



Effect of Two Species of Ticks and Lice on Some Blood and Biochemical Parameters and their Role in the Transmission of Toxoplasma Gondii to Turkey Meleagris Gallopavo during Spring and Summer Seasons in AL-Diwaniyah Province – Iraq

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Abstract

AL-Diwaniyah governorate was the research place, where the study was conducted in during spring and summer seasons from the start of March 2017 to the end of October 2018. 120 turkey birds were selected from some districts and areas of AL-Diwaniyah governorate such as AL-Diwaniyah, AL-Shamiya, AL-Daghara, AL- Sanniyah, AL-Hamza and Afak, With 20 birds per region (10 per season). Two species of ticks: *Argus persicus* and *Dermacentor variabilis* were diagnosed with 15% and 18.3% respectively, and two species of lice: *Gonicotes gallinae* and *Menacanthus stramineus* with 37.5% and 27.5% sequentially. The results showed a significant increase in the Infection of ticks and lice in spring compared to summer, where the rate of infection of tick and lice was 51.66% and 85%, respectively, while infection rate in summer was 23.33% and 35%, respectively. Infection by lice was high during spring in the areas of AL-Dagara, AL- Saniyah, and AL- Hamza . It was observed that there increasing in the numbers of isolated lice species in these areas in comparison with the number of tick, whereas the lowest rates of infection by ticks and lice were in the province center. The results revealed a significant decreasing ($P < 0.05$) in the concentration of Hb, the volume of PCV and the total number of RBC of infected birds compared with non-infected, while a high significant increasing was observed in the total number of WBC of infected birds in comparison with non-infected ones. The results of biochemical parameters of serum showed a significant decrease $P (0.05)$ in the values of total protein concentrations, cholesterol and glucose of the infected birds' serum. The lowest values were for infected birds with lice, followed by tick compared to control. Eye examination of the skin and feathers of infected birds illustrated the presence of important changes such as the fall; fracture and lack of feathers completely in some areas of skin as well as wounds, scratches, and bleeding were clearly observed. The results of polymerase chain reaction (PCR) of tick *A. persicus* and lice *M. stramineus* tissues showed that diagnostic gene B1 (399bp) of *T.gondii* was present in 20 samples of the total number. This indicates the presence of this parasite in its tissues and ability to transmit it.

Keywords: Turkey, Tick, Lice, PCR,

Introduction

Turkeys are wild birds that human farmed and aviculture all over the world. They live in the form of small swarms and feed on seeds, fruits and insects¹. Turkeys are infected with two species of parasites: ectoparasites and endoparasites. The risk of ectoparasites is almost as high as the risk of endoparasites due to the widespread of these parasites as well as their high reproductive efficiency and ability to tolerate inappropriate conditions and hiding, which made them fatal bird

parasite² parasites belong to phylum arthropoda, which is divided into two division: arachnida class, including mites, ticks, and scorpions Both us and Insect a Classes include lice, fleas, Mosquitoes, and flies³. The presence of ectoparasites in infected birds is either in a permanent or temporary manner. Tick and Lice are one of the most Common ectoparasites in birds. They play a key role in the life of birds and considered as vectors⁴. 40 species of lice and

ticks that parasite on all areas of the bird's body, accounting for economic losses in poultry breeding fields⁷. Ticks belong to Acarina class and their entire species are mandatory ectoparasites specialized on their hosts such as birds, reptiles, and eggs. Ticks are temporary ectoparasites, feeding on blood, causing many problems for infected bird such as anemia, as well as vectors for many pathogens⁵. Lice are one of the most common ectoparasites of birds and are permanent parasites.

They feed on blood absorption as well as feeding on skin and feathers, so they threaten the lives of their hosts⁶ causing large number of bird's fatalities. Lice have a vital role in transmitting various pathogens which give rise to decrease the productivity of infected birds³. *Toxoplasma gondii* is a protozoa and obligatory parasite, so it is intracellular parasites, causing toxoplasmosis which is a zoonotic disease⁸. It has three stages. Cats are its final host, while mammals, birds and insects are intermediate hosts⁹.

The role of ectoparasites such as ticks and lice in the transmission of *T. gondii* to turkeys has not been of great importance to researchers, despite the large number of infections recorded in other birds, including chickens. In view of the lack of studies on the possibility of ticks and lice ability to transmit *T. gondii*, a molecular technique such as polymerase chain reaction (PCR) was used in the investigation and detection of this parasite .

