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Prevelance of Bovine Cysticercosis in Egypt and the Cysticidal Effect of Two Extracts Obtained from *Balanites aegyptiaca* and *Moringa oleifera* on Mice Model Affected with *T. saginata* Cysticerci

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Abstract

The aim of the present study was to determine the prevalence of bovine cysticercosis in both cattle and buffloas, in Egypt and to assess the cysticidal efficacy of *Balanites aegyptiaca* fruits (*B. aegyptiaca*) and *Moringa oleifera* seeds (*M. oleifera*) extracts in experimentally infected mice. The study detected the level of tumor necrosis factor (TNF-α) to monitor the immune and inflammatory responses of experimentally infected mice. Through meat inspection, a total number of 2125 male bovine, 2 to 5 years old, (1125 cattle and 1000 buffloes) were examined under the authority of Albsatine and Alwaraq official abattoirs in Cairo Governorate, Egypt covering the period extended from March 2022 to April 2023. The overall prevalence of the disease among bovine was 7.8% (6.31% of cattle and 9.5% of buffloes). Besides, *B. aegyptiaca* and *M. oleifera* extracts showed cysticidal activity in experimentally infected mice. A decrease in the numbers of cysticerci was found in all treated mice groups, and up to 88% reduction was achieved in the *B. aegyptiaca*-treated group; higher than that was recorded in both *M. oleifera* (72.23%) and al-

bendazole-treated ones (80.56%). Postmortem findings proved that *M. oleifera* and *B. aegyptiaca* reduced cysticerci numbers comparable to a commercial anthelmintic. The study showed a significant decrease ($P < 0.001$) in TNF-*α* levels after treatment with *Balanites* and *Moringa* extracts, compared with the untreated control and the albendazole-treated groups.

Keywords

Prevalence, *Balanites aegyptiaca*, *Moringa oleifera*, Mice, *T. saginata* Cysticerci

1. Introduction

Bovine cysticercosis remains one of the serious parasitic diseases caused by the larval stage of the zoonotic cestode *Taenia saginata*; Taenidae family [1] [2]. The disease deems the most continual reported zoonosis observed through post-mortem inspection of meat at slaughter houses all over the world [3]. The infection is a widespread in different countries e.g. Egypt [4] [5] [6], Saudi Arabia [7] and Ethiopia [8]. It negatively affected beef quality causing great financial losses for the beef sector besides its adverse impact on public health. The annual financial losses in Africa related to bovine cysticercosis were about $1.8 billion [9]. In Egypt, the economic losses due to infection reached 87,032 Egyptian Pounds per year among slaughtered' cattle [4].

Bovine are the intermediate hosts of *Taenia saginata*. While humans act as the definitive host whereas they harbor the adult worm in the intestine and causing taeniosis [1]. The infection of animals starts through eating contaminated food and water with eggs of *T. saginata* disseminated in stool of infected human. The eggs hatch and hexacanth embryos (oncospheres) release to penetrate the intestinal mucosa reaching the blood circulation then they attached to heart, masseter muscles and other muscular sites mainly forming cysticerci [10] [11]. Taeniosis is arised from consumption of human to raw or under cooked beef contained cystiserci. Then, the adult worms develop and live in the intestines. Millions of eggs may be discharged into the environment each day when the terminal segments holding eggs are detached from the adult parasite [12]. There are 77 million people act as *T. saginata* carriers worldwide, of which 40% reside in Africa [13]. So, there are great risks for spreading the infection between cattle and buffaloes particularly in Africa.

Albendazole (ABZ) is usually used in treatment of bovine cysticercosis, with a variable efficiency according to the number, type and location of the cysts [14]. Cysticidal treatment induces parasite killing, resulting in a post inflammatory response, which can potentially hinder treatment and require anti-inflammatory drugs as corticosteroid treatment to control inflammation but it might pose significant health risks [15].

Utilizing of safe natural potent anti-parasitics of a plant origin is aimed main-

ly to avoid chemotherapeutics residues in meat and to delay or prevent development of drug resistance [16].

