# EFFECT OF GINGER ON HAMSTERS INFECTED BY *GIARDIA LAMBLIA*

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## ABSTRACT

The present work was carried out to evaluate the effect of ginger extract, a natural product extracted from roots of *Zingiber officinal*, in addition to Ginger Drug against *Giardia lamblia* in infected hamsters. Seventy laboratory-bred hamsters were used in the current experimental study. Hamsters were divided into 7 groups, normal control, infected control, infected treated with metronidazole, infected treated with ginger drug and, ginger plant extract Combined treatment of metronidazole with either Ginger drug or ginger plant in a half dose each were also given to a group of infected animals.

After oral infection with *G. lamblia* cysts, treatment was given 3 weeks post infection after stool examination.The drugs were given for 7 days in a single oral dose, followed by scarification of all hamsters 2 weeks after the end of treatment. The highest percentages of reduction in the number of Giardia cysts and trophozoites were in the group receiving combined therapy followed by metronidazole treated group then the ginger drug and lastly the ginger plant treated group.

Histopathological examination revealed complete healing of intestinal mucosa after the combined treatment, while partial healing of the lining epithelium of the intestine was noticed after metronidazole and either ginger drug or ginger plant treatment.

## INTRODUCTION

*Giardia lamblia* is a flagellated unicellular enteric protozoan pathogenic to digestive system of humans causing giardiasis (Thompson *et al.*, 2000). The clinical presentation of giardiasis range from an asymptomatic cyst excreting state to diarrhea which can be acute, chronic or intermittent (Rickard *et al.*, 1999) Also, Giardia infection have been associated with growth failure due to nutrient malabsorption ( Berkman *et al*., 2002) .

Giardia infection is mostly associated with developing countries, where compromised hygiene infrastructure might lead to increased transmission and endemic establishment of such diseases (Savioli, 2006). In industrialized countries, Giardia causes outbreaks of diarrheal diseases in day-care centres and water-associated outbreaks (Robertson *et al*., 2010).

There are some agents to treat giardiasis such as metronidazole, tinidazole, furazolidone, paramomycin and nitazoxanide (Davila *et al*., 2002). However, many problems are associated with the currently used chemotherapeutic agents including treatment failure, unpleasant side effects, activity against normal intestinal flora, possible carcinogenicity and Parasite resistance (Petri, 2003).

In order to improve the current chemotherapy of Giardia infection, potential antigiardial agents have been screened, including natural plant extract products (Hawrelak, 2003).

## MATERIAL AND METHODS

### Experimental animals:

The present study was conducted on seventy laboratory bred male Syrian hamsters (*Mesocricetus auratus*) with a weight range of 100-110 gm. The animals were provided by Schistosome biological supply program (SBSP) in Theodor Bilharz Research Institute (TBRI).

Throughout the study, the animals were kept on a standard diet containing 24% protein, 4% fat and about 4-5% fiber and water ad-libidum in the biological unit of TBRI under a temperature of 24 C.

### Ethics:

Anesthetic procedures complied with the ethical guidelines approved by the Ethical Committee of the Federal Legislation and National Institutes of Health Guidelines in USA were approved by the Medical Ethical Committee of Theodor Bilharz Research Institute (TBRI) in Egypt.

### Drug administration:

1- Metronidazole (Flagyl) was given orally in a suspension form in a dose for 7 mg/hamster/day for seven consecutive days (Mahmoud and Shalaby, 2006).

2-Ginger in a dose of 200 mg/hamster/day and dimethylsulphoxide 1% (DMSO) were dissolved in 99% distilled water. The suspension was orally given for 7 consecutive days. The doses were calculated by extrapolation of human therapeutic doses to animal doses according to the table of Paget and Barnes (1964).

3- Ginger plant extract was given orally in a dose of 200 mg /hamster/day.

### Preparation of *Zingiber officinale* extract:

### Plant collection:

Rhizome of Z.officinale were purchashed from the local market, the Rhizome were cut, washed with distilled water.

### Extraction:

The fresh catted roots of Z*ingiber officinale* (30 gm) soaked in 75% (1L*3) methanol for 4 weeks. The methanol solution was evaporated under vacuum using rotatory evaporator (Bushi) to give 300ml of crude methanol extract; the latter was dissolved in DMSO.