Material and Methods

Study Area

AL-Diwaniyah province was our research place, where the study was conducted in during spring and summer seasons from the start of March 2017 until the end of October 2018. 120 turkey birds were selected from

some districts and areas of AL-Diwaniyah governorate such as AL-Diwaniyah, AL-Shamiya, AL-Daghara, AL-Saniyah, AL-Shamiya, AL-Hamza and Afak. 20 birds per region (10 per season). All of these birds were then examined to investigate infected birds, whereas Non-infected birds were used as control samples for comparison purposes.

Collection of Samples

Ectoparasites, such as ticks and lice were collected manually and very accurately. All parts of infected bird's body were examined to isolate them by magnifying glass and using forceps. They were then placed in special containers containing 70% alcohol. The samples were then placed in glass tubes containing 5 KOH solutions for 3-5 days for lice and larval stages of ticks and for 12-10 days for adult ticks until all models become transparent.

The models are then transferred to a progressive concentration of alcohol starting at 70% and ending 100% by 24 hours per concentration and placed in clean petri dishes it is accompanied by pressure from both dorsal and the abdominal sides by two glass slides. It was loaded on special glass slide prepared for this purpose and placed on slide contains Canada balsam and the lid of slide is placed¹⁰. Part of them was sent to the Museum of Natural History for the purpose of classification.

Detection of *Toxoplasma Gondii* by PCR

Primers

The primers of this study were designed to diagnose *Toxoplasma gondii* by using PCR techniques. Gen Bank-NCBI was relied to design primers, where primer3plus program was used for primers designing. Primers were provided by Korea's Pioneer company Table (1).

Table 1: T. gondii primers used in the study and their nucleotide sequence

Primer	Sequence		qPCR product size	GenBank Code no.
<i>Toxoplasma gondii</i> B1 gene	F	GAACCACCAAAAATCGGAGA	399bp	AF179871.1
	R	GATCCTTTTGCACGGTTGTT		

PCR Test Procedure

To detect and investigate the presence of *T. gondii* in the tissues of *A. persicus* and *M. stramineus* samples, PCR was used for this

aim by determining the presence of a B1 gene in their tissues to study whether they act as turkey parasite vectors .DNA was extracted from tick and lice samples, based on¹¹, a group of lice and ticks were crushed

individually by sterilized sticks prepared for this purpose.

DNA extraction process was then carried out according to the instructions of processed company. After extraction process, extracted DNA was preserved at -20 ° C until use in PCR technique, then the presence and concentration of DNA was examined by Nanodrop spectrophotometer. Polymerase reaction was then carried out by using PCR thermo cycler. Finally, electrophoresis was conducted using a 1.5-agarose gel to read the result of PCR product analysis.

Blood Test

Blood was withdrawn from all infected and non-infected birds (control group) by 5 ml syringes and was divided into two parts. The first section: Blood was placed in EDTA tubes

for tests such as Hb Hemoglobin Concentration. The volume of blood cells (PCV Packed Cell Volume), the total number of white blood cells (WBC) and red blood cells (RBC). Section II: blood was placed in anti-clotting to get blood serum, where it left a period of time until blood aggregates and then placed in centrifuge at 3000 cycles/minute for 15 minutes. Serum was isolated in other sterile tubes and prepared for this purpose and was kept in frozen at a temperature of 20 °C until tests such as measuring the concentration of the total protein, glucose and Cholesterol. Blood tests were conducted in the laboratories of faculty of sciences, Department of Biology/ Qadisiyah University and in the veterinary hospital of AL-Diwaniyah governorate.

Results and Discussion

Table 2: Numbers and rates of turkeys infected by ticks and lice

No. of Ectoparasite	Parasite	No.of tested samples	No.of tested samples	Rate (%)
Ticks	<i>Argus persicus</i>	120	18	15
	<i>Dermacentor variabilis</i>	120	22	18.3
Lice	<i>Goniocotes gallinae</i>	120	45	37.5
	<i>Menacanthus straminus</i>	120	33	27.5

The results in Table (2) point out those 120 birds of turkey in AL-Diwaniyah province has been infected with two species of ectoparasite are ticks and lice. Two species of ticks: *Argus persicus* and *Dermacentor variabilis* were isolated by 15% and 18.3% respectively, and two species of lice: *Goniocotes gallinae* and *Menacanthus straminus* with 37.5% and 27.5% respectively. The results of this study agreed with¹², where they were able to isolate this species of lice parasitic on turkeys in DhiQar governorate by 37.82%, which is a very close result to the current study.