Balanites aegyptiaca is one of the foremost common wild plant species disseminated in African and known by its numerous employments for medicinal purposes [17]. *B. aegyptiaca* contained a wide assortment of bioactive compounds which have organic, pharmacological action like saponins, flavonoids, alkaloids, terpenoids [17]. It has a wide of range of medicinal benefits e.g. anthelmintic impact [18], anti bacterial effect [19], anti-cancer [20], anti-inflamatory [21], hepatoprotective activity [22] and Wound healing activity [23].

Furthermore, *Moringa oleifera* is one of the most beneficial trees that is suitable for food applications and possesses anthelminthic [24], anti-inflammatory, antimicrobial, and anti-oxidant [25] [26]. It has also modulating the immune system, and displaying anti-oxidant, anti-diabetic, and anti-tumor activity [27]. The bioactive constituents of *M. oleifera* incorporate flavanoids, enolic corrosive, alkaloids and sterols and terpene (glucosinolate and isothiocyanate) [28].

On the other hand, tumor necrosis factor-alpha (TNF-α) is a pleiotropic cytokine with having significant roles in homeostasis and disease pathogenesis. It is an essential cytokine that acts as an endogenous mediator having immune and inflammatory functions [29] [30]. It is mainly expressed by activated macrophages, natural killer cells, and T cells, and activated cells bearing the TNF-α receptor such as monocytes, macrophages, and dendritic cells, which then produce inflammatory factors [31].

Studying of the prevalence of bovine cysticercosis provides usefull data for the good understanding of disease epidemiology and outlines the required prevention and control measures to combat it. Prevention of the infection and/or treatment of live animals using potent natural product, to destroy the developed cystiserci would be of great impacts on getting healthy beef, decreases the economical losses and control risks of public infection. Therefore, this study is intended to determine the prevalence of bovine cysticercosis among cattle and buffaloes in Cairo Governorate, Egypt. Besides, the study also aimed to detect cysticidal activity of methanolic extracts of *B. aegyptiaca* and *M. oleifera* as anti-parasitic alternatives compared to albendazole (reference drug) on mice model infected with cysticerci through postmortem examination and monitoring the level of TNF-α as an important indicator for the animal immune and inflammatory response.

2. Material and Methods

2.1. Ethical Approval

The tests were conducted in compliance with the prerequisites and suggestions of the International Animal Ethics Committee and the Ethical Committee of the Faculty of Science, Helwan University, Cairo, and the current Egyptian Law and Directions for the protection of experimental animals to minimize negative

states (harm) and improve feeding and housing conditions, under certificate number HU2021/Z/MSO0121-01.

2.2. Prevalence of Bovine Cysticercosis

Abattoirs survey was done from the period extended from March 2022 to April 2023 through meat examination under the authority of Albsatine and Alwaraq official abattoirs in Cairo Governorate, Egypt. Two thousands one hundred twenty five of cattle and buffaloes (1125 cattle and 1000 buffloes) aged from 2 to 5 years old were exposed to meat inspection after slaughtering. At Albastatine abattoir 1300 animals (640 cattle and 660 buffaloes) and at Alwaraq abattoir 825 animals (485 cattle and 340 buffloes) were examined. Detection of cyst was conducted via applying several cuts in different organs like diaphragm, cardiac and, skeletal muscles, neck, tongue, kidney, liver and lung. Macroscopical and microscopical examinations of the collected cysts were carried out to determine the cyst viability. The cysts were recorded as non viable and degenerated when they were calcified (solid), cheesy (smooth) or dull (empty). Microscopical investigation of cysts was applied to identify the viability of the cyst through incubation of fluid evacuated from the cyst in a solution of 30% bull bile solution diluted in ordinary saline at 37˚C for 90 minutes [32].