### Experimental design:

All animals included in the present study were divided into 7 groups according to the drug they received.

Group A: Control group; comprising 10 healthy hamsters which were not infected and received no treatment.

Group B: Infected control group: comprising 10 hamsters which were infected with *Giardia lamblia* cysts and received no treatment.

Group C: comprising 10 infected hamsters receiving Metronidazole.

Group D: comprising 10 infected hamsters received full dose of ginger drug.

Group E: comprising 10 infected hamsters receiving full dose of ginger plant extract.

Group F: comprising 10 infected hamsters received a combination of metronidazole in reduced dose of 3.5mg/hamster/day and ginger drug in a reduced dose of 100 mg/ hamster /day for 7 consecutive days' oral doses

Group G: comprising 10 infected hamsters received a combination of metronidazole in a reduced dose of 3.5 mg/hamster/day and ginger plant extract in reduced dose of 100 mg/ hamster /day for 7 consecutive days oral doses.

## Infection of animals:

Hamsters included in groups B, C, D, E, F and G were orally infected with *Giardia lamblia* cysts using esophageal tube. Extraction of Giardia from stool: *Giardia lamblia* cysts used for infection of hamsters included in the present study were obtained from diarrheic patients attending the outpatient clinic of TBRI. The stool samples of infected patients were collected in sterile clean stool cups taking care that the specimens were not contaminated with water or urine. After collection of stool samples, they were repeatedly sieved and washed using normal saline to obtain the cysts to concentrate the cysts. Each hamster was infected with *Giardia lamblia* cysts in a dose of 10000 ±1 cysts.

The infecting dose was calculated by taking the average of 3 counts, each of them done in 1 ml of stool sediment. Three weeks after infection of hamsters, stool samples were collected and subjected to parasitological examination to detect *Giardia lamblia* cysts and to ensure that hamsters have been infected. Hamsters included in group B, C, D, E, F and G were given the corresponding drug for 7 consecutive days, and three weeks post infection.

Two weeks after administration of drugs, stool specimens were collected from infected hamsters and subjected to parasitological examination to count the number of *Giardia lamblia* cysts per each gram of stool, then animal sacrifice was undertaken.

### Collection of stool samples:

Fecal samples of hamsters were collected in clean, wide mouthed containers with tight-fitting covers. The sample should not be contaminated with water or urine for subsequent microscopic examination.

### Parasitological examination of stool samples:

All stool samples were subjected to:

a) Direct examination: done according to Baroody (1946) Wet films were examined directly by light microscopy using saline and iodine for detection of parasites.
b) Merthiolate-iodine-formaldehyde-concentration method (MIFC): done according to Blagg *et al*. (1955).

## Animal scarification:

Scarification of animals was done 2 weeks after administration of drugs and was performed by intraperitoneal anesthesia. The upper part of small intestine was removed and subjected to histopathological examination, also, the duodenal contents were subjected to parasitological examination in order to count the number of *Giardia lamblia* trophozoite in 5 successive fields /animal.

### *Histopathological examination:*

After scarification of hamsters, their small bowels were removed. Three segments of one cm length each were excised at a distance 5, 15 and 25 cm from the gastro duodenal junction. The excised segments were submitted to histopathological examination as follows:

The excised segment was opened longitudinally, oriented on a filter paper and fixed in 4% formaldehyde. After fixation; the tissues were processed for paraffin embedding. Histopathological sections of 4 mm thickness were stained with haematoxylin-eosin. They were examined microscopically under low power (X200) and high power (X400) to detect histopathological changes that occurred due to Giardiasis and to assess the degree of healing of intestinal mucosa after drug administration.

## Statistical analysis:

-Data were coded and entered using the statistical packages SPSS version 12.
-Data were summarized using mean and standard deviation for quantitative variables and qualitative variables.
-Comparisons between groups were done using chi square test for qualitative variables and analysis of variants (ANOVA) and multiple comparison post Hoc test for quantitative variables.

-P values lower than 0.05 were considered as statistically significant.

