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Biosegurity practices/parasite reduction relationship in rabbit farms in the Tulancingo Valley

Relación de buenas prácticas productivas/disminución de parásitos en granjas cunícolas del Valle de Tulancingo

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Abstract

Parasite infestations in rabbit farms are among the main problems since they generate economic losses; good practices in animal production have played a significant role in avoiding this problem. The objective of this work was to identify if there is a relationship between the parasite load and the implementation of good production practices in 11 farms in the Tulancingo Valley, Hidalgo, Mexico. First, a survey was carried out to know the general characteristics of the farms; likewise, a training program was developed for the implementation of good production practices for six weeks; feces were sampled every week for oocyst counting using the flotation technique and McMaster chamber counting. The results obtained showed that in the first week of sampling, eight farms had oocysts (3425 maximum and 50 minimum). However, as the weeks passed and implementing good production practices, this parasite load decreased significantly ($p < 0.05$), reaching zero in 5 farms at week 6. These findings suggest that the implementation of good production practices can reduce and perhaps control coccidiosis, which would reduce economic losses.
Keywords: rabbit farming, *Eimeria spp*., biosecurity practices.

Resumen

Las infestaciones por parásitos en granjas cunícolas son uno de los principales problemas, ya que generan pérdidas económicas; se ha demostrado que las buenas prácticas en la producción animal juegan un papel muy importante para evitar esta problemática. El objetivo del presente trabajo fue identificar la posible relación entre la carga parasitaria con la implementación de buenas prácticas de producción, en 11 granjas del Valle de Tulancingo, Hidalgo, México. Se realizó una encuesta para conocer las características generales de las granjas; así mismo, se desarrolló un programa de capacitación para la implementación de buenas prácticas productivas durante 6 semanas; cada semana se muestrearon heces para el conteo de ooquistes mediante la técnica de flotación y conteo en cámara McMaster. Los resultados obtenidos mostraron que en la primera semana de muestreo 8 granjas tenían la presencia de ooquistes (3425 máximo y 50 mínimo), pero al trascurrir de las semanas, ya implementando las buenas prácticas productivas, esta carga parasitaria disminuyó de manera significativa ($p<0.05$), llegando a cero en 5 granjas a la semana 6. Estos hallazgos sugieren que la implementación de buenas prácticas de producción, pueden reducir y quizás controlar la coccidiosis, lo que repercutiría en la reducción de pérdidas económicas.
Palabras clave: cunicultura, *Eimeria spp.*, buenas prácticas.

INTRODUCTION

Rabbit farming is a productive activity with great potential for development, since the rabbit is a species with the right characteristics to be used in small-scale production systems, has a high prolificacy rate and is easy to manage (Cullere & Dalle, 2018); in Mexico, it has become an alternative for meat production, increasing its popularity due to the great nutritional value it has. The main rabbit producers in the country are centered in rural communities and family productions, an activity that is part of their livelihood, either to supplement economic income with the sale of their products, or for self-consumption (Olivares-Pineda *et al.,* 2009). Mexican states that produce and consume the most rabbit meat are México, Guanajuato, Puebla, Hidalgo, Michoacán, Tlaxcala, Jalisco and Querétaro states. In 2001, the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food recognized rabbit farming as a livestock activity that could receive official support; however, despite this recognition, no statistical work has been carried out to evaluate the current situation of the activity in the country. In addition, the lack of sanitary policies to help improve production conditions is another limitation, since the programs implemented in the country are centralized, so that regions far from the center lack training to help improve production (Flores, 2016).

One of the biggest problems faced by small-scale rabbit production is the lack of information regarding good production practices, hygiene, biosecurity and animal welfare, which favors the introduction of pathogens that cause various diseases (Reynoso *et al.,* 2019). It has been observed that biosecurity is vital for the development of animal production units, to prevent the introduction and spread of infectious diseases and decreases the economic costs derived from them (Indrawan *et al.,* 2020; Tanquilut *et al.,* 2020). The National Service of Agrifood Health, Safety and Quality (SENASICA), of the Secretariat of Agriculture and Rural Development (SADER, formerly SAGARPA) published the Manual of Good Practices for Rabbit Meat Production (Manual de Buenas Prácticas de Producción de Carne de Conejo) (SAGARPA, 2015), which indicates the production conditions and facilities necessary to obtain safe food, involving hygiene and biosecurity measures. Another important problem affecting rabbit productions is the presence of enteric diseases, as they generate severe economic losses due to mortality, decreased growth and decrease in feed conversion performance (Reynoso *et al.,* 2019). Among the most important pathogens that cause these diseases it can mention the parasite of the genus *Eimeria*, which causes coccidiosis, it is a microorganism difficult to eradicate, it mainly affects newly weaned animals and in the physiological stage of growth, causing diarrhea (El-Shahawi *et al.,* 2012). Currently, 15 *Eimeria* species are known, 14 of which, affect the intestine and 1 is positioned in the bile ducts and liver, its taxonomic identification is based on microscopy techniques, based on the morphology of the oocysts