2.3. Plants

B. aegyptiaca fruits were acquired from neighborhood markets in Cairo Governorate, Egypt. The plant materials were distinguished and affirmed by the laboratory of Medicinal and Aromatic Plants Research Department, National Research Centre. The *B. aegyptiaca* fruits were cleaned with tap water, shade-dried and mechanically ground utilizing a research facility mortar and pestle. *M. oleifera* seed were provided from the Egyptian Scientific Society for *M. oleifera* at the National Research Centre, Dokki, Giza. Seeds were powdered and kept in a closed bottle. The methanolic extract of both plants was prepared according to [33] [34] as follows: the powdered seeds of *M. oleifera* and the powdered fruit of *B. aegyptiaca* (500 g) were separately soaked in methyl alcohol (1:10) at 27˚C for 48h with shaking and then filtration was applied through filter paper for each extract. The concentration of methanolic extracts was made under reduced pressure using a rotary evaporator at 40˚C. The methanolic extracts were put at 4˚C until treatments. At the time of treatment, the prepared extract was dissolved in distilled water with the addition of a few drops of Tween-80 [35].

2.4. Parasite; *in Vitro* Hatching of Oncospheres

T. saginata adult worm was obtained from infected humans with taeniasis during stool analysis in a private hospital. The eggs of *T. saginata* were collected from the gravid proglottids of adult worms, and stored at 4˚C. *In vitro* hatched oncospheres was carried using sodium hypochlorite (0.5% in PBS) technique Sigma-Aldrich [36]. One ml of egg suspension in PBS was added with 2 ml of 1.0% NaClO and 7 ml of distilled water for approximately 4 minutes with shak-

ing to facilitate *in vitro* hatching of oncospheres, then the solution was incubated for 30 min. Centrifugation of the suspension was achieved for 10 min at 3000 rpm followed by removal of the supernatant leaving 1 ml of sediment. The sediment was rinsed with distilled water several times and the viability of the oncospheres was assessed by a microscopic examination using 0.4% Trypan blue solution Sigma-Aldrich [37].

2.5. Detection of Cysticidal Efficacy of Plant Extracts on Mice Model

2.5.1. Animals

Sixty four male mice BALB/c strain weighing 25 to 30 g and 6 - 8 weeks old were utilized. The mice were housed in a well-ventilated animal room beneath standardized conditions of 24˚C; relative humidity (50 ± 5)% and 12 h light/dark cycle. All supplements including water were provided to animals at the Animal House, National Research Center, Giza, Egypt.

2.5.2. Experiment

The mice were experimentally infected with activating oncosphere of *T. saginata* through oral administration of 5000 oncospheres in 0.5 ml PBS/mouse. After 35 days, four mice were sacrificed and inspected for the presence of cysticeri. After 60 days post infection, the mice were divided into four groups of 15 mice each. Group 1 infected untreated (controls positive), Group 2 infected and treated with *B. aegyptiaca* methanolic extract at 9 gm/kg b.w.; 2 doses three days interval [38], Group 3 infected and treated with *M. olifera* methanolic extract at 150 mg/kg b.w.; 2 doses three days interval [39], The Group 4 infected and treated with albendazole at 10 mg/kg b.w.; single dose (The Egyptian Company for Chemicals and Pharmaceuticals (ADWIA) 10th of Ramadan City) [40] and Group 5 received an equal volume of distilled water (normal control).

2.5.3. Post Mortem Examination

After 16 weeks post treatment, the mice were anesthetized using Ketamine/Xylazine Pfizer 0.1 ml/20gm mouse wt. IP, sacrificed and the internal organs were examined for cysticeri and photographed using digital camera.

2.6. Estimation of Serum Level of TNF-α

During the *in vivo* experiment that extended 16 weeks, blood samples (0.1 - 0.2 ml) were collected by retro-orbital venous plexus puncture from each mouse every two weeks post-treatment. The serum samples were stored at −20˚C till utilized. The TNF-α concentration in serum of all the experimental mice groups, was measured employed a commercial quantitative sandwich ELISA (Bioneovan Co., Ltd., https://www.inovbio.com/, Cata. No.: In-Mo1920), that was specific for mouse TNF-α and sensitive down to 5 pg/ml at wave length 450.