## RESULTS AND DISCUSSION

### a- **Results of stool examination (cyst count):**

The number of *Giardia lamblia* cysts per each gram of stool of hamsters two weeks after administration of drugs was 12134±1573 cysts/gm in group B (infected hamsters receiving no treatment), 985±214 cysts/gm in group C (infected hamsters treated with metronidazole), 5426±521 cysts/gm in group D (infected hamsters treated with ginger drug) and 569±145 cysts/gm in group E (infected hamsters treated with metronidazole and ginger drug in a half dose each).

The number of *Giardia lamblia* cysts showed a percentage of reduction of 91.88% in group C, 55.28% in group D ,95.31% in group E , 39.49% in group F and 86.12%in group G when compared to the number of *Giardia* cysts in stool of group B (control infected group). These data are shown in table (1). The difference in the number of *Giardia* cysts between groups C , D, E,F,G and group B was statistically significant (P value <0.001).

**Table (1): The number of *Giardia* cysts and the percentage of reduction in the stool of infected hamsters two weeks after administration of drugs.**

| Animal groups | No. of *Giardia* cysts/gm stool 2 weeks after treatment (Mean ± SD) | Percentage of reduction in number of *Giardia* cysts |
|---|---|---|
| Group B (Infected untreated) | 12134 ± 1573 | |
| Group C (Infected treated with metronidazole) | 985 + 214 | 91.88%*** |
| Group D (Infected treated with ginger drug) | 5426 + 521 | 55.28%** |
| Group E (Infected treated with ginger drug and metronidazole) | 569 ± 145 | 95.31%*** |
| Group F(Infected treated with ginger plant) | 7342 + 862 | 39.49%* |
| Group G(Infected treated with ginger plant and metronidazole) | 1684 ± 279 | 86.12%*** |

**** High significant difference between treated and untreated group P> 0.001.*
*** Moderate significant difference between treated and untreated group P> 0.01.*
****** Low significant difference between treated and untreated group P> 0.05.*

### b- **Examination of the contents of small intestine of hamsters (trophozoite count):**

The number of *Giardia lamblia* trophozoites/H.P. F. in the contents of the small intestine 2 weeks after administration of drugs was 195 ± 94.92 cysts/gm in group B (infected hamsters receiving no treatment), 25.24 ± 8.72 cysts/gm in group C (infected hamsters treated with metronidazole), 104.15± 28 cysts/gm in group D (infected hamsters treated with ginger drug) and 10.53± 3.42 cysts/gm in group E (infected hamsters treated with metronidazole and ginger drug in a half dose each).

The number of *Giardia lamblia* trophozoites showed a percentage of reduction of 87.06% in group C, 46.6% in group D and 94.6% in group E, 37.77% in group F and88.5% in group G as shown in table (2). The difference in the number of *Giardia* trophozoites/H. P. F. between groups C, D, E ,F ,G and group B was statistically significant (P value <0.001).

**Table (2): The number of *Giardia* trophozoites and percentage of reduction in the contents of the small intestine of infected hamsters two weeks after administration of drugs.**

| Animal groups | No. of Giardia trophozoites/H.P.F. in contents of small intestine (Mean ± SD) | Percentage of reduction in Giardia trophozoites in small intestine contents |
|---|---|---|
| Group B (Infected untreated) | 195 + 94.92 | |
| Group C (Infected treated with metronidazole) | 25.24 + 8.72 | 87.06%*** |
| Group D (Infected treated with ginger drug) | 104.15 + 28 | 46.6%** |
| Group E (Infected treated with ginger drug and metronidazole) | 10.53 ± 3.42 | 94.6%*** |
| Group F(Infected treated with ginger plant) | 121.34 + 35 | 37.77%* |
| Group G(Infected treated with ginger plant and metronidazole) | 22.42 ± 4.25 | 88.5%*** |

**** Highly significant difference between treated and untreated group P> 0.001.*
*** Moderate significant difference between treated and untreated group P> 0.01.*
** Low significant difference between treated and untreated group P > 0.05.*

### 1. Histopathological results of group A (normal control group):

Histopathological examination of sections of small intestine of hamsters in this group showed normal villous architecture with average length and width of villi. Goblet cells were moderate in number with a healthy well defined brush border as demonstrated in Figure (1).