This species of lice is called the fuzzy feather plume for its presence in many area that contain dense feathers such as abdomen, back and under wings. The reason for its presence in these areas may be due to the appropriate conditions such as warm and moisture necessary for growth and hatching eggs, this species of lice is nesting on most Poultry in Iraq and the world.

These results were similar to what¹³ mentioned in the study of turkeys in AL-Diwaniyah governorate, where she isolated this species by 10%, whereas the species of lice and ticks *Menacanthus straminus* and *Argus persicus* by 2% each. These

percentages are less than those in the present study. This may be attributed to the difference in the number of examined birds as well as the difference in climatic factors. They also agreed with¹² in their study of ectoparasites on 119 turkey birds in Dhi Qar Governorate. They were able to isolate *Goniocotes gallinae* by 37.82%, which is very similar to what we found in our study.

The second species of lice *Menacanthus straminus*, which is one of the most important species of lice that affects poultry and the reason is due to the shortness of life cycle, activity, and fast movement^{14,15} observed the presence of this species parasitic on turkeys In the United States of America and by 12.5%. In the same US state¹⁶ recorded 4.4% less than in the current study. In contrast¹⁷ recorded a very high variance in France which is 62.25%.

Menacanthus straminus was isolated by¹⁸ parasitic on local chickens in province of AL-Diwaniyah; Infections may be due to the presence of these birds near each other. These two species of lice are not only turkey's parasites but were observed in different types of poultry. Locally¹⁸ isolated two species of lice *Menacanthus straminus* and *Goniocotes gallinae* from local chickens in AL-Diwaniyah

governorate with 66% and 15%. The results also showed that turkeys infected by two species of ticks: *Argus persicus* and *Dermacentor variabilis*. This result was agreed with¹³ in her study of 50 birds of turkey in AL-Diwaniyah governorate. She isolated two species of ticks: *Argus persicus* and *Haemophysalis sp. Nymph* (2 % each) *Argus persicus* has a global spread and does not specialize on a particular species of bird. It was observed in most poultry¹⁰. This species aslo isolated from pigeon by¹⁹ in AL-Diwaniyah province, with an infection rate of 1%.Globally, the results were closed to those achieved by¹⁶, where they isolated two

species of parasites from turkeys in California, USA, which included a species of tick similar to the isolated one in this study, *Dermacentor variabilis* (1%) and the species of lice *Menacanthus straminus* By 4.4%, both of which are much lower than those in the present study. The differences among results of researches may be due to study areas, number of tested birds and climatic factors, which play a large role in high and low rates of infection. This tick does not infect Turkey only, but could infect a large group of mammals and parasites on dogs causing great harm to them; this is confirmed by²⁰ in the United States.

Table 3: Numbers and rates of isolated ticks and lice from turkey

Ectoparasite		Number	Rate (%)
Ticks	<i>Argus persicus</i>	37	61.6
	<i>Dermacentor variabilis</i>	23	38.3
Total number of ticks		60	
Lice	<i>Gonicotes gallinae</i>	115	56.6
	<i>enacanthus straminus</i>	88	43.3
Total number of lice		203	

The results in Table (3) revealed that the number of lice isolated from birds was the highest compared to ticks. The number of lice was 203 distributed by (115 and 88 for the above two species and 56.6% and 43.3%, respectively), whereas the number of ticks was 60 distributed by (37, 23, and 61.6%, respectively, 38.3%). The presence of these parasites on the bird's body may be due to

their nature of living and life cycle .The increasing of numbers and widespread may be due to the shortness of life cycle and the large numbers of eggs that are placed by females ²¹ .The lack of numbers of ticks on the body of birds because they fall from birds body after taking a sufficient blood meal and complete their life cycleaway²².