2.7. Statistical Analysis

Information were measurably analyzed utilizing a one-way examination of va-

riance (ANOVA) taken after by Duncan's numerous for differences between groups. Contrasts were considered significant at $P < 0.05$ for differences between groups level utilizing SPSS statistical software version 16. The Chi square test by factual computer bundle for social science (SPSS) adaptation 15.0 (SPSS Inc., Chicago, IL), and $P < 0.05$ was utilized to analyze the impact of hazard components; age, on the in general parasitic disease. Factors were significant at $P \leq 0.05$.

3. Results

3.1. Prevalence of Bovine Cysticercosis among Bovine

The post mortem inspection of 2125 animals (1125 cattle and 1000 buffaloes) carcasses at Albasatin and Alwaraq abattoirs revealed that (166/2125) 7.8% of bovine were infected with cysticercosis, separately 6.31% (71/1125) for cattle and 9.5% (95/1000) for buffaloes. Total prevalence of infection of bovine at Albasatin abattoir was recorded (94/1300) 7.23% and it was recorded that (45/640) 7.03% cattle and (49/660) 7.42% buffaloes were positive. Meanwhile, at Alwaraq abattoir 72 bovine carcasses out of 825 were infected 8.72%; (26/485) 5.36% for cattle and (46/340) 13.52% for buffaloes as presented in Table 1. The risk of age was studied as demonstrated in Table 2. It was elicited that (65/955) 6.8% of cattle more than 2 years were positive, but 6 out of 170 cattle (3.52%) were lesser than 2 years. Furthermore, (93/815) 11.4% of buffaloes more than two years were infected compared to those less than two years (2/185) 1.08%. Out of 195 collected cysts from the inspected carcasses (116/195) 59.48% were found viable and (79/195) 40.51% were degenerated (Table 3).

Table 1. Abattoirs in Cairo Governorate, Egypt.

Abattoirs	cattle			buffaloes			Total		
	Number of examined	Infected		Number of examined	Infected		Number of examined	Infected	
		No.	%		No.	%		No.	%
Albasatin	640	45	7.03	660	49	7.42	1300	94	7.23
Alwaraq	485	26	5.36	340	46	13.52	825	72	8.72
Total	1125	71	6.31	1000	95	9.5	2125	166	7.81
χ^2 value		0.33			2.33			0.600	
P-value		0.564			0.127			0.439	

Table 2. Association between the age of inspected bovine and the suspected infection with cytisercosis.

Age in years	cattle			buffaloes		
	Number of examined	Infected		Number of examined	Infected	
		No.	%		No.	%
<2	955	65	6.8**	815	93	11.4**
≥2	170	6	3.52	185	2	1.08
χ^2 value		0.818			8.333	

**High significant.

Table 3. Different viability of cysticerci in the inspected animals carcasses.

Total	Viable cysts		Non-viable cysts		χ^2 value	P-value
	No.	%	No.	%		
195	116	59.48	79	40.51	22.080	<0.001**

**High significant.

3.2. Plants Cysticidal Activity and Post Mortem Findings

After 16 weeks of treatment, the total numbers of cysticerci in mice experimentally infected with *T. saginata* oncospheres are recorded as shown in **Table 4**. On gross examination, there was a marked ($P < 0.05$) decrease in the numbers of cysticerci found in all treated groups than in the untreated infected control. In the latter, the total number of cysticerci was 36; half of them were found in the intestine. In contrast, none of the *B. aegyptiaca* treated mice had cysticerci in the intestine showing reduction superior to 88%, and most of cysticerci were recovered from kidney 50.0%. Whereas, 20.0 and 14.29% of the total number of cysticerci were recovered from the intestine of *M. oleifera* and albendazole treated mice, respectively, and most of cysticerci were recovered from peritoneum (50.0 and 42.85%, respectively) with reduction reached to 72 and 80%, respectively. Besides, the cysts of the treated groups were smaller in size than that of the control one (tumor-like cysts). Most of them had firm contents especially in *B. aegyptiaca* treated group in which the cyst was difficult to detect and appeared as a small white or yellow spot (**Figure 1**).