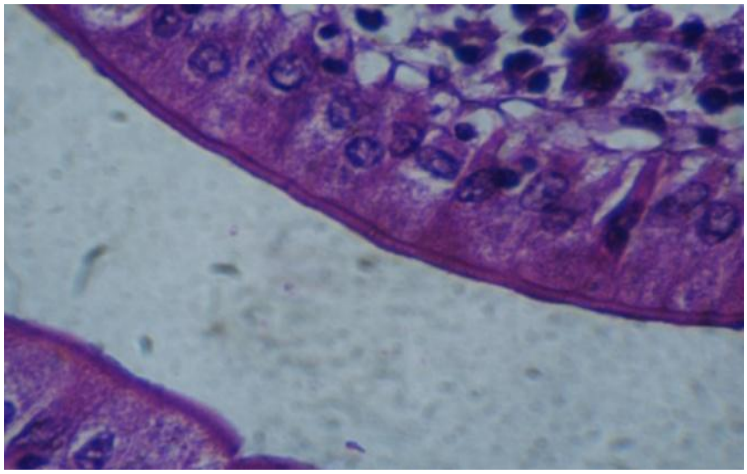

**Fig. (1): Section of small intestine in group A (normal control group) showing normal villous architecture with normal brush border (H & E stain x1000).**

### 2- Histopathological results of group B (infected control group):

Histopathological examination of sections of small intestines of hamsters in group B (infected with no treatment) revealed profound histopathological changes in the morphology of the intestinal mucosa as a result of infection with *Giardia lamblia.* These changes included shortened broad villi, decreased ratio of villous height to crypt length, goblet cell depletion, mucosal ulceration and infiltration of lamina propria with inflammatory cells mainly lymphocytes and esinophils. Also, *Giardia lamblia* trophozoites were detected in the intestinal lumen and between the villi as demonstrated in figure (2).

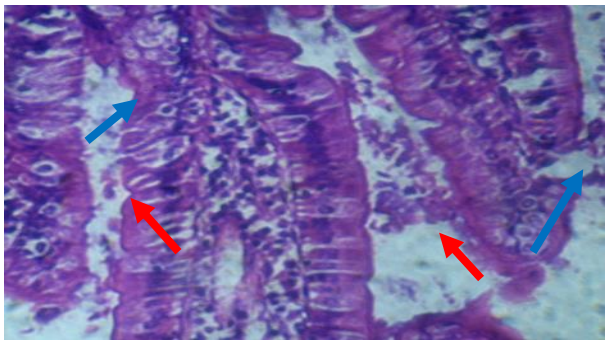

**Fig. (2): Section of small intestine in group B (infected control group) showing *Giardia lamblia* trophozoite in the intestinal lumen (red arrows) and shortened broad villi with showing ulceration of the lining intestinal epithelium (blue arrow) (H & E stain x 400).**

### 3. Histopathological results of group C (infected treated with metronidazole):

Histopathological examination of sections of small intestine of infected hamsters in this group treated with metronidazole showed improvement in the histopathological changes following *Giardia* infection. Evidences of improvement included partial healing of the intestinal mucosa with focal flattening of surface enterocytes. Mild depletion of goblet cells, mild decrease in the ratio between villous height to crypt length, focal infiltration with inflammatory cells in the lamina propria and partial mucosal ulceration were detected. A small number of *Giardia lamblia* trophozoites were still detected in the lumen as shown in Figure (3).