present in the feces of the animals (Abdel-Baki & Al-Quraishy, 2013). One option to counteract all these problems could be the implementation of a program of good production practices. The aim of this study was to identify if there is a relationship between the parasitic loads of *Eimeria* spp with the implementation of good production practices in 11 farms in the Tulancingo Valley, Hidalgo, Mexico.

MATERIAL AND METHODS

Rabbit farms

A study was conducted in 11 rabbit farms in the Tulancingo Valley, Hidalgo, to evaluate the conditions, productive and reproductive management, feeding, breeds, records, biosecurity measures and most frequent diseases, through surveys, during February to May 2019 months. Six visits were made to each producer (1 per week); in the first week, a diagnostic survey of production conditions was conducted; in the other 5 weeks, the implementation of good production practices was followed up, for which, they were given advice, training them on the implementation of basic production measures, based on the Manual of Good Rabbit Meat Production Practices (SAGARPA, 2015); the training focused on the following: 1) barriers that provide protection against wildlife, domestic fauna and people outside the farm, 2) logbook for recording visits, 3) change of clothes and hygiene of operators (use of soap, toilet paper, hand towels and personal hygiene disinfectants), 4) work clothes and footwear exclusive to the farm, 5) sanitary mat for disinfection of footwear at the entrance to the shed and 6) washing and disinfection program for floors, feeders, waterers, nests and cages. During the 6 weeks, the rabbits were not administered any type of deworming agent.

Collection of feces and counting of oocysts

Each week, fresh feces were collected from rabbits in each of farms, a clean gauze was placed under the cages for collection, and the feces were transferred in a cooler and under aseptic conditions the same day to the Biochemistry and Cell Biology Laboratory of the Institute of Agricultural Sciences of the Autonomous University of Hidalgo State for identification and quantification.

Feces were examined for the presence of oocysts by the flotation method (Zajac & Conboy, 2012); feces were homogenized with saturated saline solution for 10 min, after which time an aliquot was taken for examination under the microscope for the presence of the parasite. For the oocyst count per gram of feces, a McMaster chamber was used; for this, 4 g of the feces were homogenized in 15 mL of saturated sodium chloride solution, once homogenized it was taken to a final volume of 60 mL and immediately taken to the McMaster chamber (150 µL approximately), left for 5 min and proceeded to count through an optical microscope (Zajac & Conboy, 2012).

Statistical analysis

The results obtained from coccidial counts were analyzed using a general linear model and an ANOVA (P< 0.05) with a Tukey's mean comparison test in the statistical program Statistical Analysis Software SAS/STAT®, version 9.0.2, Cary, North Carolina, USA.

RESULTS AND DISCUSSION

Results obtained in the producer surveys showed that, in general, farms in the Tulancingo Valley are of recent creation, with an average age of 3.6±2.2 years, producers have an average age of 37±12 years, of these, 27% are women and 73% are men, 46% have high school, 27% have high school, 18% have a bachelor's degree and 9% primary school; only 36% are dedicated exclusively to rabbit production, since most of them have another source of income. Facilities are mainly constructed of sheet metal and wood, with concrete floors, and the animals are housed in galvanized cages, with galvanized feeders and drinkers (Table 1).