3.3. Serum Level of TNF-α

The dynamics of serum level of TNF-α (Th-1 pro-inflammatory cytokine) in all tested groups during 16 weeks post-treatment was determined by sandwich ELISA (**Table 5**). The data presented illustrated that the serum levels of TNF-α in mice experimentally infected with *T. saginata* oncospheres (G1) were significantly ($P < 0.001$) increased compared to the other groups (G2, G3, G4 and G5). After treatment with *B. aegyptiaca* methanolic extract (G2) the serum levels of TNF-α markedly ($P < 0.001$) decreased in comparison with the other treated groups (G1, G3, and G4), This reduction in the level of TNF-α started from the fourth week post treatment and remained later until the sixteenth week post treatment. Meanwhile Group (3) infected mice and treated with *M. olifera* seeds methanolic extract showed significant reduction ($P < 0.001$) in the level of TNF-α in comparison with the G1 and G4, this reduction in the level of TNF-α started from the second week post treatment until the sixteenth week post treatment. On the other hand, the level of TNF in Group (4) mice infected with *T. sagenita* oncospheres and treated with albendazole (G4) showed significant increase in the level of TNF-α in comparison with G2, and G3, this elevation from the fourth week post treatment.

Table 4. Effect of *B. aegyptiaca*, *M. oleifera*, and albendazole on reduction of number *T. saginata* cysticerci of mice in comparison to the untreated control group.

Group	Total No. of cysts	Percentage of *T. saginata* cysticerci in the internal organs								Reduction %
		Intestine	Peritoneum	Thorax	Muscles	Liver	Lung	Kidney	Leg	
Control infected	36	50.0	11.11	11.11	8.33	5.56	8.33	0.0	5.56	
B. aegyptiaca	4	0.0	25.0	0.0	0.0	25.0	0.0	50.0	0.0	88.89 ± 9.32
M. oleifera	10	20.0	50.0	0.0	0.0	0.0	30.0	0.0	0.0	72.23 ± 10.80
Albendazole	7	14.29	42.85	0.0	28.57	14.29	0.0	0.0	0.0	80.56 ± 13.60