Table 4: The rates of turkey spread infected by tick and lice according to region and season

Regions	Season	No .of tested samples	No. of infected for each season		Rate (%)	
			Ticks	Lice	Ticks	Lice
AL-Diwaneyah	spring	10	3	4	30	40
	summer	10	1	1	10	10
AL-Daghara	spring	10	6	10	60	100
	summer	20	2	5	20	50
AL-Saniyah	spring	10	5	10	50	100
	summer	10	1	4	10	40
AL-Hamza	spring	10	7	10	70	100
	summer	10	3	2	30	20
AL-Shamiyah	spring	10	4	8	40	80
	summer	10	3	4	30	40
Afak	spring	10	6	9	60	90
	summer	10	4	5	40	50
Total	spring	60	31	51	51.66	85
	summer	60	14	21	23.33	35

The results of table 4 pointed out that turkeys were infected by ticks and lice in six districts in AL-Diwaniyah governorate during spring and summer seasons, where the highest rate was by lice and followed by ticks and in spring season compared with summer. The highest rate of infection by lice was 100% during spring in the areas of AL-dagara, AL-Saniyah, and AL- Hamza, while the lowest rates were during summer.

Related to ticks, the highest rate was 70% during spring in the area of AL-Hamzah , while the lowest rates of infection was 10%during the summer season in AL-Diwaniyah and AL-Saniyah. The differential rates of infections among areas may due to environmental nature, where it was higher in country than city. The increasing in the rates of lice and ticks during spring may be due to the favorable weather conditions in

spring, such as moderate temperatures and moisture availability which are ideal conditions for development and reproductions. The results of the study agreed with²³ in his study on the parasitic parasites of the turkeys in Republic of the Czech Republic. He observed an increasing in

the severity of infection during spring, especially in April, due to ideal weather conditions for growth and reproduction, as low rates of infection during summer months because of appropriate conditions such as high temperatures, which caused the reduction of activity of these parasites.

Table 5: Mean and standard error $\bar{X} \pm SE$ of some parameters of turkey blood infected by ticks, lice and non -infected (control)

Test Group		Hb (Mg/100ml)	PCV (%)	RBC (10^6 Cell/Mm ³)	WBC (10^3 Cell/Mm ³)
Infected	Lice	8.81 ±0.95 7.71-9.92	23.36 ±1.76 22.11-24.62	2.39 ±1.21 2.11-2.67	25.32±0.91 24.53-26.11
	Ticks	9.47 ±1.01 8.83-10-11	24.18 ±1.38 23.13-25.23	2.87 ±0.92 2.62-3.12	23.11±0.91 22.54-23.69
Control		11.15 ±0.78 10.77-11.53	30.88±1.82 30.25-31.52	3.54±2.77± 3.22-3.86	20.54±0.91 20.21-20.88

Blood tests are considered one of the pathological indicators. The results in table (5) showed significant differences in blood tests among turkeys infected with lice and ticks and non-infected ones. It was observed a significant decrease in the concentration of Hb P (0.05), the volume of PCV and the total number of RBC compared to non-infected birds. The reason may be that these parasites are directly fed to the infected bird's blood

causing anemia and hemorrhage due to skin tissue rupture and because of itching and brushing by birds² It was also observed that there was a significant increase in the total number of white blood cells (WBC) in infected cats and lice compared to non-infected .The reason may due to an increase in the activity of the immune system and its response to infection by ectoparasites²⁴ in addition to inflammations caused by ectoparasites²⁵.

Table 6: Mean and standard error $\bar{X} \pm SE$ of some biochemical parameters of turkeys infected by ticks, lice and non-infected (control)

Test Group		Total protein	Cholesterol	Glucose
Infected	Lice	2.50±0.34 2.12-2.89	72.36±0.81 70.32-74.41	146.73±1.99 144.64-148.83
	Ticks	3.10±0.21 2.89-3.31	72.36±0.81 70.32-74.41	166.97±0.99 166.87-167.51
Control		4.37±0.16 3.87-4.87	126.64±0.57 123.55-129.73	187.87±1.50 186.84-188.11

The results in Table (6) illustrated the effect of ectoparasites such as lice and ticks on some biochemical parameters of blood serum, where there was a significant decreasing (P < 0.05) in total protein concentration, cholesterol and glucose levels in infected birds. The lowest values were by lice and then followed by tick compared to control, which achieved the highest values.

