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# Effect of Poultry Production System on Infection with Internal Parasites in “Baladi” Layer Hens of Northern West Bank, Palestine

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### Authors' contributions

This work was carried out in collaboration between both authors. Author RO designed the study and managed the collection of samples and laboratory work. Author JA managed the analysis of the study and prepared the tables of results. Both authors managed literature searches and participated in preparing the manuscript. Both authors read, reviewed and approved the final manuscript.

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## ABSTRACT

**Aims:** To study the effects of poultry production systems on prevalence of internal parasites in hens of the Baladi breed in Northern West Bank, Palestine. The study is important to provide basic information essential to design appropriate parasitic control and prevention measures.

**Methodology:** A survey study of internal parasites in Baladi layer hens was conducted in five villages of Northern West Bank, Palestine. Fecal samples were collected between September 2015 and April 2016 from 240 Baladi hens raised under four production systems (single-tier cages, double-deck cages, floor, and free range systems). The samples were examined for infection with internal parasites using the sedimentation and flotation techniques. Infection rates and their 95% confidence intervals were calculated and comparisons among production systems were performed

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using logistic regression and Pearson's Chi-square test.

**Results:** The results showed that 102 samples (42.5%) were positive for one or more types of internal parasites. The types of detected internal parasites were nematodes (25.4% *Ascaridia galli*, 11.7% *Heterakis gallinarum*, and 3.3% *Capillaria* spp.), cestodes (*Raillietina* spp., 8.3%), and protozoa (*Eimeria* spp., 4.2%). Of the parasitic infections, 73.5% were nematodes, 10.8% were cestodes, 6.9% protozoa, and 8.8% were mixed species. Prevalence rates were 23.3%, 40.0%, 50.0% and 56.7% in single-tier cages, double-deck cages, floor system and the free range system, respectively. Hens raised in double-deck cages had odds ratio of infection of 1.999 ( $P = .08$ ) compared to single cages, while hens raised in floor and free range systems had odds ratios 2.999 ( $P = .005$ ) and 3.923 ( $P < .001$ ) compared to single cage system.

**Conclusion:** This study showed that hens reared in floor and free range systems had higher risk of parasitic infection than hens reared in cages indicating a higher need for appropriate prevention and control measures in these systems compared to cage systems.

**Keywords:** Internal parasites; production system; Baladi; layer hens; Palestine.

## 1. INTRODUCTION

The poultry industry plays an important role in Palestinian agricultural economy (40% to 50% of the income of the animal production sector and 12% to 15% of the total agricultural income) [1]. Currently, egg production in Palestine is mostly from commercial farms raising White Leghorn strains under intensive production systems (cage systems). The 2010 agricultural statistics showed that the total population of layer hens in Palestine was 2.32 million including 260 thousand hens of the local (named Baladi) breeds [2]. Baladi hens are dual-purpose (egg and meat), unimproved and characterized by their small size, have different plumage colors and different comb shapes and also known for their low production rate (less than 100 eggs per year) and small egg sizes, and generally reared under traditional extensive systems [3,4]. In Palestine, Baladi hens are raised in small numbers mostly in rural areas and generally fed and taken care of by women. They are mainly raised for family consumption of eggs (and meat of male chicks) with extra production sold to neighbors or in the local markets. In recent years, there has been an increased interest (particularly in Northern West Bank) in raising Baladi hens for commercial purposes. Baladi hens are generally reared in floor and free range systems where feeding is based on household food wastes (rice, vegetables, etc), scavenging, and in some cases (e.g., winter time) commercial concentrate feed may be used as supplement. Rearing Baladi hens in cage systems (single tier and double deck), where feeding is mainly based on concentrates, is less common than the floor and free range systems.

