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Original Article

The efficacy of *Aloe vera* gel against coccidiosis in Japanese quails (*Coturnix coturnix japonica*)

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Noha B. Elbarbary[1*], Hanaa S. Ali[2], Arwa H. Nassar[3]

[1]Parasitology Department, Animal Health Research Institute (AHRI), Mansoura provincial Lab (AHRI-Mansoura), Agriculture Research Center (ARC), P.O. Box 264 Dokki, 12618 – Giza, Egypt.

[2]Pathology Department, Animal Health Research Institute (AHRI), Mansoura provincial Lab (AHRI-Mansoura), Agriculture Research Center (ARC), P.O. Box 264 Dokki, 12618 – Giza, Egypt.

[3]Food Hygiene Department, Animal Health Research Institute (AHRI), Mansoura provincial Lab (AHRI-Mansoura), Agriculture Research Center (ARC), P.O. Box 264 Dokki, 12618 – Giza, Egypt.

[*]Corresponding Author:
Dr./ Noha Elbarbary

Nohabeder@gmail.com

01060953716

ABSTRACT

Production of high quality poultry meat devoid of drug residues is a big challenge nowadays especially with presence of many diseases threatening poultry industry. Coccidiosis is one of the most important diseases affecting Japanese quails. In this trial we assed the efficacy of *Aloe vera* gel against coccidiosis in Japanese quails, 135 one-day-old quail chicks divided into 5 groups (27 birds/group) each group had three replicates (9 birds/Pen). (P1): non infected and non treated group, (P2): infected with ($1.44x10^2$) sporulated *Eimeria tsunodai* oocysts at 21 day old and not treated, (P3): provided with drinking water containing 4% *Aloe vera* gel aqueous solution starting from the 14th day old till end of trial and infected as in P2, (P4): provided with drinking water containing 6% *Aloe vera* gel aqueous solution starting from the 14th day old till end of trial as in P3 and infected as in P2, finally (P5): infected as in (P2) and treated with Amprolium 20% (0.4g/L) for five successive days. Quails in (P1) showed no clinical abnormalities with the highest significant body weight gains (175.67±.333 g) and best food conversion ratio (2.63±.009) among all groups, (P2) showed typical symptoms of cecal coccidiosis ,the lowest body weight gain(119.00±.577g) the worst food conversion ratio(2.97±.009) the highest oocyst counts with longest period of oocyst shedding, the highest caeca lesions scores, while quails in (P3) and (P4) showed few clinical symptoms with quick recovery and little effect in growth ,significant low oocyst counts, short period of oocyst shedding, significant low caeca lesions scores, while (P5) showed symptoms of cecal coccidiosis for a few days post inoculation but symptoms were diminished after Amprolium administration. Superior results of quail meat chemical composition among infected groups were recorded in P4 (quail provided with 6% *Aloe vera* gel (136±0.71, 92.8±0.37, 37.6±0.51, 81.26±0.07and6.5±0.03mg/dl) for cholesterol, triglycerides, HDL, LDL and protein respectively with improved meat sensory characteristics and carcass meat quality. In conclusion *Aloe vera* gel was proved to be effective against cecal coccidiosis in Japanese quails. In conclusion *Aloe vera* gel was proved to be effective against cecal coccidiosis.
Keywords: Quail, Coccidiosis, *Eimeria tsunodai*, *Aloe vera* gel, carcass meat quality.

INTRODUCTION

Quail breeding industry has become progressive industry in Egypt because of the rise of demand for animal proteins as a result of increased population. According to **Aminzade et al. (2012),** quail meat has high

protein content, good fatty acid profile, comparatively low levels of cholesterol, accessible potassium, sodium, iron, and important vitamins like thiamin, niacin, pantothenic acid, riboflavin and vitamin B6. Quails could be raised as a substitute for chickens to avoid many contagious infectious diseases affecting chickens and the subsequent economic losses caused by these diseases (**Jatoi et al., 2013**). Quail are little size compared to other poultry species that makes them more compatible for rearing in limited space reducing rearing costs, they also reach sexual maturity in 6 weeks (**Schusser and Doran, 2022**) thus producing large quantity of eggs in short time and showing increased ability to withstand numerous poultry disorders (**Jatoi et al., 2013)**. Like all birds, quails are exposed to parasites limiting its productivity leading to considerable economic losses specially coccidiosis caused by *Eimeria* species **(Berto et al., 2013)** It is regarded among the most harmful parasitic illnesses that affect quail and hinders the growth of the quail industry (**Bashtar et al., 2010**), It is caused by genus *Eimeria* which is intracellular protozoan parasites, that undergo direct life cycle through ingestion of persistent sporulated oocyst in litter by the bird (**Habibi et al., 2016**) causing pathological alterations **(Chand et al., 2016, Ali et al., 2019).**Three *Eimeria* species , *Eimeria bateri* **(Bathia et al., 1965),** *Eimeria uzura* **(Tsunoda and Muraki, 1971)** and *Eimeria tsunodai* **(Tsutsumi, 1972)** were recorded by **Berto et al., 2013,** while **Arafat and Abbas 2018** recorded the previous mentioned *Eimeria* species in addition to *Eimeria minima* , affected adult birds showed anorexia, poor posture and reduced reproduction and eventually decreased body weight gains in addition to mortalities in young birds **(Arafat and Abbas, 2018**). In necropsy, watery intestinal contents, thickening and necrosis with desquamation of intestinal mucosal villi, cecal ballooning and brownish colored wet content may be tinged with bloody mucus are seen **(Gesek et al., 2014,Elmorsy et al., 2020),** various chemical anticoccidial drugs were used in treatment and prevention of coccidiosis but due to excessive use of these drugs, many adverse consequences were seen **(Hafeez et al., 2020)** including , the residues of coccidiostat drugs in poultry meat with its consequences in public health **(Kadykalo et al., 2018).** So the use of effective anticoccidial herbal feed additives as an alternative to anticoccidial drugs is an instant need **(Ahmad et al., 2020).** *Aloe vera barbadensis* Miller is perfect candidate in this issue as it is packed with many bioactive compounds **(Kar and Bera, 2018)** including vitamin A, C, and E (antioxidants), along with B12, folic acid, choline, enzymes such as Bradykinase that helps to reduce excessive inflammation and 7 other enzymes(lipase, aliiase, amylase, carboxypeptidase, catalase, cellulase, peroxidase and alkaline phosphatase) that help in sugars and fats breakdown, minerals , monosaccharides, polysaccharides, glycoprotein (alprogen) and saponins**.(Surjushe et al., 2008, Sánchez-Machado et al., 2017)** giving it anti-inflammatory, immunomodulatory, antibacterial, antiviral and antifungal properties improving cellular and humoral immunity **(Radha and Laxmipriya, 2015, Aram et al., 2019).** *Aleo vera* may enhance regeneration of gut epithelium, also polysaccharides in *Aloe vera* are known to modulate gut microbiota and enhance mucosal immunity, which could be beneficial in counteracting the adverse effects of coccidial infection (**Bai et al., 2023**) reducing the lesion score and shedding of oocysts in feces of broilers infected with coccidia **(Aram et al., 2019, Ahmad et al., 2020).** This research sought to assess the role of *Aloe vera* gel aqueous solution in

prevention and control coccidiosis in quails and improve meat quality of quail without affecting carcass composition.