The reason of low concentration of total protein and glucose is the lack discomfort and loss of appetite for food, while low cholesterol may be belong to liver disorder and failure of cholesterol building due to the direct and indirect the effect of parasite on the infected bird and the toxic effects of parasites secretions in blood^{26,27}.The results of this

study agreed with²⁹ in her study on local chickens infected experimentally by lice, where the values of glucose and cholesterol were decreased, but the rates of total protein values increased. This attributed to body's requirement for proteins as objects to control the risk of parasites.

Eye Changes

The presence of changes in skin caused by infection such as the fall of feathers and break others was observed through the examination of birds infected by ectoparasites , where some areas appeared barren without feathers as well as wounds, scratches ,and bleeding due to bird scratch to his skin by beak. Images (1)and(2).



Image 1: Feather loss and appearance of featherless areas in birds infected by lice



Image 2: broken feathers of birds infected by lice

Molecular Detection by Using PCR

The outcomes of polymerase chain reaction for 35 lice *menacanthus straminus* and 20 ticks *Argus persicus* samples collected from turkeys referred to the presence of 22 and 8 positive samples of both lice and ticks with percentages amounted to 62.8% and 40% Respectively. This confirmed the presence of parasite as shown in Table (7) and images (3) and (4). The results of the current study agreed with the investigations of ²⁸AL-Lebawi (2015) in her study on the lice collected from local chickens in AL-

Diwanayah province, confirming the presence of parasite in *Menacanthus straminus* lice tissue by 57.57% by using PCR which is very close to the result to the current study. Worldwide, these results agreed with²⁹. This species of lice is considered one of the most important reservoirs and carrier for these parasites especially in poultry. Many local and international scientific papers pointed out that poultry are exposed to infection by these parasites, as well as its presence in its blood and tissue due to the parasitism of infected lice such as^{18, 30}.

Table 7: The number of tested and positive samples of lice and tick and the presence of B1 gene of *T.gondii* in *M. stramineus* and *Argus persicus* tissues by using PCR

Parasite	No.of tested samples	No.of positive samples	Rate (%)
<i>Menacanthus straminus</i>	35	22	62.8
<i>Argus persicus</i>	20	8	40

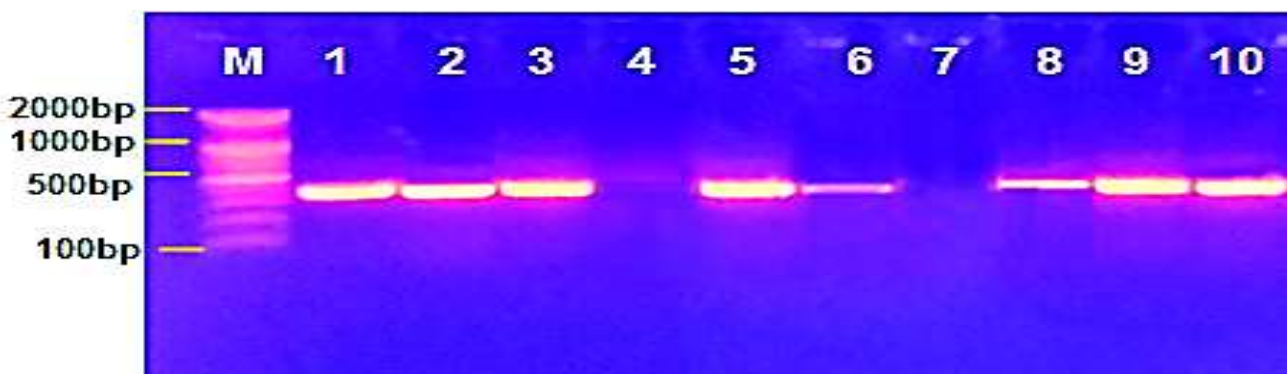


Figure 3: Electrophoresis of DNA samples from (1-10) of *M.stramineus* on agarose gel at concentration (1.5%). The results of PCR of B1 gene for the diagnosis of *T.gondii* are shown. 3,2,1 10,9,8,6,5, Samples are positive samples ,while 7 and 4 samples represent negative ones