Rearing hens under traditional extensive systems without health care programs makes them prone to infection with parasites [5-8]. Parasitic infection causes important economic losses due to lowered growth and egg production and increased susceptibility to other diseases [5,6,8-13]. The most common external parasites in layer hens include lice, fleas, ticks, and red mites while helminths are the most important internal parasites. There is currently lack of studies on the types of internal parasites and their prevalence in Baladi hens in Palestine. One study in Gaza Strip [14] identified three nematodes (*Ascaridia galli*, *Heterakis gallinarum*, and *Capillaria* spp.) and two cestodes (*Raillietina echinobothrida* and *Choanotaenia infundibulum*) in free range Baladi chicken. These nematode and cestode parasites were also the most prevalent in local chicken of neighbor countries [15-17].

While vaccination against important epidemic poultry diseases (like Newcastle) is widely practiced in commercial poultry farms in Palestine, control and prevention measures against internal parasites are practically absent in both traditional and commercial production. This study was carried out to investigate the types and prevalence of internal parasites in Baladi hens reared in Northern West Bank and to compare infection rates among four types of production systems (single-tier cages, double-deck cages, floor, and free range systems). To our knowledge, this is the first study concerning internal parasites of chicken in the West Bank and provides essential information to design and implement appropriate control and prevention measures in Palestine.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The study area is in the Northern part of the West Bank, Palestine. The West Bank is located 31°56'48" N, 35°18'10" E and has a total area of about 5900 km<sup>2</sup>. The altitude varies from 408 m below sea level to 1022 m above sea level. It has warm to hot summers and mild to cold winters. The study covered two villages in the district of Nablus (Aseera Alshamaleyeh and Yaseed) and three villages in the district of Jenin (Aqaba, Mythaloon, and Yabad). Four farms were selected per village, one farm in each of the four common egg production systems in the West Bank: single-tier cages, double-deck cages, floor, and free range production.

### 2.2 Collection of Fecal Samples and Parasitological Examination

Twelve hens were randomly sampled from each farm in each production system (total of 240 hens). Age was not determined for individual birds (no records were available), but according to approximate information by farmers, age of sampled birds roughly ranged from six months to two years. Fecal samples were collected directly from the cloaca of hens in the period between September 2015 and April 2016. The samples were collected in plastic vials and kept at 4°C till examination. The samples were examined for color, texture, presence of worms, mucus or blood [18]. The samples were examined for presence of eggs of helminths and coccidian ova using the sedimentation and flotation techniques (with NaCl solution used in the flotation method). Two-gram feces per sample were suspended in 45 ml of sodium chloride floatation fluid and poured through a tea filter. The filtrate was then transferred into a test tube and covered with a cover slip for 30 minutes. The cover slip was then carefully removed and placed on microscopic slide for examination under 10X magnification. The types of parasites were identified based on the characteristics described by other research [18-20].

### 2.3 Litter Cleaning Survey

In addition to collection of fecal samples, the owners of farms of sampled hens were asked about litter cleaning frequency and the results were recorded for each farm.

### 2.4 Statistical Analysis

The infection status of each sample and each type of parasite was recorded (coded as 0 = not infected or 1 = infected). Prevalence of internal parasites (the proportion of infected samples) was calculated for each production type (single-tier cages, double-deck cages, floor, and free range systems) and type of parasites identified. The 95% confidence intervals for estimates of the proportion infected were calculated based on a normal approximation as:

$$\hat{p}_i \pm 1.96 \sqrt{\frac{\hat{p}_i(1-\hat{p}_i)}{n_i}}$$

(where  $\hat{p}_i$  and  $n_i$  are the estimated proportion of infected samples and the number of tested samples for the  $i^{\text{th}}$  production system or infection type when type of parasite is concerned, respectively).

To test differences in prevalence of internal parasites among production systems, a binomial (logistic) regression was performed on the binary data (0 = not infected, 1 = infected) with the logit used as link function. The odds ratios (with the single cage system used as base reference) were obtained for each production system and compared using Pearson's Chi-square test. The statistical analysis was carried out using the Statistical Package for Social Sciences (SPSS) software, V16.0 [21].