MATERIALS AND METHODS

Ethical approval

This research was approved by the committee of Animal Welfare and Research Ethics, at the Animal Health Research Institute in Dokki, Egypt. No. (ARC /AHRI /9/29).

Aloe vera gel active components

The slippery transparent substance contained in the parenchymal cells in fresh plant leaves in known as *Aloe vera* gel **(Kılıç et al., 2020)** The non-aqueous portion of the gel is mostly composed of several bioactive substances including essential and secondary amino acids, hromones, mono-and polysaccharides, anthraquinones, organic acids, enzymes, vitamins, minerals and trace elements, while the remaining 98% is moisture. **(Añibarro-Ortega et al., 2019, Yoruk and Paksoy, 2024).**

Aloe vera gel aqueous solution Preparation

A taxonomist from Mansoura University's Faculty of Agriculture identified *Aloe vera* leaves. To prevent rapid degradation of the gel contents, the mucilaginous leaf gel was extracted from the *Aloe vera* leaves 3–4 hours after harvest. **(Isah et al., 2019).** *Aloe vera* leaves were washed, incised longitudinally by sharp sterilized knife, the gel was scraped gently **(Abdel –Dayem et al., 2021).** 60 g of *Aloe vera* gel were homogenized with 1000 mL of sterile water by electric blender to form 6% *Aloe vera* gel aqueous solution, filtered through fine sieve **(Idowu et al., 2022)** and stored not more than five days at 4°C till being used.

Animal feeding and housing

Quail chicks were reared on suitable wire cages, given plenty food and a 24-hour lighting schedule at first week and second week of age then decrease gradually to 12 H with initial temperature 35°C which progressively decreased in accordance with breeding norms. All groups experienced the identical levels of light, ventilation, humidity, and temperature.

Experimental design

135 one-day-old quail chicks weighted (12.3±0.2g) raised as a single group until day fourteen, then divided into 5 groups (27 birds/group) each group had three replicates (9 birds/pen).First group negative control group(P1): non infected and non treated group**,** the 2nd positive control group (P2): infected with ($1.44x10^2$) sporulated *Eimeria tsunodai* oocysts at 21 day old and not treated, 3rd group(P3): provided with drinking water containing 4% *Aloe vera* gel aqueous solution (**Hafeez et al., 2024)** starting from day fourteen till end of trial and infected as in P2 , 4th group (P4): provided with drinking water containing 6% *Aloe vera* gel aqueous solution starting from day fourteen till end of trial and infected as in (P2) , finally 5th group(P5): infected as in (P2) and treated with Amprolium 20% (0.4g/L) for five successive days starting from the 6th day post inoculation (PI). All groups were reared at the same condition. Clinical signs, mortalities, body weight, food conversion ratio and fecal oocyst counts were recorded in all groups. 3 individuals from each group were slaughtered by the 11th day PI (32 day old) for post mortem, histopathological examination and lesion scores. Also at the end of the trial (35 day old) birds of all groups were slaughtered for determination of sensory characteristics, PH ,total protein , triglyceride , LDL , HDL , MDA, CAT ,SOD ,GPX and cholesterol.

Experimental infection

Preparation of *Eimeria tsunodai* oocysts used in experimental infection

Quails from naturally infected farms exhibiting sings of cecal coccidiosis (bloody droppings, anorexia and decreased body weight gains) were slaughtered and the ceca

were collected, ceca contents were mixed with potassium dichromate 2.5 % in petri dish 2cm depth in 25°C for 3 days in order to confirm sporulation. Sporulated *E. tsunodai* oocysts were identified according to key provided by **Tsutsumi (1972).** Oocysts were transferred into tubes to be centrifuged at 2000 rpm for 10 minutes, and the supernatant was disposed off, oocysts in the sediment were counted by McMaster technique **(Gibbons et al., 2016)** then re-suspended in physiological saline to reach the concentration required for experimental infection. Using rubber syringe each bird was inoculated intra proventriculary with.1ml of suspension containing ($1.44x10^2$) Sporulated *E. tsunodai* oocysts **(Tsutsumi, 1972).**

Effect of *Aloe vera* gel on Performance parameters of experimental groups

Clinical signs and mortality rate

The primary clinical indicators and death rates were compared among all groups for evaluating *Aloe vera* gel efficacy, quails were daily examined after inoculation till the end of trial, clinical signs and mortality rate were record.

Body weight and Food Conversion Ratio

Quails weights of each group were recorded at the start of the trial (14 day old) and every week till the 5th week (35 days) to get the average body weights, The difference between the quails' starting and ending body weight values was used to determine the average body increase for each group, food conversion rate (FCR) were determined by dividing the quantity of feed that was consumed throughout the trial by the quails' body weight gain in each group **(Zayeda et al., 2020)**

Fecal oocyst counts

Starting from the 6th day PI till the end of the trial, litter were collected independently from all groups and examined for presence of *E. tsunodai* oocysts, McMaster slide was used to assess fecal oocyst counts per gram (OPG) following the technique used by **Hauck and Pacheco, 2021.** Oocyst reduction percent (R %) was determined by the equation provided by **Seddiek and Metwally, 2013** as follows:

$$R\% = \frac{\text{(OPG) of infected group} - \text{(OPG) of treated group}}{\text{Oocyst count per gram (OPG) of infected group}} x100$$

Gross pathological examination

During post mortem, each carcass was opened and ceca were observed. This was followed by detailed examination of all organs and observed gross alterations were daily recorded. Cecal tissues showing positive lesion for coccidial infection were collected **(Elmorsy et al., 2020)**

Histopathological examination

Several intestinal sections were removed from birds that had been sacrificed for histological examination. A 10% formalin solution was used to preserve the items. Tissue samples were sliced into 2-3 mm thick sections and stored for later fixing. After an overnight soak in tap water, the tissues were dehydrated using increasing alcohol grades, cleaned in xylene, and finally embedded in paraffin. Following the usual protocol of **Luna (1968),** the paraffin-embedded tissues were cut into sections that were 4-5 microns (µ) thick and stained using the standard Haematoxylin and Eosin method.