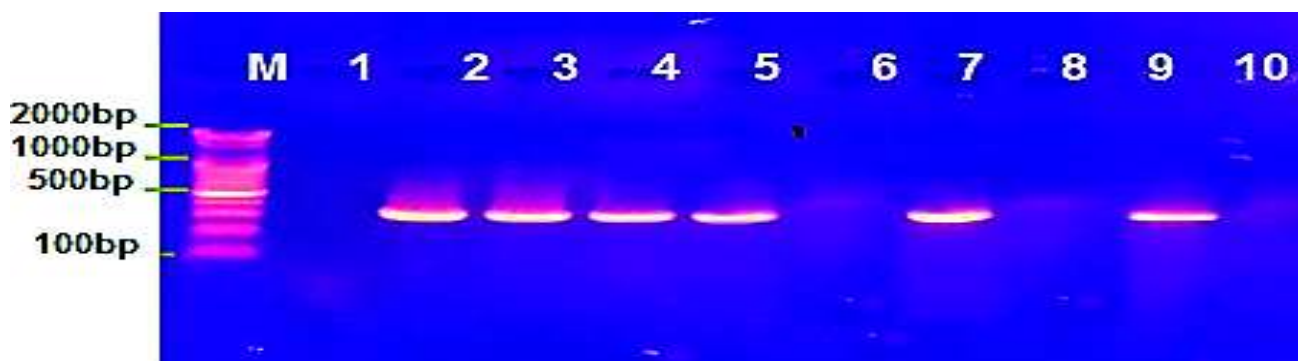


Figure 4: Electrophoresis of DNA samples from (1-10) of *Argus persicus* on 1.5% agarose gel, where the results of PCR of B1 gene related to the diagnosis of *T.gondii* are shown. 3,2,1,9,7,5,4 Samples represent Positive samples, whereas 8 and 6 samples represent negative ones

References

- Gardner S, T Blankenship, J Decker (2004) Strategic plan for wild turkey management. State of California, the Resources Agency, Department of Fish and Game, Sacramento, California, 41.
- Permin A, Hansen JW (1998) Epidemiology, diagnosis and control of poultry parasites FAO Animal Health Manuals 4. Rome Food and Agriculture Organization of the United Nations (FAO). 160.
- Al-Bahi, Muhammad (2005) External parasites of the animal and methods of elimination, Faculty of Agriculture and Veterinary Medicine, Qassim University: 5 p.
- Awad AH, Abdullah BH, Al-Mayah SH (1994) Some nematodes parasitized in seven species of aquatic birds in Basrah, Iraq. Basrah J. Sci., Ser. B, 12(1): 64-69.
- Keirans JE, Durden, LA (2005) Tick systematics and identification In: Goodman, J.L.; Dennis, D.T.; Sonenshine, D.E., editors.. Tick-Borne Diseases of Humans. Washington, DC- ASM Press. 401.
- Borror DJ, Triplehorn CA, Johnson JF (1989) An Introduction to the Study of Insects. 6th ed. Saunders, Philadelphia. Brazilian Purpuric Fever Study Group. Brazilian purpuric fever identified. in a new region of Brazil. J. Inf. Dis., 165(1): 16-19.
- Saif YM, Barnes HJ, Glisson JR, Fadly AM, Mc Dougal, CR Swagne DE (2003) Diseases of Poultry. 11th ed. Iowa State Press, Black well publishing Co.
- Kim K, Weiss LM (2004) *Toxoplasma gondii* the model apicomplexan. Int. J. Parasitol., 34: 423-432.
- Karatepe B, Bahur C, Karatepe M, Kilic S, Bundar B (2008) Prevalence of *Toxoplasma gondii* antibodies and intestinal parasites in stray cats from Nigde, Turkey. Italian J. Anim. Sci., 7: 113-118.
- Soulsby EJ (1982) Helminthes, Arthropods and protozoa of. Domesticated Animals. 7th ed., Bailliere Tindall, London, UK.
- Sanei Dehkordi, A Rassi, Y Oshaghi, MA Abai, MR Rafizadeh, S Yag- hoobi, MR Mohebali, M Zarei, Z Mohtarami, F Jafarzadeh, B Ranj, barkhah A, Javadian E (2011) Molecular Detection of *Leishmania infantum* in naturally infected phlebotomus perfilli in transcaucasica in Bilesaver District, Northwestern Iran. Iran J. Arthropod-Borne Dis.: 5(1) 20-27.
- Flaiyyh MM, Kadhim FS (2014). Identification chewing lice (*Gonicocotes gallinae*) in Mealignis Gallopavo in some areas Thi-Qar governorate. Thi-Qar J. Agric. Res., 1 (3) : 99-110.
- Al shabani H, Abdulzahra (2015) Diagnostic and Taxoomical study of Turkey (*Meleagris gallopavo*) Parasites in AL-Qadisiya Province Ph.D. Thesis. College of Edu. Univ. of AL-Qadisiya. 114p.
- Wall R, Shearer D (1997) Veterinary Entomology Arthropod Ecto- parasites of veterinary Importance .Chapman & Hall,15.
- Lane RS, Kucera TF, Barrett RH, Mun J, Wu C, Smith VS (2006) Wild Turkey (*Meleagris Gallopavo*) As A Host of Ixodid Ticks, Lice, and Lyme Disease Spirochetes (*Borrelia burgdorferi* Sensu Lato) in California State Parks. J. wildlife. Dis., 42 (4): 759-771.