## 3. RESULTS

Of all samples examined, 102 (42.5%) were infected with internal parasites. Of the 102 parasitic infections 75 (73.5%) were nematodes, 11 (10.8%) cestodes, 7 (6.9%) protozoa, and 9 (8.8%) mixed (Table 1). Internal parasites detected were 25.4% *Ascaridia galli*, 11.7% *Heterakis gallinarum*, 3.3% *Capillaria* spp., 8.3% *Raillietina* spp., and 4.2% *Eimeria* spp.

Infection rates (percentage of infected samples) were 23.3%, 40.0%, 50.0% and 56.7% in birds reared in single-tier cages, double-deck cages, floor system and the free range system, respectively (Table 2). With the single cage system taken as a reference, Baladi hens reared in double-deck cages had 1.999 higher odds of infection ( $P = .08$ ) with internal parasites than hens reared in single cages, while hens reared in floor and free range systems had respectively 2.999 ( $P = .005$ ) and 3.923 ( $P < .001$ )

higher odds of infection than single cage system (Table 3).

Litter cleaning is not practiced in 40%, 60%, 40%, and 80% of the farms in single-tier cages, double-deck cages, floor system and the free range system, respectively. Only 20% of the farms in single and double deck cage systems clean litter twice a year while 40% in the single-tier cages and 20% in the double-deck cages clean litter once a year. Only 20% of the farms in the free-range system and 60% in the floor system clean litter and only once a year (Table 4).

**Table 1. Infection pattern of internal parasites in Baladi layer hens in Northern West Bank, Palestine**

Pattern of infection	No. of infected samples	% of all infected samples *
Single infection		
Nematodes	75	73.5
Cestodes	11	10.8
Protozoa	7	6.9
Mixed infection	9	8.8

\*Out of 102 infected samples

#### 4. DISCUSSION

This study was carried out to investigate the prevalence of internal parasites in Baladi hens of Northern West Bank, Palestine and compare infection rates among the four common production systems. The results of the present study showed that hens reared in floor and free range systems had higher prevalence of internal parasites than birds reared in cages. The high infection rates in both free range and floor reared birds can be explained by the fact that these birds are exposed to various types of feed ingredients including insects and other materials that put them at risk of infection. Birds reared in

floor and free range systems have an increased chance to be in contact with eggs, larvae and intermediate hosts of internal parasites which increases infection rates. The wet feeds they often consume could add to the problem as a good media for infection agents [22-24]. The physical contact with wild birds and sharing the feed and water increases the incidence of infection in floor and the free range birds compared to birds in cages [6,14,25,26]. Litter cleaning is another factor which likely influenced the differences in prevalence rates among production systems as it has negative impact on infection [22]. Our study showed that litter cleaning is done less frequently in the floor and free range systems than cage systems with lowest frequency of cleaning in the free range system.

The overall prevalence rate found in this study (42.5%) was similar to those found in Nigeria (45.5%) and southeastern Ethiopia (41.4%), [26, 27] but much lower than the rates (68.8% – 100.0%) reported in other studies [6,13,14-17, 28-31]. The variations in infection rates in different studies may be due to type of rearing system and variations in the environment, management, and breed and age of birds [6,23, 25].

Different species of internal parasites were detected in this study including nematodes (*A. galli*, *H. gallinarum*, and *Capillaria* spp.), cestodes (*Raillietina* spp.), and protozoa (*Eimeria* spp.) with nematodes being the most prevalent. No trematodes were detected in this study which agrees with results from other studies in Gaza strip, Jordan, Egypt, and Iraq where no trematodes were detected in local chicken [14-17,32]. The absence of trematodes may be linked with their complex life cycle requiring an aquatic intermediate host which helps break the life cycle where water is absent and hence reducing the spread of the worms [32].

