucatán, Mexico
https://orcid.org/0009-0009-7936-319X

Fausto Javier Montes-Cruz
Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria (SENASICA)
Villahermosa, Tabasco, Mexico
https://orcid.org/0009-0008-6419-6037

Abstract: The objectives of this research were to determine the genera of gastrointestinal parasites of Pecari tajacu in captivity; estimate the prevalence of gastrointestinal parasitosis, measure the number of coccidial oocysts and nematode eggs per gram of feces, evaluate the relationship between prevalence and egg excretion.
The research was descriptive and longitudinal with wild animals in captivity. The study site was the "Xmatkuil" Wildlife Conservation Management Unit, in Mérida, Yucatán, Mexico. The duration of the research was one year. Fecal samples of Pecari tajacu were collected from the rectum in confinement every month for a year. The genera of gastrointestinal parasites were determined by the MacMaster and centrifugal flotation techniques. The prevalence and quantity of eggs and oocysts excreted per gram of feces were calculated. A linear regression model was fitted between the number of eggs excreted and the prevalence. Two genera of the order Eucoccidiida were determined: Eimeria, Isospora, and a genus of the Strongylidae family: Oesophagostomum. The prevalence of Oesophagostomum was 33.3% to 100% throughout the year. The prevalence of the order Eucoccidiida was from 60% to 93.3% during the year. Individual discharges ranged from 0 to 5100 eggs/gram and from 0 to 15900 oocysts/gram. A linear regression model was fitted between the prevalence of Oesophagostomum parasitosis and the discharge of eggs/gram. It is concluded that the gastrointestinal parasitosis of P. tajacu by Oesophagostomum occurred throughout the year. The prevalence of Eucoccidiida was relatively higher than that of Oesophagostomum. The average number of oocysts per gram of feces was greater than that of eggs per gram. The linear regression model between helminth prevalence and Oesophagostomum egg excretion is significant.

Keywords: collared peccary, Pecari tajacu, Parasitosis, Coccidia, Helminth, Annual monitoring.

INTRODUCTION

Several families and species of gastrointestinal parasites (PGI) have been reported in the collared peccary (Mukul et al, 2014), which correspond to the genera Strongyloides, Eimeria, Isospora, Oesophagostomum. In Bolivia Limachi et al., (2021) report the following PGI Texicospirura turki, Monodontus aguiari, Eucyathostomum dentatum and Ascaris sp, Moniezia benedeni, Stichorchis giganteus, Eimeria spp.; Molina (2012) in Yucatán mention the presence of Eimeria sp. Isospora sp, Metastrongylus sp., Strongyloides sp., Oesophagostumum sp., Ascaris sp. Eimeria sp. and Isospora sp; However, there are no records of annual monitoring under captive conditions. This information is important to identify times or months of the year when the amounts of egg or oocyst excretion of PGI increase or decrease. Once this information is available, it is possible to plan deworming strategies that are effective, and thereby reduce the risks of indiscriminate use of antiparasitic drugs, which could generate resistance of parasites to these products (Toro et al., 2014).). By making strategic planning of deworming possible, costs are reduced due to the application of effective treatments, and reducing the prevalence of PGI, consequently allowing the conservation or improvement of the productive and reproductive performance of the herd (Torres-Acosta et al., 2009). .

The objectives of this research were to determine the genera of gastrointestinal parasites of Pecari tajacu in captivity in Yucatan Mexico, estimate the prevalence of gastrointestinal parasitosis, measure the number of coccidial oocysts and nematode eggs per gram of feces, evaluate the relationship

between prevalence and excretion of eggs, for one year.

MATERIALS AND METHODS

Study site. Management Unit for Wildlife Conservation (UMA) Xmatkuil. Located south of the City of Mérida, Yucatán, Mexico. The climate of the site is warm subhumid classification Aw0 (x') g, (Orellana et al., 2010); average annual temperature of 26°C and average annual precipitation of 1100 mm (INEGI, 2022).

Excrement monitoring was carried out with 15 adult animals: ten females and five males, with average weights of 21 ± 2.5 Kg, and age of 2 to 4 years. No antiparasitic treatment was applied to the animals before or during this investigation.