Lesion Scoring

According to **Johnson and Reid's (1970)** scoring system, caeca were taken from the dead or sacrificed birds and their lesions were evaluated on a scale of 0 to + 4. Depending on the lesions found in the caeca

of various groups, scores ranging from 0 for no lesion to + 1 to + 4 are permitted.

Carcass meat quality assessment

Samples of quail meat were collected, put in insulated ice box, labeled and send to laboratory with a minimum of delay for determination of sensory characteristics, PH, total protein, triglyceride, LDL, HDL, MDA, CAT, SOD, GPx and cholesterol.

Carcass measurement (sensory evaluation)

Slaughtered quails from each treatment were rinsed with running water, dried thoroughly, and then put in a plastic container. The sensory profiles (color, odor, and tast) of the muscles under examination were assessed by a trained descriptive panel consisting of five individuals. The sensory profiles were assigned a score ranging from 1 to 5, where 5 denotes a normal muscle, 4 a minor deviation, 3 a moderate deviation, 2 a high deviation, and 1 an extremely deviated muscle **(Moawad et al., 2018).**

PH measurement

The PH –meter (Jenway 3510 PH –meter ,Cole –Parmer, Staffordshire , United Kingdom) was used to measure the PH of the collected quail breast muscles 24 hour post slaughter, in the current study three points calibration at 4 , 7, 10 PH was used with range 2.000 to 19.999 PH , resolution 0.001/00.01/0.1 PH and accuracy ± 0.003 PH .

Determination of protein percent

Determination of protein percent was performed according to **AOAC (2019).**

Determination of Cholesterol content

Lipid extraction and saponification were operated on about 2 g of each sample. Samples were analyzed using high-performance liquid chromatography (HPLC), results were expressed as mg/dl of meat **(Nistor et al., 2013).**

Determination of Triglycerides, HDL-Cholesterol and LDL- Cholesterol

Triglycerides, HDL- Cholesterol, and Cholesterol were measured using an enzymatic colorimetric test with assay kits provided by Spinract, Spain. While LDL-Cholesterol was calculated using the equation LDL-C= Cholesterol - (triglyceride/5 + HDL-C).

Determination of antioxidant in quail meat samples

Ready diagnostic kits (Bio-diagnostic, Egypt) were used in Enzymatic colorimetric method to estimate malondialdehyde (MDA), superoxide dismutase (SOD) and glutathione peroxidase (GPx) while ready kits (Alpha, USA) were used to estimate catalase (CAT) activity**.**

Statistical analysis

One way ANOVA test was used to compare Growth performance, fecal oocyst counts, lesion scores , pH value - chemical composition and antioxidant in in the examined samples of quail meat ,followed by Duncan test to assesse Significant difference ($P \leq 0.05$) between groups under study

RESULTS

Effect of *Aloe vera* gel on Performance parameters of experimental quail groups

Clinical signs

Quails in negative control group (P1) showed no clinical abnormalities while quails in positive control group (p2) showed mucoid bloody droppings, ruffled feathers, depression, dullness, reduction of feed intake and loss of weight. Quails in the infected

provided with *Aloe vera* gel groups (P3) and (P4)) showed few clinical symptoms as mucoid bloody droppings for few period with quick recovery and little effect in growth rate, while infected treated group (P5) showed the clinical symptoms as in (P2) few days post inoculation but symptoms were diminished after adding Amprolium as a treatment with complete recovery by the 11th day post inoculation, no mortalities were recorded.

Body weight and food conversion ratio

As it shown in table 1 quails on non infected group P1 showed significant higher body weights (BW) and body weight gains (BWG) among all groups followed by P5, while quails in infected non-treated group P2 showed the lowest BW and BWG. Quails in both P3 and P4 showed good BW and BWG at 21day old and decreased after infection with *E. tsunodai* but significantly higher than P2. Quails on P1 showed the lowest food conversion ratio (FCR) followed by P3, P4 and P5 respectively.

Table 1: Effect of *Aloe vera* gel on body weight (BW), body weight gain (BWG) in g and food conversion ratio (FCR) among infected quails groups with *E. tsunodai*

Groups	P1	P2	P3	P4	P5
BW At 14 D	45.67±.333^{a}	45.00±.575^{a}	45.67±.333 ^{a}	45.00±.577 ^{a}	46.00±.000 ^{a}
BW At 21 D	100.33±.333^{bc}	99.67±.602^{c}	103.00±.578 $^{a\,b}$	104.00±.547 ^{a}	100.33±.881^{bc}
BW At 28D	160.67±.667^{a}	120.33±.882^{d}	154.67±.667^{b}	156.33±.333^{b}	135.00±577^{c}
BW At 35D	221.67±.667^{a}	164.00±.577^{e}	195.67±.882^{d}	198.33±.882^{c}	210.33±.882^{b}
Total BWG	175.67±.333^{a}	119.00±.577^{d}	151.67±.881^{c}	153.00±.577^{c}	164.00±.577^{b}
FI	460	354	403	405	440
FCR	2.63±.009^{c}	2.97±.009^{a}	2.65±.003^{bc}	2.64±.010 ^{bc}	2.67±.008^{b}

Data are expressed as Means± SE. Values with different letters (a, b, c, d, e) within the same raw are significantly different at P value < 0.05. (P1) =negative control group, (P2) = positive Control group (P3) = infected provided with 4*% Aloe vera*, (P4) = infected provided with 6% *Aloe vera* & (P5)= infected treated with Amprolium, D =day, FI= Food intake .

Fecal oocyst counts

Eimeria tsunodai oocysts were observed in fecal sample of infected groups by the 6th day PI. *E. tsunodai* oocysts were broad ovoid in shape with colorless double wall, average size were 18.4 µ in length and 14.1 µ in width, with no micropyle present ,but polar granules present , when sporulated four sporocysts were formed each one with triangular stiedae body at one pointed end, no sporocystic residual body was found but few granules were found (fig 1). No oocysts were found in dropping samples of P1 along the whole experiment. By the 6th day post inoculation *E. tsunodai* oocysts were detected in dropping samples in all infected groups ,P2 showed the highest oocyst counts by the 10th post inoculation and continued till the 17th day post inoculation, while P3 , P4,P5 showed lower counts and shorter duration (table 2 fig 2).