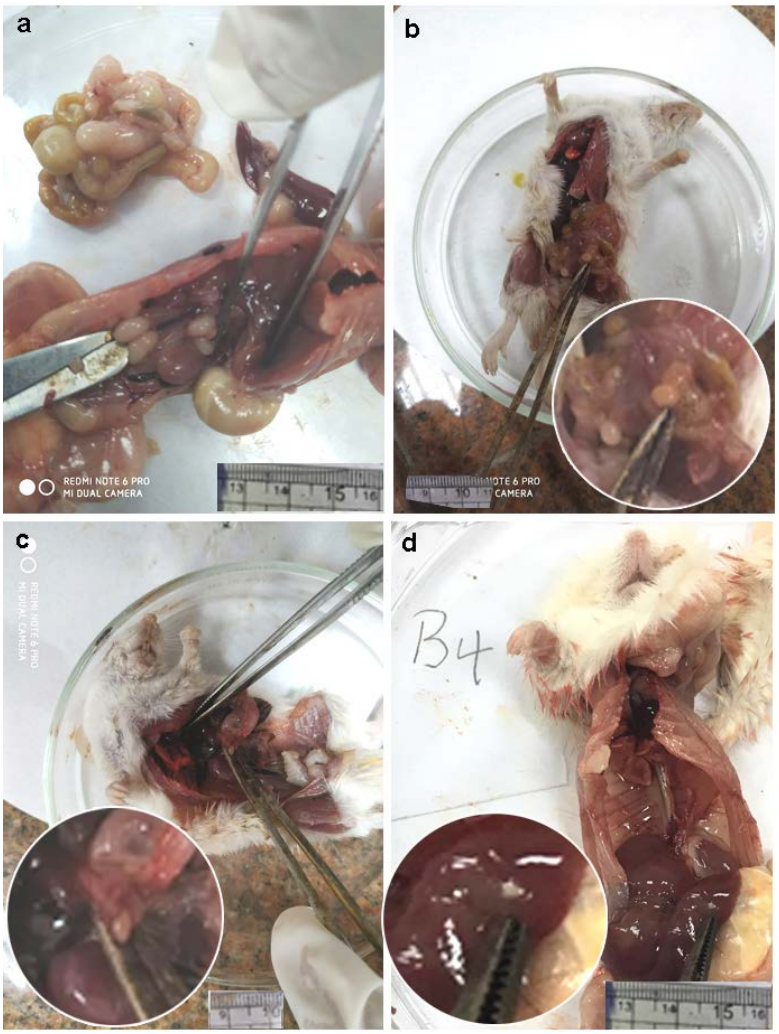

Figure 1. Macrographs showing cysts in internal organs of the different groups of BALB/c mice at the 16th week post treatment. (a) Untreated infected control group; (b) Albendazole treated group; (c) Moringa treated group; (d) Balanites treated group.

4. Discussion

Bovine cysticercosis is a major obstacle affecting livestock production due to the losses in the meat industry resulting from meat condemnation [1] [2]. The current study revealed that the prevalence of the disease among slaughtered bovine

Table 5. The dynamics of serum level of TNF-*α* in all treated groups during 16 weeks post-treatment.

Animal groups/ Experimental weeks post treatment	Group (1) infected untreated (pg/ml)	Group (2) infected and treated *B. aegyptiaca* methanolic extract (pg/ml)	Group (3) infected and treated with *M. olifera* methanolic extract (pg/ml)	Group (4) infected and treated with albendazole (pg/ml)	Group (5) Normal control (pg/ml)	F value	P value
1st week	456.7 ± 3.73^{a}	162.5 ± 1.5^{dA}	182.1 ± 2.46^{cA}	282.7 ± 2.22^{bD}	63 ± 1.0^{e}	2.988	<0.001
2nd week	456.57 ± 2.27^{a}	159.3 ± 2.3^{cA}	172.9 ± 10.3^{cAB}	287.4 ± 3.55^{bD}	60 ± 3.0^{d}	584.21	<0.001
4th week	445.1 ± 1.0^{a}	142.1 ± 1.45^{dB}	165.8 ± 5.9^{cBC}	322.6 ± 1.40^{bC}	62 ± 2.1^{e}	2.006	<0.001
6th week	458.6 ± 18.0^{a}	119.4 ± 3.44^{dC}	163.7 ± 2.8^{cBC}	332.0 ± 13.7^{bC}	63 ± 1.0^{e}	182.89	<0.001
8th week	461.7 ± 2.2^{a}	114.0 ± 1.0^{dD}	157.6 ± 2.1^{cC}	382.8 ± 7.3^{bA}	61 ± 3.0^{e}	1.796	<0.001
10th week	456.0 ± 2.2^{a}	111.8 ± 1.2^{dD}	153.4 ± 1.45^{cCD}	380.8 ± 3.02^{bA}	64 ± 2.0^{e}	6.450	<0.001
12th week	473.6 ± 13.0^{a}	101.8 ± 1.06^{dE}	141.4 ± 1. 0^{cD}	397.5 ± 1.47^{bA}	62 ± 1.5^{e}	790.34	<0.001
14th week	463.4 ± 19.0^{a}	100.7 ± 1.2^{cE}	123.5 ± 1.0^{cE}	354.5 ± 2.6^{bB}	62 ± 2.0^{d}	338.86	<0.001
16th week	465.5 ± 2.9^{a}	98.3493 ± 1.0^{cE}	101.4 ± 3.42^{cF}	338.3 ± 1.0^{bBC}	60 ± 1.0^{d}	6,315	<0.001
F value	0.621	207.658	33.177	53.582	0.731		
P value	NS	<0.001	<0.001	<0.001	NS		