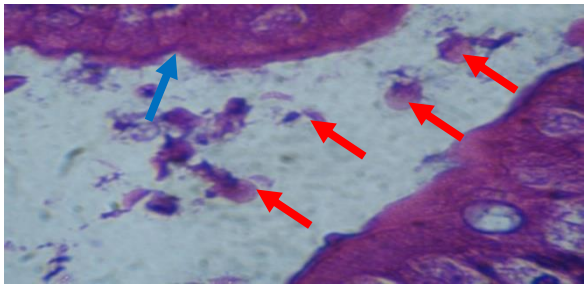

**Fig. (3): Partial healing of the lining epithelium with mild flattening of villi of the intestine of hamsters after metronidazole treatment (H & E stain x 1000).**

### 4. Histopathological results of group D (infected treated with ginger drug):

Histopathological examination of sections of small intestine of infected hamsters included in this group treated with ginger drug showed improvement in the histopathological changes following *Giardia* infection. Evidences of improvement included partial healing of the intestinal mucosa and mild shortening and thickening of villi. Partial mucosal ulceration, mild depletion of goblet cells, mild decrease in the ratio between villous height to crypt length and focal infiltration with inflammatory cells in the lamina propria was detected. A small number of *Giardia lamblia* trophozoites were detected in the lumen as shown in Figure (4).

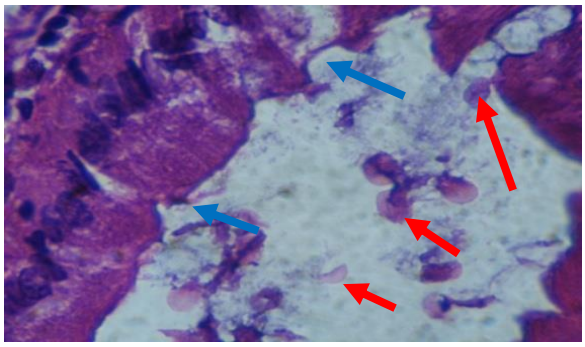

**Figure (4): Partial healing of the intestinal villi of hamsters in group D after ginger drug treatment with some ulcerated areas (blue arrow) could be detected (H &E stain x1000).**

**5. Histopathological results of group E (infected treated with metronidazole and ginger drug in reduced dose):**

Histopathological examination of sections of small intestine of hamsters given combined therapy (group E) revealed a significant improvement of the histopathological changes in the form of complete healing of intestinal mucosa, preserved brush border, absence of mucosal ulceration, normal villous architecture, very mild depletion of goblet cells, patchy inflammatory cellular infiltration of lamina propria, ratio between villous height to crypt length more or less preserved and no *Giardia lamblia* trophozoites could be detected as shown in figure (5).

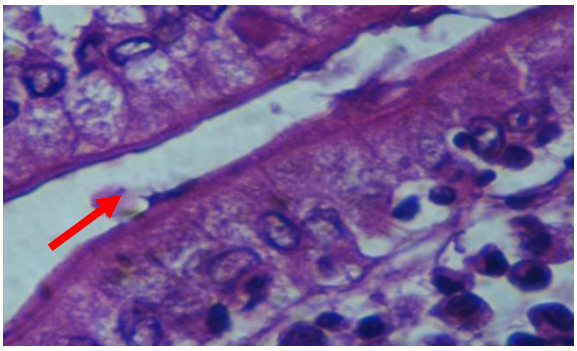

**Fig. (5): Partial healing of the lining epithelium with mild flattening of villi of the intestine of hamsters after ginger drug and metronidazole treatment (H & E stain x 1000).**

**6. Histopathological results of group F (infected treated with ginger plant):**

Histopathological examination of sections of small intestine of infected hamsters included in this group treated with ginger plant extract showed improvement in the histopathological changes following *Giardia* infection. Evidences of improvement included partial healing of the intestinal mucosa and mild shortening and thickening of villi. Partial mucosal ulceration, mild depletion of goblet cells, mild decrease in the ratio between villous height to crypt length and focal infiltration with inflammatory cells in the lamina propria was detected. A small number of *Giardia lamblia* trophozoite were detected in the lumen as shown in figure (6).