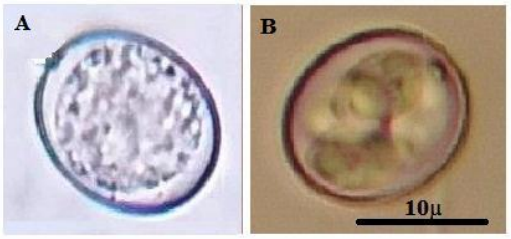

Fig 1: A) Un sporulated *E. tsunodai* oocyst, B) Sporulated *E. tsunodai* oocyst

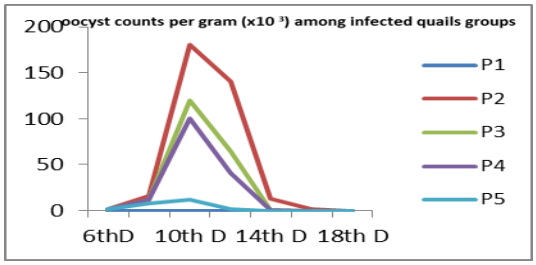

Fig2: Effect of *Aloe vera* gel on fecal oocyst counts per gram (x10 3) among infected quails groups with *E. tsunodai*

Table 2: Effect of *Aloe vera* gel on fecal oocyst counts per gram (x10^3) among infected quail groups with *E. tsunodai.*

Groups / OPG at	P1	R%	P2	R%	P3	R%	P4	R%	P5	R%
6thD	0±000^e	----	1.53± .006^a	0%	1.30±.005^c	15%	1.21±.009^d	21.6 %	1.46±.006^b	3.9%
8th D	0±000^e	---	16.2±.058^a	0%	12.4±.057^b	23.4%	11.6±.054^c	28%	8.3±.056^d	48.7%
10th D	0±000^e	---	180.47±.088^a	0%	120.4±.115^b	33.5%	100.3±.088^c	44.4%	12.1±.088^d	93.3%
12th D	0±000^e	----	140.53±.145^a	0%	64.3±.089^b	54.2%	40.4±.088^c	71%	1.2±.088^d	99%
14th D	0±000^c	----	12.85±.130^a	0%	.8±.088^b	93.7%	.6±.058^b	95.3%	0±000^c	100%
16th D	0±000^c	---	1.87±.137^a	0%	0±000^b	100%	0±000^b	100%	0±000^b	100%

Data are expressed as Means± SE. Values with different letters (a, b, c, d, e) within the same raw are significantly different at P value < 0.05. Oocyst counts per gram =OPG, D=day, D=day, (P1) =negative control group, (P2) = positive Control group (P3)= infected provided with 4% Aloe vera, (P4)= infected provided with 6% Aloe vera &(P5)= infected treated with Amprolium.

Histopathology and lesion scores

Cecal coat was apparently normal in P1 (Fig3. a). The cecal mucosa, sub-mucosa and serosal vasculature were normal. The cecal villi appeared destructed by various developmental stages of *E. tsunodai* oocytes in P2 (Fig3.b &c) with mucosal and submucosal hemorrhage (Fig3.d). Focal massive lymphocytic infiltrates sub mucosa (Fig3.e) with diffuse atrophy of submucosal glands in addition to inter glandular lymphocytic cells infiltration (Fig3.f). There were severe mucinous degeneration and destruction of enterocytes (Fig3.g), severe hemorrhage of both submucosal and serosal blood vessels in P2 (Fig3.h). Mild splitting destructed serosa inP3 (Fig4.a), also normal

mucosal villi with mild mucinous degeneration in P4 (Fig4.b), while cecal mucosa and sub-mucosa were free from any *Eimeria* developmental stage in P4 (Fig4.c).
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P5 (Fig2.d) showed apparently normal cecal mucosa and sub-mucosa. Mean lesion scores are presented in figure 5