For fecal sampling, the peccaries were sedated with an intramuscular injection of Ketamine solution at a dose of 10 mg/kg. From each sedated animal, a feces sample (5-10 grams) was obtained directly from the rectum through a clean and properly identified polyethylene bag. The samples were refrigerated at a temperature of 8 °C until they were analyzed in the laboratory on the same day of collection. The collections were made monthly during the period of one year, from October 2002 to September 2003.

The samples were processed using the MacMaster and Centrifugal Flotation techniques described by Figueroa-Castillo et al. (2015) for counting eggs/g and oocysts/g of feces. Samples positive for nematode eggs of the Strongylidae family were transferred to a Petri dish to allow the eggs to hatch and obtain L3 larvae using the Corticelli-Lai technique (Figueroa-Castillo et al., 2015). The larvae obtained from the culture were identified based on their morphological characteristics and size described by MAFF (1986).

Samples positive for Eucoccidiida were cultured as a group from each sample in 2% potassium dichromate (Rodríguez et al., 1994). The oocysts were identified at the genus level according to the number of sporozoites they presented (MAFF, 1986).

Based on the amount of eggs and oocysts excreted per gram of feces from each of the 15 animals each month, they were graphed with the quartile method and minimum and maximum values (boxes and whiskers). The prevalence of each order of PGI in each month was graphed. The Chi square test was applied to evaluate the homogeneity of parasitic prevalence with respect to months, between sexes and between pens. Simple linear regression analysis was applied between prevalences of each order with the corresponding excretions of eggs or oocysts per month.

The median number of oocysts/g vs months and eggs/g vs months were evaluated with the Kruskal-Wallis test, because the assumptions of parametric tests were not met, subsequently paired comparisons with the Bonferroni procedure. Statistical calculations were carried out with Statgraphics Centurion (XVI) (Statgraphics Technologies, Inc, 2013).

RESULTS

Three genera and two orders of PGI were identified. One genus corresponds to helminths and two to protozoans (Table 1).

Order	Gender
Rhabditida	*Oesophagostomum*
Eucoccidiida	*Eimeria*
	Isospora

Table 1. Orders and genera of gastrointestinal parasites in the captive Collared Peccary at the Xmatkuil Wildlife Conservation Management Unit in Yucatán, Mexico.

The presence of Eimeria sp oocysts was in the months of December and September, but those of Isospora sp were present throughout the year.

Figure 1 shows the prevalence values of parasites of the order Rhabditida and Eucoccidiida over a year. The prevalence of Oesophagostomum varied between a minimum of 33.3% in the months of February and March, and a maximum of 100% in the month of May. In the case of the order Eucoccidiida, it had 60% in the month of December, which was the minimum value, and the maximum value in the months of October and January was 93.3%. There was no significant difference in the prevalence of PGI between months, nor between pens, nor between sexes.

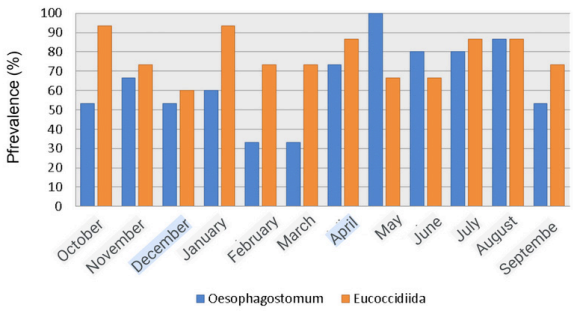

Figure 1. Monthly prevalence of gastrointestinal parasitosis of Oesophagostomum and Eucoccidiida in 15 captive collared peccaries in the Xmatkuil Wildlife Conservation Management Unit, in Yucatán, Mexico.