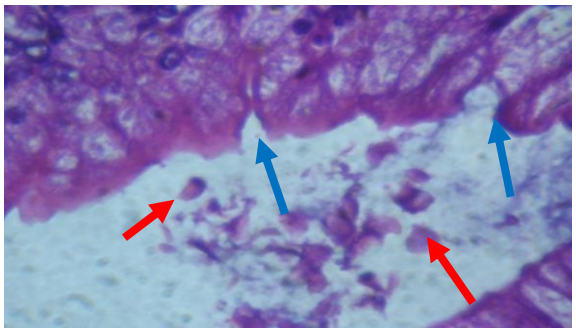

**Fig. (6): Partial healing of the intestinal villi of hamsters in group after ginger plant treatment with some ulcerated areas (blue arrow) could be detected) H & E stain x1000).**

## 7. Histopathological results of group G (infected treated with metronidazole and ginger plant):

Histopathological examination of sections of small intestine of hamsters in metronidazole and ginger plant treated group (group G) revealed a significant improvement of the histopathological changes in the form of complete healing of intestinal mucosa, preserved brush border, absence of mucosal ulceration, normal villous architecture, very mild depletion of goblet cells, patchy inflammatory cellular infiltration of lamina propria, ratio between villous height to crypt length more or less preserved and no *Giardia lamblia* trophozoites could be detected as shown in figure (7).

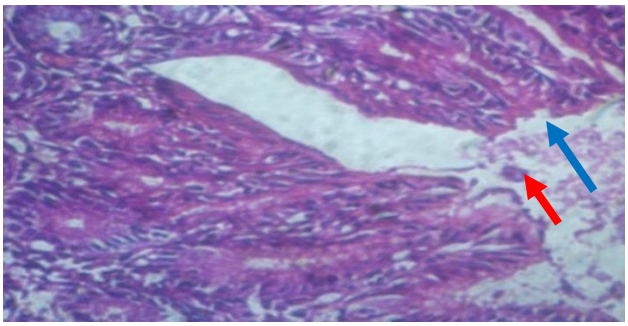

**Fig. (7): Partial healing of the lining epithelium with mild flattening of villi of the intestine of hamsters after ginger plant and metronidazole treatment (H & E stain x 400).**

*Giardia lamblia* infection is a common protozoan causing diarrheal diseases Worldwide (Adam, 2001). Giardia is unicellular parasite that resides in small intestinal lumen, attaches to the epithelium and overlying mucus and causes mild or mucosal inflammation.

Usually, most infections are controlled by an effective immune response, but some individuals develop chronic disease, as it is unclear what immune mechanisms are responsible for effective control of infections as reported by Faubert (2000) and Eckmann (2003).

In this work the marketed drug ginger was given to hamsters experimentally infected with *Giardia lamblia* cysts. The use of ginger drug revealed or significant reduction in the number of Giardia cysts 2 weeks post treatment (55,28%) metronidozole in its full dose revealed a very high significant reduction cysts count in stool (91,88%) when the dose of metronidozole is reduced to the half in the combination therapy regimens (metronidazole + ginger) the reduction in cysts count reached (95,31%).

The use of ginger plant extract similarly reduced cyst number but far less significant (39, 49%).The combination therapy (metronidozole + ginger plant extract) also revealed a significant reduction in cyst count in stool (86, 12%) but still less than (metronidozole + ginger drug). The same comment in this work applies to trophozoite count in small intestine where the percentage reduction (94.6%) reached after using combination regimen (ginger and honey) also

yielded higher percentage reduction in parasite burden then each compound individually (Al-masoudy, 2011).

The combination of lauric acid and metronidozole the treatment of *Giardia lamblia*, revealed high percentage of reduction in cyst count in stool and vegetative forms in the small intestine (Aly *et al.,* 2012). Addition of *Ailanthus altissimo* to metronidozole, the drug most currently used for treatment of giardiasis, revealed the highest percent reduction (Shalaby *et al*., 2008). More trials using different natural compound at different doses with different time intervals are highly indicative to give the highest efficacy to the available used drugs especially in endemic areas, (Mahmoud and Shalaby, 2006).

As regards the histopathological changes, *Giardia lamblia* trophozoites were detected in the intestinal lumen and in between the villi in group B. These findings were in accordance with (Randhawa *et al*, 1994) who revealed variable histopathologic changes ranging from partial to complete villous atrophy and inflammatory infiltrate attributed to Giardia infection. Similar histopathological findings were reported by Eckmanne and Gillin (2001).