Table 1. Materials used in the facilities and utensils of the rabbits farms in the Tulancingo Valley

FARM	INSTALLATION MATERIAL					UTENSILS MATERIAL								
	CONSTRUCTION			FLOOR		FEEDER			DRINKER			CAGE		
	block and concrete	laminate	wood	concrete	ground	plastic	galvanized hopper	galvanized sieve	plastic	galvanized hopper	automatic	plastic	galvanized	wood
1	X			X				X			X		X	
2		X	X	X			X				X		X	
3	X	X		X	X		X	X		X	X		X	
4	X	X		X			X		X			X	X	
5		X		X			X		X	X			X	
6			X		X		X	X		X			X	
7	X	X		X				X	X		X		X	
8	X	X	X	X	X	X	X		X				X	X
9			X		X		X			X			X	X
10			X		X		X	X		X			X	
11		X	X		X		X		X	X			X	
Total	5	7	6	7	6	1	9	5	5	6	4	1	11	2

According to the National Council for the Evaluation of Social Development Policy (CONEVAL), as of 2018 there are 1,311,103 people in poverty *status* registered in Hidalgo state, which is why rabbit farming has been seen as a food security alternative within the National Crusade against Hunger proposed in 2016; because rabbit meat is a livestock product with high development possibilities, which can be exploited in rural, urban or peri-urban areas, since for example, in Mexico 90% of production is carried out by small producers (Garduño-Millán *et al.,* 2019). Main entities that have rabbit production are: Puebla, Tlaxcala, Morelos, Mexico City, Michoacán, Guanajuato, Querétaro, México state, Hidalgo and Jalisco (SADER, 2016). Garduño-Millán *et al.,* (2019) evaluated 33 rabbit farms in Morelos state, Mexico, where he described that producers are aged between 20 and 60 years, of which, 43% have a bachelor's degree, 22% with high school, 33% with basic studies and 2% with no schooling. According to the Manual of Good Practices for Rabbit Meat Production (SAGARPA, 2015), farms must be at least 3 km away from areas exposed to physical, chemical or microbiological contamination, must be clean and free of weeds around it, to avoid harmful fauna, have the necessary mechanisms to prevent the entry of animals and people outside the unit. Construction must be made with materials that are local, economical, resistant, good thermal insulators and impermeable, so that they do not absorb humidity or steam from the atmosphere and remain dry in the rainy season, they must also be easy to wash and disinfect, the windows must be protected to prevent the entry of animals, the roof height should be 2 to 3. 5 meters for good ventilation, floors should be concrete and be declined towards a drainage channel to avoid flooding in addition to facilitating cleaning and disinfection, carrying out all these recommendations, helps to control the temperature, which should be between 16 to 22 ºC, since at temperatures higher than 29 °C the productive parameters are negatively affected (Cruz-Bacab *et al.,* 2018). In a research conducted by Aceves-Martínez (2019), materials used in rabbit farms in the Mexico state were identified, where 51% use metal or galvanized sheet roofing, 18% have canvas roofing, 18% have cardboard lamina and 13% have asbestos roofing, and suggests that this reflects certain training or knowledge in the activity.

Regarding reproductive management, most of farms (7) have a semi-intensive production system, because they have lapses between births of 45 days, with mating from 10 to 17 days postpartum, obtaining 8 births/female/year and a weaning of 35 or 40 days; on the other hand, the zootechnical purpose of the farms is mostly the production of live rabbits (9) followed by carcasses (4); it should be mentioned that some farms have more than one zootechnical purpose (Table 2).

Biosecurity refers to the actions and measures implemented to prevent and control the introduction and spread of infectious diseases, which is vital for the successful performance of a production system, these interventions can also affect the transmission of zoonotic pathogens to humans, which has a beneficial impact on public health (Youssef *et al.,* 2021).

Table 2. Reproductive management and zootechnical purpose of rabbit farms in the Tulancingo Valley

FARM	REPRODUCTIVE MANAGEMENT			ZOOTECHNICAL END					
	INTENSIVE	SEMI-INTENSIVE	EXTENSIVE	BREEDING RABBIT´S STOCK	YOUNG RABBITS	PETS	MEAT PRODUCTS	ON FOOT	CARCASS
1		X						X	
2		X		X			X		X
3		X			X			X	X
4		X		X		X			
5	X					X		X	X
6		X						X	
7	X				X			X	X
8		X						X	
9			X		X			X	
10		X						X	
11			X					X	
Total	2	7	2	2	3	2	1	9	4