The elimination of eggs and oocysts of Oesophagostomum and order Eucoccidiida are presented in figures 2 and 3 respectively, which show the variability of egg and oocyst excretion each month of 15 analyzed peccaries. In the month of January there were an average of 496.7 eggs per gram of feces (h/g), in May 1110.73h/g, 413.33h/g in June and in the month of August 360h/g as maximum values of Oesophagostomum, throughout the entire the term. In the order of Eucoccidiida, maximum average values of 660 oocysts per gram of feces (ooq/g) were observed in the month of January, 960 ooq/g in March, 1734.07 ooq/g in May, this was the highest throughout the year. cycle, 683.33 ooq/g in July and 1490 ooq/g in August. The minimums in November and December with 160 and 100 ooq/g, respectively. Table 2 shows significant differences between the pairs of monthly medians of egg excretion/g. Table 3 shows the significant differences between the pairs of monthly medians of oocyst excretion/g feces. A linear regression model was fitted between the number of eggs per gram of feces with their corresponding prevalence (Figure 3), the model is Prevalence of Oesophagostomum% = 51.4351 + 0.0486712*egg/g; R2 = 0.734 ($P<0.01$).

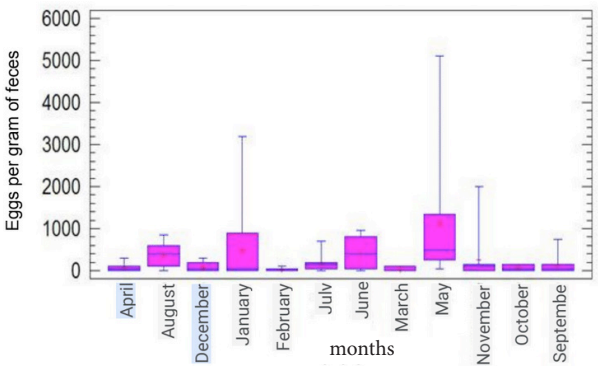

Figure 2. Amounts of elimination of Oesophagostomum eggs per gram of feces per monthin 15 Collared Peccaries (Pecari tajacu) in captivity in the Xmatkuil Wildlife Conservation Management Unit, Yucatán, Mexico.

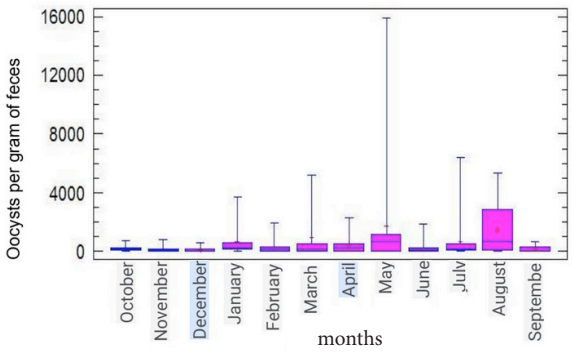

Figure 3. Oocyst clearance amounts: Oesophagostomum per gram of feces per month in 15 collared peccaries (Pecari tajacu) in captivity at the Xmatkuil Wildlife Conservation Management Unit, Yucatán, Mexico.

Contrast	Difference
October-May	-74.83*
October-June	-48.36*
October-August	-54.63*
November-May	-58.16*
December-May	-69*
December-August	-48.8*
January, May	-50.83*
February may	-96.9*
February June	-70.43*
February July	-51.03*
February August	-76.7*
March may	-92.1*
March, June	-65.63*
March July	-46.23*
March August	-71.9*
April May	-65.36*
May-September	74.26*
June September	47.8*
August September	54.06*

Table 2. Pairwise contrast of monthly medians of egg excretion/g of collared peccary feces, which showed significant differences. *indicates significant difference less than 0.05

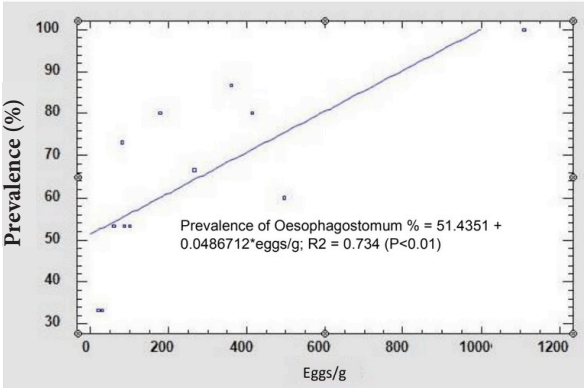

Figure 3. Simple linear regression model between the number of Oesophagostomum eggs per gram of feces and the prevalence of Strongylida parasitosis in % during an annual period, with a sample of 15 Pecari tajacu in the "Xmatkuil" Wildlife Management Unit.