In the current study, histopathological examination of the infected group treated with metronidozole revealed an improvement in the form of partial healing of the intestinal mucosa, mild shortening and thickening of villi with focal flattening of surface enterocytes and mild depletion of goblet cells. The ratio between villous heights to crypt length was mildly decreased and there was focal infiltration of inflammatory cells in the lamina propria and partial mucosal ulceration. Few *Giardia lamblia* trophozoites were detected in the lumen. In agreement with the present results regarding the histopathological changes following metronidozole treatment, Amer *et al*. (2007) and Fahmy *et al*. (2008) reported partial healing of intestinal villi after metronidozole treatment.

Histopathological examination of the infected group treated with ginger revealed an improvement in the form of partial healing of the intestinal mucosa, mild shortening and thickening of villi. Partial mucosal ulceration, mild depletion of goblet cells, mild decrease in the ratio between villous heights to
Crypt length and focal inflammatory cells in the lamina propria were detected.

A small number of *Giardia lamblia* trophozoite was detected in the lumen. Also, combined treatment with metronidozole and ginger was evaluated on the basis of histopathological changes. Examination of sections of small intestine revealed marked improvement of the histopathological changes in the form of complete healing of intestinal mucosa, preserved Bruch border, absence of mucosal ulceration, normal villous architecture, and mild depletion of goblet cells and patchy inflammatory cellular infiltration of lamina propria.

In the present work, the combined administration of metronidozole and ginger reported good evidences of cure when compared to the results obtained following administration of the two separately. This can be explained by a potential synergistic effect as each of the two drugs has a different mechanism of action. In the present study, histopathological examination of the infected control group revealed profound effect on the structure of the intestinal mucosa in comparison with the non-infected control group. This effect was in the form of villous shortening and atrophy, decrease in the ratio of villous height to crypt length, goblet cell depletion, mucosal ulceration and infiltration of lamina propria with inflammatory cells mainly lymphocytes and esinophils with diffuse loss of brush border micro villous surface area.

The ratio between villous heights to crypt length was more or less preserved and no *Giardia lamblia* trophozoites could be detected. It has been shown that ginger (and some of its constituents) is effective against cytokines synthesized and secreted at sites of inflammation (Grzanna *et al.,* 2005). Cytokines are small proteins secreted at sites of inflammation by lymphocytes, macrophages, fibroblasts and other cells, and act as chemical messengers between cells involved in immune and inflammatory responses. Ginger was found to modulate some biochemical pathways activated in chronic inflammation (Grazanna *et al.,* 2005).

# CONCLUSION

It could be concluded that ginger offers an alternative therapy to be used in place of, or concurrently with conventional anti-protozoals used for treatment of giardiasis. The combination of ginger and metronidozole for the treatment of *Giardia lamblia* revealed high percentage of reduction in cyst count in stool and vegetative forms in the small intestine. Additionally, the combined treatment with metronidazole and ginger displayed marked improvement of the histopathological changes of the small intestine caused by *Giardia lamblia* infection. In addition the best cure rates were obtained following combined treatment of metronidazole together with ginger drug or ginger plant extract.

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## تأثير نبات الزنجبيل على الهامستر المعداه بالجياردیا لامبليا

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أهمية البحث الحد من الآثار السلبية التي يسببها هذا المرض ويوجد 2.5 مليون شخص يموتون سنويا بسبب الإسهال الناتج عن هذا المرض.

وقد أجريت هذ ة الدراسة على70 فأرا من فئران الجرذ الذهبى (الهامستر) حيث تراوحت اوزانهم من 100 الى110 جرام ثم قسمت الفئران الى 7 مجموعات و هم :مجموعة ضابطة ، مجموعة ضابطة معداة بالجياردیا و لم تأخذعلاج, اما فأرا المتبقيون تم عدواهم عن طريق الفم ب10000 حويصلة من الجياردیا لامبليا لكل فأر منهم.

وقد قسموا الى خمسة مجموعات و هم:1- مجموعة معداة مجموعة اخذت الميترونيدازول جرعة كاملة2- مجموعة اخذت دواء الزنجبيل جرعة كاملة, 3- مجموعة اخذت مستخلص الزبجبيل جرعة كاملة 4-مجموعة اخذت الدوائين معا بنصف الجرعة(الميترونيدازول و دواء الزنجبيل ),5- مجموعة اخذت الدوائين معا بنصف الجرعة(الميترونيدازول و مستخلص الزبجبيل). تم اعطاء الأدوية للفئران لمدة 7 ايام متتالية و بعدها باسبوعين تم عمل تحليل براز للفئران وذلك لعد حويصلات الجياردیا لكل جرام براز ثم تمت الضحية بالفئران بعد ذالك.