Biosecurity survey results showed that farms in general do not have biosecurity measures in place, since they do not use adequate clothing, allow uncontrolled entry of harmful fauna, other animals and people from outside the farm, do not have a sanitary mat or temperature and humidity control. They have not implemented personal or facility hygiene procedures, which generates the appearance of various pathologies (Fig. 1), among which we can mention the highest percentage of occurrence of scabies (27%), diarrhea (20%) and meteorism (20%). The incidence of infectious enteric diseases in rabbits raises questions regarding disease prevention and management practices on farms. Factors implicated in the persistence of infectious diseases include the intensive nature of production, the lack of effective vaccines against common diseases, and the lack of effective antimicrobial agents licensed for use in this species; specific biosecurity measures can significantly reduce infectious diseases and aid in disease control ((Kylie *et al.,* 2017).

According to the Manual of Good Practices for Rabbit Meat Production (SAGARPA, 2015), the infrastructure of the shed must have a perimeter fence that provides protection against wildlife, domestic fauna and people outside the production unit in addition to having a visitor logbook and a sanitary mat at the entrance; have facilities for changing clothes and hygiene of the operators; work clothes and footwear will be for the exclusive use of the production unit. Personnel hygiene is essential for production; upon entering

the facilities, workers should go directly to the changing rooms or, if necessary, to the area set aside for this purpose, where they should put on work clothes and footwear; all personnel in contact with animals or involved in the direct handling of animals should have adequate training in animal health, animal welfare and food hygiene and the risks associated with their work; cleanliness must be the most important and take the necessary precautions to prevent contamination of and to the animals considering equipment and implements within the production, in addition to a cleaning and disinfection program.

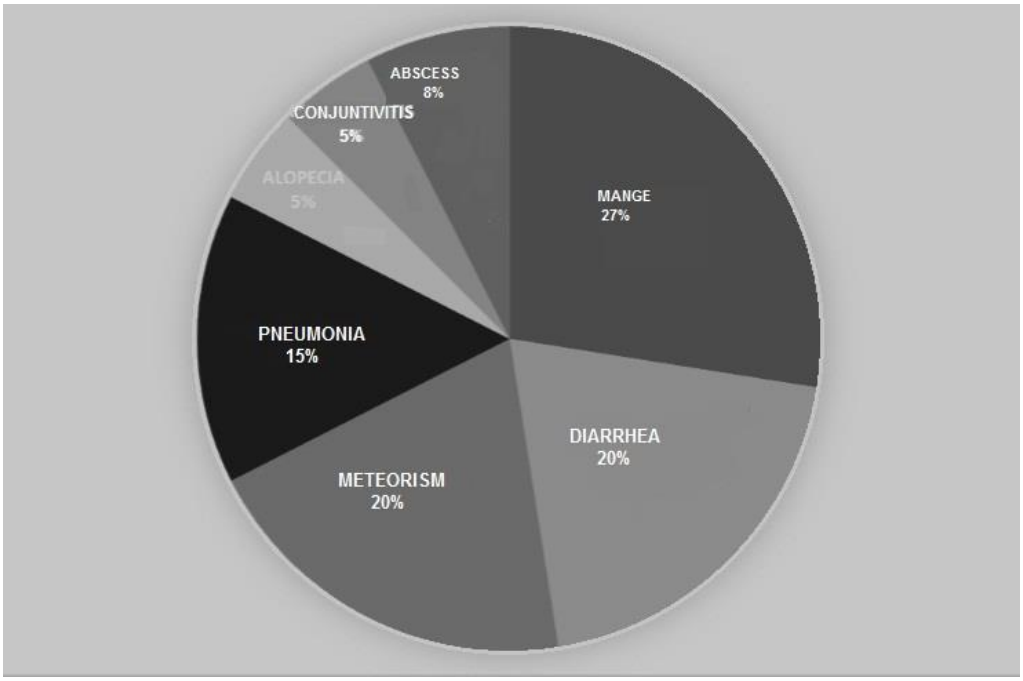

Figure 1. Pathologies present in the rabbit farms of Tulancingo Valley

Regarding the presence of parasites, in 3 farms it was not possible to collect feces, because the producers forgot to put the gauze for feces collection; in the remaining 8 farms it was possible to identify different species of *Eimeria* spp, since the morphology observed in the oocysts indicates the presence of several species (Fig. 2).