Contrast	Difference
November – August	-54.43*
December January	-54.26*
December - May	-50.46*
December - July	-47.2*
December - August	-66.7*
June August	-51.23*
August September	52.33*

Table 3. Pairwise contrast of monthly medians of oocyst excretion/g of feces of 15 collared peccaries, which showed significant differences. *indicates significant difference less than 0.05

DISCUSSION

The genera Oesophagostomum, Eimeria and Isospora have been reported in P. tajacu in Yucatán (Molina, 2012).

However, this same author reports that in the latrine, the prevalence of Oesophagostomum was 8.7%, Strongyloides 16.4%, and the Eimeriidae family 17.4%. It is pertinent to inform that the sampling period carried out by this researcher was during the transition season from rain to dry with only two collections, which correspond to the months of October to November, also reports that the prevalence of samples collected in rectum of the genus Eimeria was 54%, Isospora 46%. The prevalence values of Strongylidae and Eucoccidiida are lower than those reported in our research throughout the year. However, the total prevalence of PGI reported by Molina (2012) is 61.9% in samples collected in the rectum, 69.5% in the latrine, both values are similar to what was reported in our research for helminths in the same months, but slightly lower for the Eucoccidiida prevalences. For their part, Delprá et al. (2022) in a UMA in San Luis Potosí found a prevalence in peccaries for Eimeria of 33% and for Isospora and Oesophagostomum of 100% taking into account that only three samples of excreta were analyzed, however, they coincide with

the species of parasites found in the present study. Although there are few studies on the prevalence of gastrointestinal parasites in peccaries, coincidences are observed with other swine; Stojanov et al. (2018) in wild boars reported a prevalence of 30.76% for Oesophagostomum and 21.15 and 19.23% respectively for Eimeria deblecki and Eimeria suis. While Tamara et al. (2021) found prevalences of 76.38% of Eimeria, 32.26% of Isospora and 48.39% of Oesophagostomum similarly in wild boars.

Throughout the year there is PGI in the peccary population, but we did not find reports of the annual dynamics of this parasitosis in collared peccaries, in addition we did not detect a decrease in body condition, presence of diarrhea or behavioral depression as a manifestation of the negative effect on the health of these animals, and there were no deaths during this period that would have been associated with a degree of parasitism. There is a characteristic feature of the prevalence of Eimeria sp that appeared only during two months (December and September), but Isospora sp appears all year round.

We do not have evidence of the cause regarding the short duration of the presence of Eimeria sp, but there is the following explanation, which is adaptive immunity by the host (Suárez and Villegas, 2020), Yuño and Gogorza (2008) report that the The immune response does not prevent the invasion of the Eimeria sp sporozoite into intestinal cells, but it does prevent the development of the sporozoites. These authors mention that there is intraluminal destruction of sporozoites by antibodies and lymphocytic cells, hence the decrease in these PGI in the feces of the specimens. .

The prevalence of Isospora sp during the year could be due to reinfection of the animals, because feces are not removed in the pens, and climatic conditions favor the development of Eucoccidiida eggs and oocysts. Cordero del Campillo et al. (1999) report that at ambient temperatures of 10 to 30 °C, relative humidity of 75 to 100% favor the development of these PGI, these climatic conditions are frequent in the UMA under study, which showed temperatures that fluctuated from 15.4 to 39.3°C and humidity from 36.2 to 97.3%. In addition to this, the oral-fecal transmission route that occurs due to the lack of hygiene and cleaning measures must be considered, due to the conditions of confinement and the presence of organic matter can serve as a refuge for oocysts, in the same way the The presence of asymptomatic animals that present a certain degree of parasitism can maintain the reinfection cycle (Delprá-Cachulo et al, 2022).

Fitte et al. (2023) mentions that Eimeria sporulates in an oocyst structure when there are high temperatures between 32 and 35 °C with high humidity, maintaining viability for about 10 months. An advantage of Isospora to sporulate is that it can do so within the host and not like others that need the external environment for their development (Cordero del Campillo, et al. 1999; Martínez et al, 2001), this partly explains why the Isospora genus has been presented throughout the year. We found a highly significant difference in the median oocysts between the months of December (100 ooq/g) vs August (1490 ooq/g), which are the months where temperatures and humidity are different, December is the relatively cold month (18 to 28 °C) and little rain (10 mm), May is the beginning of the rainy season, in which the temperature is high (24 to 39.3 °C) and rainfall begins to rise (10 to 20 mm), recorded data in this research.