وجـــــد ان هناك انخفاض ذى دلالة احصائية واضحة فى عدد حويصلات التى تم عـدها فى كل جرام براز بين المجموعات المعالجة مقارنة بالمجموعات الضابطة حيث وجد ان أعلى نسبة انخفاض فى عدد حويصلات كانت فى المجموعة التى اعطيت دواء الميترونيدازول و دواء الزنجبيل (95,31% ) ثم المجموعة التي أعطيت دواء الميترونيدازول بمفردة(91,88% ) و اخيرا المجموعة التى أعطيت دواء الزنجبيل(55,28% ). وأيضا تمت دراسة تأثير الأنظمة الدوائية المختلفة على الطور الخضرى ( التروفوزويت ) لطفيل الجياردیا فى الجزء العلوي من الأمعـــــاء الدقيقة للفئـــران التى تمت التضحية بها حيث وجد ان اتحاد كلا مـــن الدوائين معا ( دواء الزنجبيل + الميترونيدازول ) أعطى نسبة شفاء واضحة وانخفاض فى عـــدد الطور الخضرى بنسبة ( 94,6% ) أما على الجانب الأخر عند اعطاء الفلاجيل ودواء الزنجبيل بفردهما لوحظ أن معدلات الأنخفاض كانت (87,06%) و ( 46,6% ) على التوالي.

وجد ان هناك انخفاض ذى دلالة احصائية واضحة فى عدد حويصلات التى تم عدها فى كل جرام براز بين المجموعات المعالجة مقارنة بالمجموعات الضابطة حيث وجد ان أعلى نسبة انخفاض فى عدد حويصلات كانت فى المجموعة التى اعطيت من دواء الميترونيدازول (91,88%)ثم المجموعة التي أعطيت مستخلص الزنجبيل+ الميترونيدازول (86,12%) و اخيرا المجموعة التى أعطيت مستخلص الزنجبيل(39,49%). وأيضا تمت دراسة تأثير الأنظمة الدوائية المختلفة على الطور الخضرى ( التروفوزويت) لطفيل الجياردیا فى الجزء العلوي من الامعاء الدقيقة للفئران التى تمت التضحية بها حيث وجد ان اتحاد كلا من الدوائين معا (مستخلص الزنجبيل + الميترونيدازول)معا أعطى نسبة شفاء واضحة وانخفاض فى عدد الطور الخضرى بنسبة( 88,5%) .و اخيرا المجموعة التى احذت مستخلص الزنجبيل (37,77%).

اوضحت الاختبارات الباثولوجية اكتمال الشفاء فى الغشاء المخاطى الجزء العلوي من للأمعاء الدقيقة بعد اقران الدوائين معا ،بينما لوحظ وجود شفاء جزئى للغشاء المخاطى الجزء العلوى للأمعاء الدقيقة بعد اعطاء دواء الميترونيدازول او دواء الزنجبيل او مستخلص الزنجبيل بمفردهما.

وخلصت الدراسة إلي :

تعتبر الأعشاب الطبية مصدر غني ورئيسى في استخلاص الكيمياء النباتية ذات التاثير التوافقي لإحتوائها علي مواد كيميائية متعددة وقد زاد الاحتياج إلي الاتجاه للعلاج بالأعشاب الطبيعية لتجنب الآثار الجانبية الغير مستحبة في العلاج الكيميائي، ولذالك نحن في حاجة الي تقيم واستخلاص مواد فعالة في علاج الجياردا مثل الزنجبيل وقد وجد في هذا البحث عند استخدام نصف الجرعة من دواء الميترونيدازول مع نصف الجرعة من دواء الزنجبيل أعطيت نتائج جيدة من الشفاء عند المقارنة بإعطاء كل دواء بمفرده.