16. Robert SL, Thomas FK, Reginald H, Barrett Jeomhee M, Chunling W, Vincent SS (2006) Wild turkey (*Meleagris gallopavo*) as a host of ixodid Tick, Lice, and Lyme disease spirochetes in California state parks. *Journal of Wildlife Diseases*, 42(4): 759–771.
17. Salifou S, Natta YA, Odjo AM, Pangui LJ (2008) Arthropodes ectoparasites du dindon (*Meleagris gallopavo*) dans le nord-ouest du Bénin. *Revue Elev. Med. Vet. Pays trop.*, 61(3-4): 185-189.
18. Al-Jubouri SAA (2010) Endo and Ectoparasitic infections in domestic fowl *Gallus gallus domesticus* (Linnaeus, 1758). In: Al-Diwaniya city. M.Sc. Thesis, College of Education, University of Al Qadisiya, Iraq.
19. Al-Shaibani KTM (2008) Isolation and diagnosis of ectoparasites and worm's parasites in the digestive system of *Columba livia* (Gmelin, 1789) in Al-Diwaniya city. M.Sc. Thesis, College of Education, University of Al Qadisiya, Iraq. 138.
20. Mulengu A, Macaluso KR, Simser JA, Azad A (2003) The American dog tick, *Dermacentor variabilis*, encodes functional histamine release factor homolog. *Insect Biochem Mol Biol.* 33(9):911-9.
21. Bush SH, Clayton DH (2006) The Role of Body size in host specificity reciprocal transfer Experiments with Feather lice. *Evolution*, 60(10): 2157-2167.
22. Calnek BW, Barnes HJ, McDougald LR, Beard CW, Salf YM (1991) Diseases of poultry. Publisher Ames. Press. Iowa, USA. 1080.
23. Sychra O (2005) Chewing Lice (Phthiraptera: Amblycera, Ischnocera) from chukars (*Alectoris chukar*) from a pheasant farm in Jinacovice (Czech Republic). *Vet. Med.*, 50 (5): 213-218.
24. Wikel, SK (1996) *The Immunology of Host-Ectoparasitic Arthropod Relationships*, CABI, Wallingford, UK. 331.
25. Rick LC, Elsevier M (2004) *Veterinary clinical pathology secrets 2nd ed*, Elsevier Mosby Missouri: 282-301.
26. Machado CM (2002) Crescimento do Tecido Adiposo. In: Macari, M.; Furlan, R.L and Gonzales, E. *Fisiologia aviária aplicada a frangos de corte*. Jaboticabal: FUNEP-UNESP. 375.
27. Freeman BM (1970) Carbohydrate stores in chickens infected with *Eimeria tenella*. *Parasitology*, 61(1):245-251.
28. AL-Lebawi, F IM (2015) Haematological, Biochemical and Histopathological changes in experimentally infected local chickens with Biting lice, and its relationship in transmission of *Toxoplasma gondii* in chickens. A Thesis Master, College of Education / University of AL-Qadisiya. 80.
29. Saxena AK, Agarwal GP, Chandra S, Singh OP (1985) Pathogenic involvement of Mallophaga. *Zur angewandte Entomologi.* 99:294-300.
30. Asgari O, Farzaneh A, Kalantari M, Akrami Mohajeri, F Moana, M Zarifi, M Esmaeil-zadeh, B Motazedian MH (2006) Seroprevalence of free-ranging chickens toxoplasmosis in sub-urban regions of Shiraz, Iran. *J. Poult. Sci.* 5:262-264. Shiraz, Iran. *J. Poult. Sci.* 5:262-264.