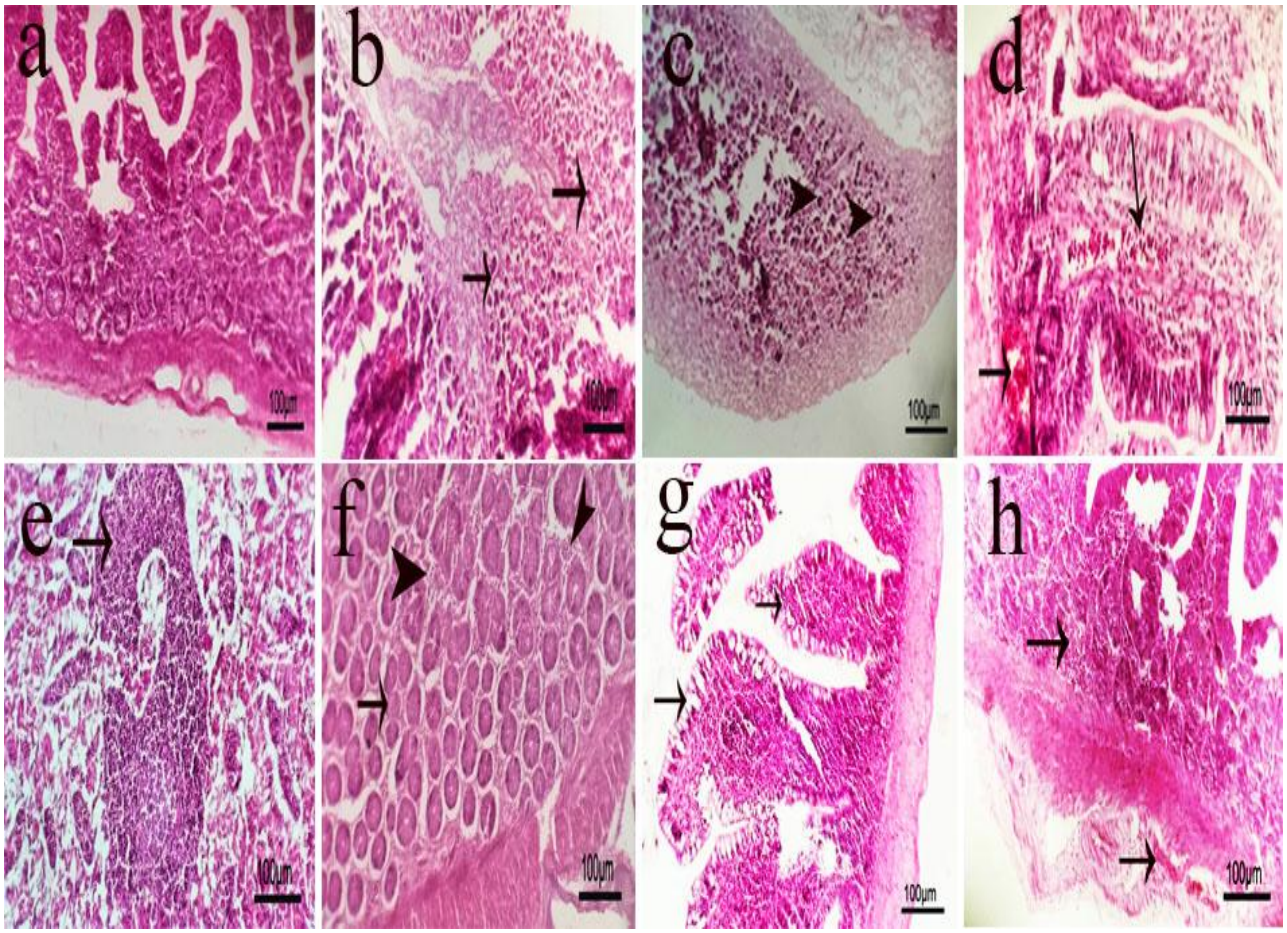


Fig3: Photomicrographs of H&E stained Quil cecal sections of different experimental groups showing a) P(1) with normal cecal mucosa ,submucosa and serosal vasculature .b &c) P(2) with villus destruction by various developmental stages of *Eimeria spp*. oocytes .d) P(2) with mucosal and submucosal hemorrhage (arrows). e) P(2) with focal massive lymphocytic infiltrates submucosa(arrow). f) P(2) with diffuse atrophy of submucosal glands (arrow) in addition to inter glandular lymphocytic cells infiltration(arrowhead) P(2) with severe mucinous degeneration and destruction of enterocytes(arrows) h) severe hemorrhage of both submucosal and serosal blood vessels (arrows).(scale bar = 100µm)

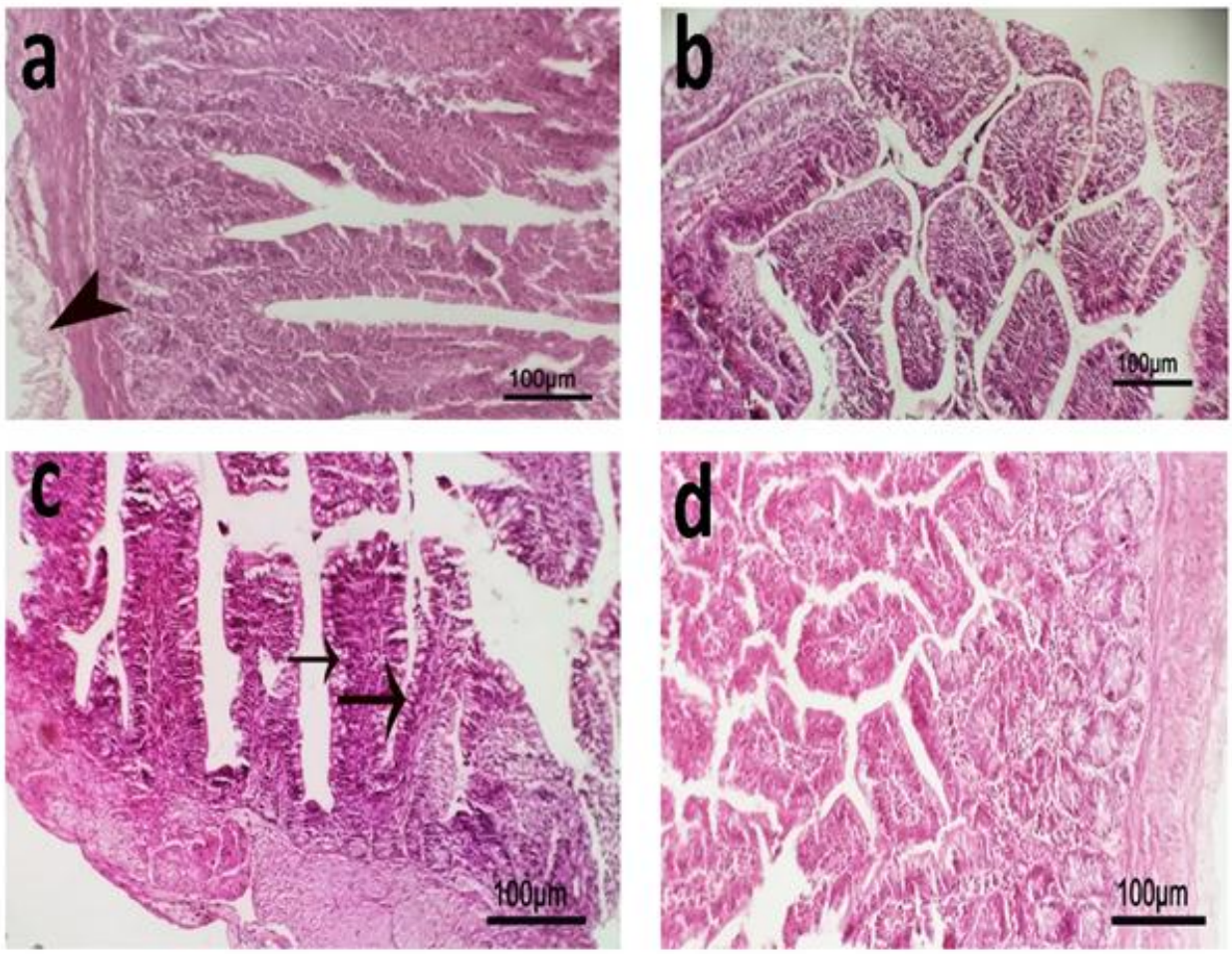
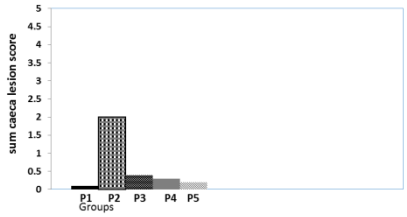


Fig4: Photomicrographs of H&E stained quil cecal sections of different experimental groups showing a) P(3) with mild splitting destructed serosa (arrowhead) .b) P(4) with apparently normal mucosal villi. c) P (4) with mild mucinous degeneration (arrows) while cecal mucosa and submucosa are free from any *Eimeria* developmental stages d) P (5) with apparently normal cecal mucosa and submucosa.. (scale bar = 100µm)

Statistical analysis of lesions in caeca

Statistical analysis showed significant reduction of caeca lesions scores in groups provided with 4%, 6% *Aloe vera* gel P3 &P4 and group treated with Amprolium when compared to group P2.