Different small letters at the same row indicate to significant differences between animal groups while different capital letters at the same column indicate to significant differences between weeks post treatment at P ≤ 0.05, NS = Non-significant. pg/ml = picogram/milliliter. All data were statistically analyzed and presented as means ± standard error (SE).

at Albasatin and Alwaraq abattoirs in Cairo Governorate, Egypt were 7.8%, separately 6.31% for cattle and 9.5% for buffaloes. These results might be in accordance with that reported by [41] who reported that 9.07% of buffaloes slaughtered in Kaliouba Governorate, were infected with cysticercosis. Besides, [6] who found that 7.3% of the inspected cattle in North Egypt had cysticercosis lesions during postmortem inspection. Moreover, similar findings were observed by [5] in Egypt where the infection rate was (7.5%). Lower infection rate than our findings were recorded by [42] in Nigeria 3%, and [43] 3.6% in Ethiopia [8] conducted a cross-sectional study on the disease, in slaughtered cattle at municipal abattoirs in Ethiopia and recorded very high prevalence 27.3%. These differences in the prevalence might be due to variation in the climate conditions, immune status of animals and the followed hygienic and control measures in the suspected areas around world.

Concerning the age, this study declared that the infection rate was significantly higher in adult cattle than young ones. That was in agreement with [44] while [45] revealed that the age factor did not affect the prevalence of the disease among cattle. The findings elicited that 59.48% of the collected cysts were viable while 40.51% were degenerated. This result was consistent with [41] while it disagreed with [8] who detected that the degenerated cysts were more than the viable ones. Major financial losses were recorded through condemnation of meat containing cystiserci during inspection of cattle carcasses. So, Adequate preven-

tion and treatment of the diseases is a must. Albendazole is used in treament of cysticercosis [46]. On oral administration of albendazole, albendazole sulphone, an inactive form of albendazole, was promptly biotransformed from the active intermediate metabolite albendazole sulphoxide. Albendazole has a low water solubility similar to other benzimidazole carbamates, which limited its oral absorption and reduced its bioavailability [47]. However, some studies demonstrated an elevated cysticidal activity of albendazole and high percentage of reduction in the number of *T. saginata* cysticerci after treatment reached to 100% for animals treated with 7.5 mg/kg dosage on the 40th day after treatment [48]. Besides, [49] reported that ABZ induced degenerative alterations in parasite tegument cells, damaging its metabolism, resulting in immobilization and death of the cyst. On contrary, [46] suggested that albendazole had inconsequential viability values against *T. saginata* hatchings parasitizing tentatively contaminated bovines. But, there is a lot of interest in creating new cysticidal medications, particularly ones derived from medicinal plants that possess a variety of bioactive substances that may result in a variety of parasite-killing processes, and limiting the likelihood of anthelmintic resistance.

In the present study, there was a marked decrease in the numbers of cysticerci found in all treated groups and up to 88% reduction was achieved in the *B. aegyptiaca* treated group; higher than that was recorded in both *M. oleifera* and albendazole treated ones. The number of cysticerci recovered in different parts of the animals that the rate of absorption of dead cysts was more note worthy within the muscles, thorax and leg than within the intestine, but in *Balanites* treated group that appeared the greatest absorption of dead cysts in the intestine. Indeed, the effect of this difference in the rate of absorption was to change the overall distribution of cysticerci within the animals. Thus in *Balanites* treated group, the majority of cysticerci (50%) was found in kidney, whereas in *Moringa* and albendazole treated groups, 50 and 42%, respectively, of the total remaining cysts were found in the peritoneum. These findings might be attributed to the bioactive compounds present in the plant extracts which induced different parasiticidal mechanisms. Previous publications concerning *B. aegyptiaca* promising anthelmintic efficacy [50] [51] [52] [53] and [18] were available. *B. aegyptiaca* had a high saponin content and a high potency of anthelmintic activity as assured by [54]. The destructive effect of saponins was linked with their capacity to combine with the cholesterol molecules existing in cuticle membranes of the larvae and herewith led to damage of membrane integrity [55].