The values of paired contrasts of eggs/g show that positive values appear in the months of May vs September, June vs September, August vs September, which means that the increase in egg discharge is greater in the months of May, June and August compared to

September, and the months with the lowest egg discharge are October, November, December, February, March and April, (these months correspond to the time of lowest rainfall) compared to May (transition month of lowest the highest rainfall), June, July, August, the last three months correspond to the time of greatest rainfall.

Animals were found with egg and oocyst discharges that varied from 0 to 5100 h/g and 0 to 15900 ooq/g respectively. The presence of eggs and oocysts in the feces does not necessarily indicate that the animal is sick and their absence does not rule out the possibility of parasitosis, although it also depends on the susceptibility of the animal (Quiroz, 2002). With quantities greater than 319.9 eggs/g in cattle, it is considered a high degree of parasitism (Morales et al., 2001). Pinilla et al (2018) mention that quantities greater than 530 oocysts/g of Eucoccidiida are also high in cattle; on the other hand, Sievers et al., (2002) report that parasitosis by nematodes reaches values greater than 800 eggs/g. in summer and 1500 oocysts/g in spring, which are values similar to our research.

The linear regression model shows a positive change coefficient (b= 0.0486712 eggs/g), between prevalence of Oesophagostomum parasitosis and egg excretion/g, with a relatively high value of the coefficient of determination ($R2 = 0.734$; $p<0.01$), which means that there is a significant and directly proportional relationship between the amount of egg excretion and the prevalence of gastrointestinal parasitosis, a situation that is expected, because the accumulation of excreta in pens throughout the year facilitates the reinfection of the nematode and Eucoccidiida, generating a positive feedback process on the host and the parasites; However, we did not detect damage in the population, which supports the hypothesis that the peccary population has generated adaptive immune resistance.

In the collared peccary there is no information on the annual dynamics of the PGI to make any comparison in this regard. Medium and long-term studies (3 to 5 years) need to be carried out, including the results of blood variables, weight changes, fertility rates, mortality and body condition to determine if the frequency and parasitic discharges reported in the present study could have a significant effect on the productive or reproductive behavior of the peccary kept in captivity in this region of Mexico.

However, gastrointestinal parasitic infections can not only represent a risk for animals but also a risk for public health, mainly for caregivers who are in greater contact with them, due to the zoonotic potential that some parasites may present. A clear example of this risk was presented by Calvopina et al (2016) who presented the first case report in the Americas of a human lung infection in Ecuador due to a zoonotic nematode Metastrongylus salmi, a parasite found mainly in pigs and that at least in the Amazon region where the patient who was diagnosed was originally from; It has been observed that Tayassu pecari has a 30% infection rate for this parasite. In addition to this, it has been observed that the parasitic fauna between domestic and wild species is similar, which suggests that there is a possibility of mutual transmission of parasites between the groups (Stojanov et al, 2018), even between free-living populations. The possibility of parasite transmission exists, the same author mentions that they detected the same species of parasites in different hunting areas which were separated by rivers, canals or hills that served as natural barriers; however, these did not prevent the dispersal of the parasites. in the areas examined. This indicates that even wild animals kept in captivity could at some point acquire parasites from other species that are also susceptible, which is why the establishment of deworming plans

according to systematic monitoring becomes relevant for the maintenance of animal and public health.

We conclude that gastrointestinal parasitosis of P. tajacu by Oesophagostomum sp was throughout the year with prevalence values of 33.3% to 100%. The prevalence of Eimeria sp and Isospora sp showed fluctuations throughout the year with values from 60 to 93.3%, with Isospora being the one that remained throughout the year. The highest amount of Oesophagostomum eggs excreted was in May and the lowest in February with individual values from 0 to 5100 h/g. The highest amount of oocysts excreted was in May and the lowest in December with individual values from 0 to 15900 ooq/g. The linear regression model between helminth prevalence and Oesophagostomum egg excretion is significant.

INTEREST CONFLICT

There is no conflict of interest between the authors for the publication of this document.