Fig 5: Statistical analysis of lesions in caeca.



Effect of *Aloe vera* gel on Carcass meat quality

Effect of *Aloe vera* gel on Sensory evaluation

As shown in Fig 6 values of taste, flavor, and color did not differ significantly ($P < 0.05$) among the examined groups and the scores given for all attributes are above the moderate acceptability level.

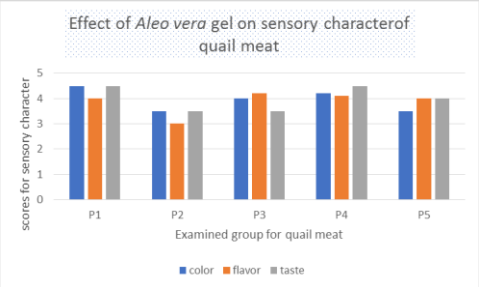


Fig 6: The effect of *Aloe vera* gel on the physical characteristics of the quail's meat values represent mean ± SE of the scores of the trained panelists.

PH measurement

Table3: The effect of *Aloe vera* gel on the pH of quail meat.

Groups	P1	P2	P3	P4	P5
PH	5.36 ±0.05^{a}	6.16 ±0.05^{c}	5.84 ±0.04^{b}	5.76 ±0.05^{b}	5.46 ±0.05^{a}

As it shown in Table 3 quail meat PH on groups provided with Aloe vera gel 4% and 6% were 5.84±0.04 and 5.76 ±0.05respectively, while in meat of group treated with Amprolium was5.46±0.05, the highest pH level for quail meat was found in the infected non treated group.

Effect of *Aloe vera* gel on Triglycerides, HDL- Cholesterol and LDL- Cholesterol and Protein percent

As presented in Table 4 The highest level of Triglycerides was found in infected non treated quail group p2 (168±0.32) , while the lowest level were found in p5 (91±0.32), the highest cholesterol level among infected groups was recorded in infected non treated group p2 (187.2±0.71) while lower level found in p 4 and p 5 (136±0.71 and 135±0.58) respectively .it is noted that groups provided with Aloe vera gel showed Triglycerides, HDL- Cholesterol and LDL- Cholesterol and Protein percent near that recorded by non infected group indicating quick recovery and restoring normal meat chemical composition .

Effect of *Aloe vera* gel on Antioxidant of examined quail's meat

Based on data presented in table (5) quail meat in groups provided with *Aloe vera* showed high levels of CAT near that recorded in non infected and infected treated groups while the lowest levels were recorded in infected non treated group P2(3.66±0.04) , high SOD levels specially in group provided with 6% *Aloe vera* gel P4 in which SOD levels were(391.6±0.60) higher than that recorded in non infected group P1 and lowest levels (263.8±0.58)were recorded in infected non treated group P2 , MDA showed highest level in infected non treated group P2(69.06±0.04), as for GPX the highest level were recorded in P4(36.16±0.05) and lowest level (14.06±0.05)in P2.

Table (4) Effect of *Aloe vera* gel on chemical composition of the examined quail's meat

Groups	Cholesterol (mg/dl)	Triglycerides (mg/dl)	HDL-C (mg/dl)	LDL-C (mg/dl)	Protein (g/dl)
P1	134.78±0.71^{e}	91±0.32^{d}	40±0.55^{a}	76.58±0.15^{e}	6.8±0.03^{a}
P2	187.2±0.71^{a}	168±0.32^{a}	21.6±0.51^{e}	132.36±0.39^{a}	4.4±0.03^{d}
P3	142.38±0.66^{b}	111.8±0.37^{b}	33.6±0.51^{d}	86.42±0.11^{b}	5±0.03^{c}
P4	136±0.71^{c}	92.8±0.37^{c}	37.9±0.51^{c}	81.29±0.07^{c}	6.5±0.03^{b}
P5	135±0.58^{d}	91±0.32^{d}	38.6±0.51^{b}	78.78±0.20^{d}	6.5±0.03^{b}

Data are presented as mean ±SE. mean values with different superscripts letters in the same column are significantly different at ($p \leq 0.05$).

Table (5) Effect of *Aloe vera* gel on antioxidant of the examined quail's meat

Groups	CAT (U/ g. Tissue)	SOD (U/ g. Tissue)	MDA (nmol/tissue)	GPX (mu/gTissue)
P1	9.06±0.04^{a}	367.8±0.58^{b}	27.28±0.07^{e}	29.56±0.05^{b}
P2	3.66±0.04^{c}	263.8±0.58^{e}	69.06±0.04^{a}	14.06±0.05^{e}
P3	6.28±0.04^{b}	353.8±0.58^{d}	50.94±0.30^{b}	27.028±0.04^{c}
P4	7.76±0.04^{a}	391.6±0.60^{a}	44.268±0.19^{c}	36.16±0.05^{a}
P5	8.58±0.04^{a}	364.8±0.58^{c}	29.06±0.04^{d}	25.96±0.05^{d}

Data are presented as mean ±SE. mean values with different superscripts letters in the same column are significantly different at ($p \leq 0.05$).

Discussion

Coccidiosis in quails is considered one of the serious challenge in quails raising industry, leading to great losses **(Ahmad et al., 2020, Ishaq et al., 2022**). Different *Eimeria* species affecting quails are implicated in quail coccidiosis including *E. tsunodai* which was first introduced as a pure coccidian isolate that is specific for quails by **Tsutsumi (1972)** who demonstrated its developmental stages in the epithelial cells lining crypts and villi of caeca causing cecal coccidiosis in quails manifested by bloody droppings, ballooning of caeca and gross lesion at necropthy. *E. tsunodai* used in this