Ladrón de Guevara *et al.,* (2019), conducted a study in backyard farms in Mexico State and found an overall prevalence of *Eimeria* spp. in the southeastern region of the state (48.3%), registering the highest prevalence in winter (88%) and the lowest in spring (5%). Jing *et al.,* (2012), conducted a study in 48 farms in China and found an overall prevalence of *Eimeria* spp. of 41.9%, likewise, found that larger farms had lower prevalence of *Eimeria* spp. (34.2%) compared to small farms which was higher (61.4%); regarding species identification, they found ten species of *Eimeria*; *E*. *perforans* was the most prevalent

species (35.2%), followed in order of *E*. *media*, *E*. *magna*, *E*. *irresidua* and *E*. *intestinalis* with prevalences of 31.3%, 28.8%, 19.4% and 14.8%, respectively.

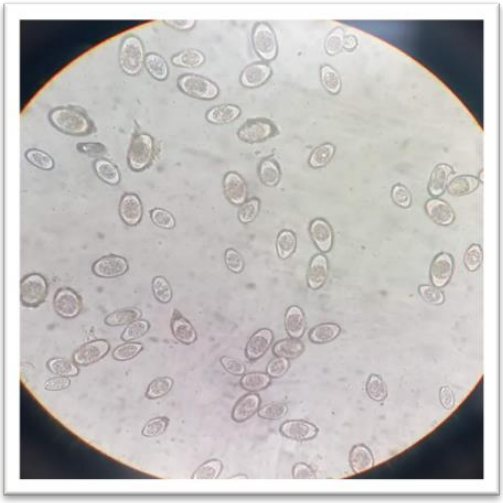

Figure 2. Oocysts of *Eimeria* spp. in fresh feces (Objective 25X)

The results obtained with respect to the oocyst count during weeks of sampling are presented in Table 3. It was observed that, in the 8 farms sampled at the beginning, all had the presence of oocysts, from a maximum of 3425 to a minimum of 50; with the passage of time and applying basic biosecurity measures, this parasite load decreased in a statistically significant manner ($P<0.05$) as of week 4, showing in week 6 a maximum of 450 and a minimum of 0 oocysts. It is worth mentioning that making the comparison between farms, 2 of them had the highest parasite load (1400 and 3425 oocysts) statistically significant ($P<0.05$) with respect to the other 6, and also to highlight that three farms started with a parasite load of 50 oocysts; these results suggest that there may be a positive relationship between the decrease of the parasite load with the basic production measures within the farms.

Enteric diseases play an important role in animal production farms, as they generate severe economic losses due to mortality, decreased growth and feed conversion (Reynoso *et al.,* 2019). Ladrón de Guevara *et al.,* (2019) found 407 oocysts per gram of feces in autumn, while the highest amount was in summer with 18,330 oocysts. González-Redondo *et al*., (2008), compared farms in which high hygiene measures and good production management were followed, in which they suggest that these measures may be sufficient to control coccidial infestation without the use of drugs. In addition, it has been reported that the use of coccidiostats as a preventive or corrective measure does not minimize the parasite load (Yin *et. al.,* 2016). On the other hand, Okumu *et al.* (2014) reported a high coccidial load in feces despite the implementation of hygienic measures,

which suggests that minimum biosecurity measures should be quite strict. Migration of *Eimeria* spp. oocysts during infection takes place mainly from the small intestine and through the tract, although some species can lodge in the liver and bile ducts, once there the animal starts an immune response, it has been suggested that macrophages and intraepithelial lymphocytes play a very important role in the defense against these parasites (Pakandl, 2009). There are some factors that favor coccidial infestations mainly in young rabbits, such as stress derived from weaning that compromises the immunity of the animals and productive management, which if not adequate becomes a risk factor, since the ingestion of solid food contaminated with coccidia can increase the intensity of the infection (Okumu *et al.*, 2014).