REFERENCES

1. Calvopina M., Caballero H., Morita T. y Korenaga M. (2016). Case Report: Human Pulmonary Infection by the Zoonotic Metastrongylus salmi Nematode. The First Reported Case in the Americas. American Journal of Tropical Medicine and Hygiene 95(4): 871–873. doi:10.4269/ajtmh.16-0247

2. Cordero del Campillo M, Rojo V, Martinez F, Sanchez A, Hernandez R, Navarrete I, Diez B, Quiroz R, Carvalho V. (1999). Parasitologia Veterinaria. MacGraw-Hill Interamericana. España.

3. Delprá-Cachulo, J. M., Labrada-Martagón, V., Comas-García, M., Baéz-Ruiz, G. A., & González-Hernández, M. (2022). Endoparasitic infections in captive wild mammals under human care in San Luis Potosí, Mexico. Agro Productividad. https://doi.org/ 10.32854/agrop.v15i9.2246

4. Figueroa-Castillo, J.A., Jasso-Villazul, C., Liébano-Hernández, E., Martínez-Labat, P., Rodríguez-Vivas, R.I. Zárate-Ramos, J.J. (2015). Capítulo 3: Examen coproparasitoscópico En: Técnicas para el diagnóstico de parásitos con importancia en salud pública y veterinaria. Rodríguez-Vivas R.I. Editor. AMPAVE-CONASA. Mexico, D.F. pp. 78-128. Disponible en https://www.researchgate.net/publication/279530633_Figueroa-Castillo_JA_Jasso-Villazul_C_Liebano-Hernandez_E_Martinez-Labat_P_Rodriguez-Vivas_RI_Zarate-Ramos_JJ_2015_Capitulo_3_Examen_coproparasitoscopico_En_Tecnicas_para_el_diagnostico_de_parasitos_c.

5. Fitte B, de Felice L, Eiras DF y Unzaga JM. (2023) CAPÍTULO 14 Isospora spp. En: Juan Manuel Unzaga y María Lorena Zonta (coordinadores). Protozoos parásitos de importancia sanitaria: un abordaje transdisciplinar. Pp:115-120. Editorial de la Universidad Nacional de la Plata. Disponible en: https://libros.unlp.edu.ar/index.php/unlp/catalog/book/2286

6. INEGI, Instituto Nacional de Estadística, Geografía e Informática. (2022). Clima: Yucatán. Disponible en https://cuentame.inegi.org.mx/monografias/informacion/yuc/territorio/clima.aspx.

7. Limachi QR, Nallar G, R., & A RE. (2021). Parásitos gastrointestinales en Tayassu pecari y Pecari tajacu de vida libre de la Reserva de la Biósfera y Territorio comunitario de origen Pilón Lajas, Beni-Bolivia. Neotropical Helminthology, 8(2): 269-277. Disponible en: https://biblat.unam.mx/es/revista/neotropical-helminthology/articulo/parasitos-gastrointestinales-en-tayassu-pecari-y-pecari-tajacu-de-vida-libre-de-la-reserva-de-la-biosfera-y-territorio-comunitario-de-origen-pilon-lajas-beni-bolivia.

8. MAFF. Ministry of Agriculture Fisheries and Food. (1986). Manual of veterinary parasitological laboratory Techniques. Reference Book 418. Her Majesty's stationary office. Londres. Pp 159.

9. Molina HN. (2012). Estudio sobre los parásitos gastrointestinales y hemoparásitos que afectan al Pecari de collar (*Pecari tajacu*) en condiciones de cautiverio en el Centro para la Conservación e Investigación de la Vida Silvestre en Yucatán, Mexico. Tesis de pregrado. Universidad Nacional Autónoma de Mexico. Mexico D.F. 41 p. http://132.248.9.195/ptd2012/noviembre/0686092/Index.html

10. Morales G, Pino AL, Sandoval E, De Moreno L, Jiménez LD, Balestrini C. (2021). Dinámica de los niveles de infección por estrongilidos digestivos en bovinos a pastoreo. Parasitologia al día 25(3-4): 115-120. Disponible en: http://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0716-07202001000300008&lng=es. http://dx.doi.org/10.4067/S0716-07202001000300008.