**Table 2. Infection rates with internal parasites in four different production systems of Baladi layer hens raised in Northern West Bank, Palestine**

Production system	No. of examined samples	No. of positive samples	Infection rate (%)	95% confidence intervals
Single-tier cages	60	14	23.3	(12.6, 34.0)
Double-deck cages	60	24	40.0	(27.6, 52.4)
Floor	60	30	50.0	(37.3, 62.7)
Free range	60	34	56.7	(44.1, 69.2)
Total	240	102	42.5	(46.2, 48.8)

**Table 3. Odds ratios of infection with internal parasites in four different production systems of Baladi layer hens raised in Northern West Bank, Palestine (results from the binomial logistic regression)**

Production system	$\beta$	SE( $\beta$ )	Odds ratio *	$\chi^2$	Significance of odds ratios (P value)
Single-tier cage	Ref.	-	1.00	-	-
Double-deck cage	0.6931	0.3979	1.999	3.03	.08
Floor	1.0986	0.3944	2.999	7.76	.005
Free range	1.3669	0.3959	3.923	13.58	.001

\*Odds ratio measures risk of infection for each level of the factor relative to the reference level (single-cage system).

**Table 4. Percentage (%) of Baladi layer farms according to litter cleaning frequency per year**

Poultry production system	Frequency of litter cleaning / year			
	None	Once	Twice	Three times or more
Single-tier cage	40.0	40.0	20.0	0
Double-deck cage	60.0	20.0	20.0	0
Floor	40.0	60.0	0	0
Free range	80.0	20.0	0	0

*A. galli* was the most prevalent (25.4%) followed by *H. gallinarum* (11.7%) which agrees with results from other studies [14, 23, 26-27, 29-30]. In Gaza strip, prevalence rates of 75.6% for *A. galli* and 68.9% for *H. gallinarum* were found in free range Baladi hens [14]. Estimates of 28% *A. galli* and 33% *H. gallinarum* were reported for local scavenging hens in Northern Jordan [16], while prevalence rates were 56.1% for *H. gallinarum* and 50.8% for *A. galli* in backyard-reared Baladi chickens in Upper Egypt [15]. Levels of infection with these parasites were variable in different countries and locations which may be related to environmental changes, season of the year, management as well as type of hens examined [14,23,24,26-29,33].

*Capillaria* spp. was the third type of detected nematodes but had the lowest prevalence among all detected types of parasites (3.3%). Low infection rates were also found for *Capillaria* spp. in Gaza (2.2%), Northern Jordan (0.5%) and Upper Egypt (3.5%) [14-16]. A study on house-reared chickens in Al-Dewania city of Iraq showed that *Capillaria* spp. was the third most prevalent parasite (13.6%) after *A. galli* (21.6%) and *Eimeria* spp. (15.2%) [17].

The infection with cestodes (*Raillietina* spp.) was estimated at 8.3%. This is a dangerous parasite which causes harm effects on health and performance of birds through diarrhea and hemorrhages of the small intestine. The infection rate with *Raillietina* spp. found in the present study was similar to the estimate of 6.4% in Iraq

[17] but was much lower than the estimates found in Gaza (50.7%) and neighbor countries (16% to 39.5%) [14-16]. The infection by *Raillietina* parasite is facilitated by the availability of intermediate hosts like ants, some insects and earth worms [26,27,30]. Similar variability in rates of infection was reported worldwide which was influenced by the factors mentioned earlier [6,8, 14,23,27,28,30,33,34]. Infection rate with protozoa (*Eimeria* spp.) was 4.2%. Protozoan infection is related to poor management and the favorable environmental conditions (temperature and humidity) that are important for the development of oocysts [20].

The results of this study are very important given the lack of information and the lack of programs for prevention and control of poultry internal parasites in the West Bank. To our knowledge, this is the first study of its kind in the West Bank and provides essential information to help design control and prevention measures against internal parasites in Palestine.

## 5. CONCLUSION

This present study showed that parasitic helminths are common in Baladi hens reared in Northern West Bank. A relationship was found between rearing system and infection rate with hens reared in floor and free range systems having higher risk of infection than hens reared in cages. Therefore appropriate prevention and control measures should be designed to reduce the effects of internal parasites of Baladi hens in

the West Bank. Given that floor and free range systems provide better welfare conditions for birds, peasants should perform more frequent cleaning and sanitation to reduce infection rates in these systems.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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