Table 3. *Eimeria* spp. oocyst counts during the 6 weeks of sampling in rabbit farms of Tulancingo Valley

Farm	Week 1^{A}	Week 2^{A}	Week 3^{A}	Week 4^{B}	Week 5^{B}	Week 6^{B}
	OPG					
1^{b}	400	100	50	0	0	0
2^{b}	150	0	50	0	0	0
3^{a}	1400	2050	1450	175	75	250
4^{b}	50	1425	275	0	75	450
5^{b}	70	75	50	0	0	0
6^{b}	50	25	0	50	0	0
7^{b}	50	0	0	0	0	0
8^{a}	3425	775	975	50	0	50
S.E.	266	266	266	266	266	266

OPG= Oocysts per gram. ^{AB}=Literals indicate statistically significant difference by columns. ^{ab}=Literals indicate statistically significant difference by rows. S.E.= Standard error

CONCLUSIONS

The results found suggest that the infrastructure of the rabbit farms in the Tulancingo Valley does not meet the requirements of the Manual of Good Practices for Rabbit Meat Production; however, minimum biosecurity measures were adapted. On the other hand, with respect to parasites, we can mention that the main affectations that the farms have are caused by the parasite of the genus *Eimeria* and the main thing, the correct implementation of minimum biosecurity measures minimized the parasitic load, this can have a beneficial impact by reducing the economic losses generated by these pathologies for the producers.

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CITED LITERATURE

ABDEL-BAKI AAS, Al-Quraishy S. 2013. Prevalence of coccidia (*Eimeria spp.*) infection in domestic rabbits, *Oryctolagus cuniculus*, in Riyadh, Saudi Arabia. *Pakistan Journal of Zoology*. 45(5):1329–1333. ISSN: 0030-9923. http://zsp.com.pk/pdf45/1329-1333%20_20_%20PJZ-1386-13%2019-9-13%20Revised%20MS%20_1_.pdf

ACEVES-MARTÍNEZ R. 2019. Análisis económico de la producción cunícola en la región de los Volcanes del Estado de México. Universidad Autónoma del Estado de México, México. http://ri.uaemex.mx/bitstream/handle/20.500.11799/105885/Documento%20-%20tesis.pdf?sequence=4&isAllowed=y

CRUZ-BACAB LE, Ramírez-Vera S, Vázquez-García MC, Zapata-Campos CC. 2018. Reproducción de conejos bajo condiciones tropicales, efectos negativos y posibles soluciones. *Ciencia UAT*. 13(1):135-145. ISSN 2007-7521. https://revistaciencia.uat.edu.mx/index.php/CienciaUAT/article/view/989

CULLERE M, DALLE ZOTTE A. 2018. Rabbit meat production and consumption: State of knowledge and future perspectives. *Meat Science*. 143:137–146. https://doi.org/10.1016/j.meatsci.2018.04.029

EL-SHAHAWI GA, El-Fayomi HM, Abdel-Haleem HM. 2012. Coccidiosis of domestic rabbit (*Oryctolagus cuniculus*) in Egypt: Light microscopic study. *Parasitology Research.* 110(1):251–258. ISSN: 1432-1955. https://doi.org/10.1007/s00436-011-2479-0

FLORES DJA. 2016. Análisis situacional y propuesta de estrategias para apoyar el desarrollo de la cunicultura de tipo semi-industrial en el municipio de Texcoco, México. Universidad Nacional Autónoma de México. http://132.248.9.195/ptd2016/octubre/0751149/Index.html

GARDUÑO-MILLÁN ML, Oca ERD, Reynoso-Patiño MA, Saldaña-Fernández C. 2019. La cunicultura de traspatio como parte de las estrategias de seguridad alimentaria en Morelos, México. *Revista ESPAMCIENCIA.* 10(2):43-51. ISSN 1390-8103. http://190.15.136.171/index.php/Revista_ESPAMCIENCIA/article/view/174

GONZÁLEZ-REDONDO P, Finzi A, Negretti P, Micci M. 2008. Incidence of coccidiosis in different rabbit keeping systems. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*. 60(5):1267–1270. ISSN: 0102-0935. https://doi.org/10.1590/S0102-09352008000500034

INDRAWAN D, Cahyadi ER, Daryanto A, Hogeveen H. 2020. The role of farm business type on biosecurity practices in West Java broiler farms. *Preventive Veterinary Medicine.* 176:104910. ISSN: 0167-5877. https://doi.org/10.1016/j.prevetmed.2020.104910

JING F, Yin G, Liu X, Suo X, Qin Y. 2012. Large-scale survey of the prevalence of *Eimeria* infections in domestic rabbits in China. *Parasitology Research*. 110(4):1495-500. ISSN: 1432-1955. https://doi.org/10.1007/s00436-011-2653-4