11. Mukul YJM, Zapata EMR, Montes PRC, Rodríguez VRI, Torres AJF. (2014). Parásitos gastrointestinales y ectoparásitos de ungulados silvestres en condiciones de vida libre y cautiverio en el trópico mexicano Revista Mexicana de Ciencias Pecuarias, 5: 459-469. Disponible en: https://www.redalyc.org/articulo.oa?id=265632520006.

12. Orellana LR., Celene EM., Nava MF. (2010). Climas. En: Durán R. y M. Méndez, Biodiversidad y Desarrollo Humano en Yucatán. Mérida, Yucatán: CICY, PPD-FMAM, CONABIO, SEDUMA. 496 p. ISBN 978-607-7823-05-6. Disponible en: https://www.cicy.mx/documentos/CICY/sitios/Biodiversidad/pdfs/Cap1/03%2°Climas.pdf.

13. Pinilla JC, Flórez P, Sierra M, Morales E, Sierra R, Vásquez MA, Tobon JC, Ortiz D. (2018). Prevalencia del parasitismo en bovinos del departamento Cesar, Colombia. Revista de Investigaciones Veterinarias del Perú 29: 278-287

14. Quiroz, R. (2002). Parasitología y enfermedades parasitarias de animales domésticos. Editorial UTEHA. Mexico, D.F

15. Rodríguez, V.R.I; Domínguez, A.J.; Cob, G. (1994). Técnicas Diagnósticas de Parasitología Veterinaria. Editorial Universidad Autónoma de Yucatán. Mérida, Yucatán.

16. Sievers G, Jara M, Cardenas C, Nuñez J. (2002). Estudio anual de la eliminación de huevos y ooquistes de parásitos gastrointestinales y larvas de nemátodos pulmonares en ovinos de una estancia en Magallanes, Chile. Archivos de medicina veterinaria. 34:37-47. https://www.scielo.cl/scielo.php?script=sci_arttext&pid=S0301-732X2002000100004

17. Statgraphics Technologies, Inc. The Plains, Virginia. STATGRAPHICS Centurion (XVI) 16.2.04 (2013). Disponible en http://www.statgraphics.com/download-.statgraphics-centurion-XVI.

18. Stojanov I, Pavlovic I, Pusic I, Prodanov-Radulovic J, Ratajac R, Marcic D. y Savic B. (2018). Determination of endoparasites by faecal examination in the wild boar population in Vojvodina (Serbia). Macedonian Veterinary Review 41(1): 39-46. https://doi.org/10.1515/macvetrev-2017-0029

Suárez RA, Villegas VCA. (2020). Características y especialización de la respuesta imunitaria en la COVID-19. Revista de la Facultad de Medicia (Mexico). 63(4): 7-18. Disponible en https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0026-17422020000400007

19. Tamara, I., Nataša, M., Sanda, D. et al. (2021). The Prevalence and Degree of Endoparasitic Infections in Wild Boars Using the Semi-quantitative Fecal Egg Count Method. Acta Parasitologica 66, 104–115. https://doi.org/10.1007/s11686-020-00261-8

20. Toro A, Rubilar L, Palma C, Pérez R. (2014). Resistencia antihelmíntica en nematodos gastrointestinales de ovinos tratados con ivermectina y fenbendazol Anthelmintic resistance of gastrointestinal nematode in sheep treated with ivermectin and fenbendazole. Archivos de Medicina Veterinaria 46: 247-252. https://www.scielo.cl/pdf/amv/v46n2/art10.pdf

21. Torres-Acosta JFJ, Cámara-Sarmiento R, Aguilar-Caballero AJ, Canul-Ku HL, Pérez-Cruz M. (2009). Estrategias de desparasitación selectiva dirigida. En: Avances en el control de la parasitosis gastrointestinal de ovinos en el trópico. Pp: 1-13. https://www.researchgate.net/publication/301356894_Estrategias_de_desparasitacion_selectiva_dirigida_En_Avances_en_el_control_de_la_parasitosis_gastrointestinal_de_ovinos_en_el_tropico

22. Yuño MM. y Gogorza LM. (2008). Coccidiosis aviar. Revista Veterinaria 19: 1, 61–66. https://revistas.unne.edu.ar/index.php/vet/article/view/4304