Concerning *M. oleifera*, it was recorded to hold various bioactive as polyphenols, phenolic acids, flavonoids, alkaloids, glucosinolates, isothiocyanates, tannins and saponin and thiocarbamates [56] and [34], with pharmacological activities such as antiparasitic property [57]. Moreover, [24] proved that *M. oleifera* methanolic extract had fasciolicide activity and the hepato-protective impacts on rabbits experimentally infected with *Fasciola hepatica*. Phytochemical screening detected tannins in the ethanolic extract as the primary secondary metabolites in

M. oleifera seeds and were implicated in some plants for helminthicidal activities [58]. In addition to the essential oil, flavonoid, flavones which have been previously reported to have an antiparasitic effect [59].

It was reported that TNF-α serum level has an importante role in regulating inflammation both locally and systemically [60]. TNF-α produced by activated lymphocytes, macrophages, neutrophils, mast cells, eosinophils, and neurons. In the present study the TNF-α cytokine production is significantly elevated in mice experimentally infected with *T. saginata* oncospheres (G1) this result was consistent with [61] who studied postoncosphere development in an *in vitro* model and the capacity of *Taenia solium* and *Taenia saginata* for in vivo infection. They recorded that *T. saginata* 30-day postoncosphere stimulated a profile of pro-inflammatory cytokines (IL-1, IL-6, IL-12, TNF-α), as well as a combination of TH1 and TH2 related cytokines (IL-4, IL-5, IL13 and IFN-γ) that was stronger than the response produced by *T. solium*. Suggesting that this global immune response stimulated by different forms could permit survival or destruction of the parasite depending of their life-cycle stage. Following treatment of infected mice with *B. aegyptiaca* (G2) showed significant reduction in the level TNF-α started from the fourth week post treatment. Previous studies showed that *B. aegyptiaca* fruits exhibit potent anti-inflammatory effect. The anti-inflammatory response of *B. aegyptiaca* could be attributed to polyphenols, which affect macrophages by inhibiting a number of crucial inflammatory response regulators, including TNF-α [62]. Furthermore, flavonoids have been shown to have the capacity to lower the levels of a number of pro-inflammatory cytokines such as TNF-α [63].

Results of the present study revealed that, therapeutic administration of *M. oleifera* seeds extract caused a significant decrease in serum TNF-α level. The anti-inflamatory effect of *M. oleifera* seeds attributed to isothiocyanates which have been proved to have anti-inflammatory as well as immunomodulatory activities [64]. In addition to isovitexin which has been reported to be responsible for inhibition of TNF-α level [34]. On the other hand, a significant increase in the serum TNF-α level was seen in the mice infected with *T. saginata* oncospheres and treated with albendazole (G4) which is similar to the finding of [15] who found that the sudden destruction of the parasite by a cysticidal drug is accompanied by acute inflammation and significant up regulation of TNF-α. Also A remarkable feature of *Taenia* infections is that damaged cysts by anthelmintic treatment provoke inflammatory responses [65].

5. Conclusion

It was concluded that bovine cysticercosis is a common disease among bovine; cattle and buffaloes in Egypt. The *B. aegyptiaca* fruits and *M. oleifera* seed methanolic extracts possessed both potent anti parasitic and anti-inflammatory effects against *T. saginata* cysticercosis. The *in vivo* efficacy of *M. oleifera* extract was comparable to a commercial anthelmintic and the *B. aegyptiaca* extract was

superior in reduction of cysticerci numbers.

Author Contributions

Conceptualization and Supervision, O.M.K. and H.S.A.; Methodology, O.M.K., N.M.F.H., D.S., H.M.A., N.M.T.A., S.M.K. and M.S.A.; Validation, O.M.K., E.M.A. Y.L. and E.O.; Formal Analysis, O.M.K., H.S.A., D.S. and N.M.F.H.; Writing Original Draft Preparation, O.M.K., H.S.A., N.M.F.H. and D.S.; Writing, Review & Editing, O.M.K., H.S.A., N.M.F.H., D.S. and H.M.A. All the authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

The macrographs data used to support the findings of this study are included within the article

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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