study was collected from cecal content of quails showing clinical manifestation and PM lesion described by **Tsutsumi(1972)** and identified morphologically as described by **Tsutsumi (1972), Arafat And Abbas (2018)and Ramadan et al. (2021).** In present study groups provided with *Aloe vera* showed good body weights and body weight gains even so after infection with *E. tsunodai* the decrease of body weight gains, oocyst counts and lesion scores were less than infected non provided group also group provided with 6% *Aloe vera* showed superior results than group provided with 4%implaing that the higher concentration is butter. proving the good anti-coccidial effect of *Aloe vera* this results could be due to the anti-inflammatory and immune modulatory effect of *Aloe vera* **Tariq et al. (2014)** and its probable ability to regenerate the damaged gut epithelium in agreement with **Akram et al. (2019), Khan et al.(2023) and Hafeez et al. (2024)** who suggested that *Aloe vera* can improve gut health with the increase food intake and increase body weight gain subsequently enhance FCR in quails infected with coccidia, also being rich in polysaccharides that known to modulate gut microbiota enhancing mucosal immunity suggesting that it might have some benefits in counteracting *Eimeria* infection adverse effects **Bai et al. (2023)**plus containing vitamins B12, C, A, E, folic acid and choline that act as Antioxidant neutralize free radicals, enzymes such as bradykinase which helps to reduce excessive inflammation and minerals needed for various enzyme to function properly **Surjushe et al. (2008)** improving feed intake by birds in agreement with **Ebrahim et al. (2020)** who suggested that the change in taste stimulate the appetite, and improve digestive enzymes secretions improving feed intake also increase intestinal absorption of nutrients may be due to anthraquinones contained in phenolic components of *Aloe vera* subsequently increasing body weight gains, while **Nalge et al.(2017)** referred the increase of body weight gains to antibacterial properties of *Aloe vera* acemannan polysaccharide and to the film formed by *Aloe vera* in the intestinal tract epithelial mucosa protecting it from infections and toxins.

As for the effect of *Aloe vera* gel on fecal oocyst counts, groups provided with *Aloe vera* showed decreased fecal oocyst counts and short duration of oocyst shedding than non treated non provided group, the same results were recorded by **Khaliq et al. (2017), Desalegn and Ahmed (2020), Abdel-Dayem (2021)** this result could be due to the effect of *Aloe vera* gel bioactive materials that inhibit oocysts sporulation thus decrease reinfection. Sporulation inhibition was increased in the higher gel concentration (**Desalegn and Ahmed, 2020)** in agreement with our results , in addition to the protecting film formed by *Aloe vera* on epithelial mucosa that protect it from infection **(Nalge et al., 2017),**also polysaccharides contained in *Aloe vera* stimulate humoral and cellular immune responses that may neutralize pathogens such as *Eimeria* **(Madan et al., 2008)**it also enhance gut T-lymphocytes and macrophages activity(**Ashouri et al., 2019)** preventing *Eimeria* from mucosal epithelial penetration, also dihydroxyanthraquinone and its derivatives contained in *Aloe vera* promote intestinal motility, helping the fast elimination of *Eimeria* oocysts **(Nghonjuyi et al., 2015).**

Histopathological examination revealed that negative control (P1) showed no oocysts because there was no induction of infection in it to ensure coccidian free birds while in positive control (P2) the oocyst per gram (OPG) continued to increase due to absence of any treatment (**Munir et al., 2018).** Histopathological analysis of the cecal lesions in P2 showed extensive atrophy of submucosal glands, fibrous connective tissue growth, hemorrhage in the mucosa and submucosal layers, necrosis, sloughing of epithelial cells, and clogged blood vessels. Large numbers of the parasite's developmental stages were seen, which is in line with earlier reports **(Ellakany et al., 2011 and Hassan et al., 2024)** while cecal tissue inP3& P4 showed normal cecal villi, mild necrosis and with mild mucinous degeneration and a decreased number of *Eimeria* stages in the mucosa and submucosa, implying that the development of *E. tsunodai* stages were suppressed by *Aloe vera* gel , this result could be explained by the antiprotozoal and anti-inflammatory properties of biologically important compounds contained in *Aloe vera* gel **(Hassan et al., 2024).** Additionally, *Aloe vera* has antibacterial and antiseptic qualities **(Alemdar and Agaoglu, 2009),** which help to cure and shield affected host tissues from harm brought on by *E. tsunodai* and other infections In P5, Amprolium showed efficacy as anticoccidial medication. This led to improved cecal histopathological lesions, which were characterized by the elimination of *Eimeria* stages, a decrease in the quantity of *Eimeria* oocysts, and the preservation of intestinal villi integrity (**Hassan et al., 2024**).

The sensory evaluation was based on several sensory features, such as color, texture, and odor. A sensory profile enables us to assess food quality and, eventually, spot undesirable substances **(Rasooli, 2007),** no significant differences were observed between all treatment groups in subjective meat quality attributes (color, flavor, and taste) of quail meat, all the scores were at above moderate values, similar results were shown by **Mansoub, 2011** who found that herbal plants cause a good effect on the quality of the carcass by higher absorption of amino acids, nutrient utilization and improved protein metabolism .

The degree of acidity or alkalinity in meat is referred to as pH, it is a crucial element in assessing the quality of the meat, as meat that has the right pH level is guaranteed to be juicy, tender, and fresh. for longer time, but meat with excessive high or low pH level deteriorate rapidly , in our trial meat pH of infected provided groups with *Aloe vera* gel and treated group with Amprolium (p3 , p4 & P5) recorded proper PH with no significant difference from that recorded in non infected group (p1) while meat pH of infected non treated group recorded higher values (6.16±0.05)which indicate the ability of *Aloe vera* to maintain proper meat pH in spite infection similar result was found by **Bhat et al., 2015,** this could be attributed to the variety of substances found in *Aloe vera*, such as, phenolic compounds, polysaccharides, organic acids, vitamins, and enzymes **(Boudreau and Beland, 2006),** while The analytic data on quails muscle cholesterol level revealed a decrease cholesterol level in infected groups provided with *Aloe vera* gel as compared to infected non treated group, which clearly indicates that the *Aloe vera* gel has a muscle cholesterol-reducing effect when included in the quail diet, similar results were reported by **Mehala and Moorthy (2008)**