KYLIE J, Brash M, Whiteman A, Tapscott B, Slavic D, Weese JS, Turner PV. 2017. Biosecurity practices and causes of enteritis on Ontario meat rabbit farms. *The Canadian Veterinary Journal*. 58(6):571–578. ISSN 0008-5286. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5432143/pdf/cvj_06_571.pdf

LADRON DE GUEVARA OS, Perez-Rivero JJ, Perez-Martinez M, Flores-Perez FI, Romero-Callejas E. 2019. *Eimeria spp.* in broiler rabbit: seasonal prevalence in the backyard farms of the State of Mexico. *Veterinaria Italiana.* 55(2):183-187. ISSN 1828-1427. https://www.izs.it/vet_italiana/2019/55_2/VetIt_443_2154_3.pdf

OKUMU PO, Gathumbi PK, Karanja DN, Mande JD, Wanyoike MM, Gachuiri CK, Kiarie N, Mwanza RN, Borter DK. 2014. Prevalence, pathology and risk factors for coccidiosis in domestic rabbits (*Oryctolagus cuniculus*) in selected regions in Kenya. *Veterinary Quarterly*. 34(4):205–210. ISSN: 0165-2176. https://doi.org/10.1080/01652176.2014.978044

OLIVARES-PINEDA R, Gómez-Cruz MA, Schwentesius-Rindermann R, Carrera-Chávez B. 2009. Alternativas a la producción y mercadeo para la carne de conejo en Tlaxcala, México. *Región y Sociedad*. 21(46):191-207. ISSN 1870-3925. https://doi.org/10.22198/rys.2009.46.a482

PAKANDL M. 2009. Coccidia of rabbit: A review. *Folia Parasitologica*. 56(3):53-166. ISSN: 1803-6465. https://doi.org/10.14411/fp.2009.019

REYNOSO EU, Bautista LGG, Martínez JSC, López GAA, Romero CN, García VGR, Hernández PAG, Espinosa EA. 2019. Avnalysis of rotavirus in rabbits in the State of Mexico. *Revista Mexicana de Ciencias Pecuarias*. 10(2):511-521. ISSN: 2428-6698. https://doi.org/10.22319/rmcp.v10i2.4638

SECRETARÍA DE AGRICULTURA, GANADERÍA, DESARROLLO RURAL, PESCA Y ALIMENTACIÓN (SAGARPA). 2015. *Manual de buenas prácticas de producción de carne de conejo*. México. Pp 64. https://drive.google.com/file/d/10zq65tCQdT4x6mBOMKzQy01XZWCtTY4M/view

SAS Institute. 2012. Statistical Analysis Software SAS/STAT®, versión 9.0.2, Cary, North Carolina, USA: SAS Institute Inc., ISBN: 978-1-60764-599-3. http://www.sas.com/en_us/software/analytics/stat.html#

SECRETARÍA DE AGRICULTURA Y DESARROLLO SOCIAL (SADER). 2016. *Todo sobre la producción de carne de conejo.* México. https://www.gob.mx/agricultura/es/articulos/conoce-todo-sobre-la-produccion-de-carne-de-conejo

TANQUILUT NC, Espaldon MVO, Eslava DF, Ancog RC, Medina CDR, Paraso MGV, Domingo RD, Dewulf J. 2020. Quantitative assessment of biosecurity in broiler farms using Biocheck.UGent in Central Luzon, Philippines. *Poultry Science*. 99(6):3047-3059. ISSN: 0032-5791. https://doi.org/10.1016/j.psj.2020.02.004

YIN G, Goraya MU, Huang J, Suo X, Huang Z, Liu X. 2016. Survey of coccidial infection of rabbits in Sichuan Province, Southwest China. *SpringerPlus.* 5:870. https://doi.org/10.1186/s40064-016-2586-6

YOUSSEF DM, Wieland B, Knight GM, Lines J, Naylor NR. 2021. The effectiveness of biosecurity interventions in reducing the transmission of bacteria from livestock to humans at the farm level: A systematic literature review. *Zoonoses and Public Health*. 68:549-562. ISSN:1863-2378. https://doi.org/10.1111/zph.12807

ZAJAC AM, Conboy GA. 2012. Veterinary Clinical Parasitology. Eight Edition. Wiley-Blackwell, Reino Unido. Pp. 354. ISBN 978-0-8138-2053-8.