and Ashraf et al. (2023), the highest level of low-density lipoprotein cholesterol LDL was in the infected non treated group of quail which is considered a risk factor for heart disease while higher level of high-density lipoprotein HDL was in quail provided with 6% *Aloe vera* gel similar results were recorded **by Rajasekaran et al. (2006),** and **Arif et al. (2022)** HDL is considered good cholesterol as it absorb cholesterol from the blood and carries it back to the liver , the low fat and cholesterol content and high amount of iron in white quail meat make it superior to red meat **(Jaturasitha et al., 2004)** while triglycerides were higher in infected non treated group and lower in groups provided with *Aloe vera* gel the same results were recorded by **Putra et al. (2015).** Protein content in quail muscle was lower in infected non treated quail group while in infected provided group with 6% *Aloe vera* gel protein returned back to its normal level, similar to the control non infected group but protein percent was lower than that recorded by **Jumaa et al. (2021)** and higher than recorded by **Ghasemi-sadabadi et al. (2020)** this may be due to different diet formula**.** Meat prosperities were improved in infected groups provided with *Aloe vera* gel, as it is known that Malondialdehyde(MDA) concentration increases in stress caused by infection leading to meat deterioration after slaughtering, our results showed that MDA was lower in infected groups provided with *Aloe vera* gel 4% and 6% (50.94±0.30 and 44.268±0.19) respectively than that of infected non treated group(69.06±0.04) this due to the antioxidant properties of *Aloe vera* gel that eliminates the negative effects caused by oxidative stress in agreement with result reported by **Truong and King (2023),**furthermore antioxidant enzymes that prevent further oxidation were in higher in quail meat of group provide with 6% *Aloe vera* gel (391.6±0.60)for SOD , (7.76 ±0.04)for CAT and (36.16±0.05) for GPx than that of infected non treated group preventing further oxidation, **Hamman, 2008** refered the antioxidant effects of *Aloe vera* gel to its high content of Glutathione peroxidase, superoxide dismutase enzymes and phenolic antioxidant that have the ability to stimulate the production of endogenous antioxidants, which eventually raises antioxidant levels. Thus *Aloe vera* gel was proved to be safe alternative for anticoccidial drugs in quails maintaining meat composition, physiochemical properties, and antioxidant properties.

Conclusion:

Coccidiosis is one of the most important diseases affecting Japanese quails which need medical treatment but intensive use of drug have its hazard especially drug resistance issue that lead us to search for natural alternatives, *Aloe vera* gel as a potential natural antioxidant was proved to be effective against cecal coccidiosis in Japanese quails maintaining body weight gain (BWG), lowering oocyst counts, shedding period, caeca lesions scores maintaining carcass sensorial characteristics, physiochemical properties and nutritive value of quail carcass meat.

Conflict of interest

The authors declare that they have no conflict of interest.

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الملخص العربي

فاعلية جل الألو فيرا في السيطرة على الكوكسيديا في قطعان السمان

نهى بدير القطب البربري [1*]، هناء سعيد علي عبد المجيد[2] ، أروى حسن نصار[3]

قسم الطفيليات بمعهد بحوث الصحة الحيوانية بالدقي (معمل فرعي المنصورة) – مركز البحوث الزراعية (1*)

قسم الباثولوجي بمعهد بحوث الصحة الحيوانية بالدقي (معمل فرعي المنصورة) – مركز البحوث الزراعية (2)

قسم صحة أغذية بمعهد بحوث الصحة الحيوانية بالدقي (معمل فرعي المنصورة) – مركز البحوث الزراعية(3)

يُعد إنتاج لحوم دواجن عالية الجودة وخالية من بقايا الأدوية تحديًا كبيرًا في الوقت الحالي، لا سيما مع وجود العديد من الأمراض التي تهدد صناعة الدواجن. يُعد مرض الكوكسيديا من أهم الأمراض التي تصيب السمان الياباني. في هذه التجربة، قمنا بتقييم فعالية جل الصبار ضد مرض الكوكسيديا في السمان الياباني.تم اجراء هذه التجربة على 135 فرخ سمان عمر يوم واحد مقسمة إلى 5 مجموعات (27 طائر / مجموعة) كل مجموعة تحتوي على ثلاثة مكررات (9 طيور / حظيرة) المجموعة الاولى(P1): غير المصابة وغير المعالجة، المجموعة الثانية (P2) :يتم فيها عدوى افراخ السمان في عمر 21 يوما بـ (1.44×10^2) بويضات إيميريا تسونوداي المتبوغة ولا يتم فيا العلاج ،المجوعة الثالثة(P3) : زودت بماء شرب يحتوي على محلول مائي من جل الصبار بنسبة 4٪ بدءًا من اليوم الرابع عشر حتى نهاية التجربة و يتم فيها عدوى افراخ السمان كما في المجموعة الثانية ، المجموعة الرابعة (P4) : زودت بماء شرب يحتوي على محلول مائي من جل الصبار بنسبة 6٪ كما في المجوعة الثالثة ومصابة كما في المجموعة الثانية وأخيرًا المجموعة الخامسة(P5) : مصابة كما في المجموعة الثانية و يتم معالجتها بأمبروليوم 20٪ (0.4 جم / لتر) لمدة خمسة أيام متتالية. لم يظهر على السمان في المجموعة الاولى أي تشوهات سريرية كما كانت هناك زيادة كبيرة في وزن الجسم (175.67 ± 333. جم) ونسبة تحويل الغذاء جيدة (2.63 ± 009.) بين جميع المجموعات، وأظهرت المجموعة الثانية أعراضًا نموذجية لمرض الكوكسيديا الأعورية، وأقل زيادة في وزن الجسم (119.00 ± 577. جم) وأسوأ نسبة تحويل غذائي (2.97 ± 009.) وأعلى عدد من البويضات مع أطول فترة تواجد في البراز ، وأعلى درجات لإعراض الاصابة بالكوكسيديا الأعورية ، بينما ظهرت على السمان في المجموعة الثالثة(P3) و المجموعة الرابعة (P4) أعراضًا سريرية قليلة مع تعافي سريع وتأثير ضئيل في النمو، وعدد منخفض كبير من البويضات، وفترة قصيرة من التواجد في البراز ، ودرجات منخفضة لإعراض الاصابة بالكوكسيديا الأعورية بينما أظهرت المجموعة الخامسة (P5) أعراض داء الكوكسيديا الأعورية لعدة أيام بعد الإصابة ولكن الأعراض تلاشت بعد العلاج بالأمبروليوم. سجلت المجموعة الرابعة P4 (السمان المغذي بـ 6٪ جل الصبار) نتائج متفوقة في التركيب الكيميائي للحوم السمان بين المجموعات المصابة (136 ± 0.71، 92.8 ± 0.37، 37.6 ± 0.51، 81.26 ± 0.07 و 6.5 ± 0.03 ملغ / ديسيلتر) للكوليسترول والدهون الثلاثية و HDL و LDL والبروتين على التوالي مع تحسين الخصائص الحسية للحوم وجودة لحوم الذبيحة. اثبت هذه الدراسة أن جل الصبار فعال ضد مرض الكوكسيديا الأعورية في السمان الياباني من خلال الحفاظ على زيادة وزن الجسم (BWG)، وخفض عددالبويضات ، وفترة تواجدها في البراز ، ودرجات الإصابة الأعورية ، والحفاظ على التركيب الكيميائي، والخصائص الفيزيائية والكيميائية، وخصائص مضادات الأكسدة في لحم الذبائح.