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The Evaluation of *Prospis Farcta* Fruit Nanoparticle to Conventional Sulfasalazine in The Treatment of Chemically Induced Colitis in Male Rats: A Comparative Study

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ABSTRACT

Inflammatory bowel disease (IBD) lacks ideal treatments due to adverse effects of conventional drugs like sulfasalazine. Nano technology and plant-based therapies offers targeted drug delivery system, which might reducing side effects and dosing frequency. *Prosopis farcta*, a medicinal plant with anti-inflammatory and antioxidant properties, shows a hope for IBD therapy. This study evaluated the effects of zinc oxide nanoparticles (Zinc-O-NP) synthesized from P. farcta fruit extract in a rat model of colitis, compared to sulfasalazine. This study aimed at evaluation the efficacy of Zinc Oxide nanoparticle of watery extract of PP.F. fruit, in compared to sulfasalazine in the treatment of chemically induced colitis in rats. 69 male rats were divided in a random way to 6 groups, includes: positive control group (chemically induced colitis), negative control (placebo), and treatment groups which were treated after inducing colitis, and the treatment groups were treated as follow: with watery extract of PP.F., Zinc-O-NP. of *Prosopis farcta* fruit, with combination of sulfasalazine and Zinc-O-NP. for watery extract of *Prosopis farcta* fruit and a group with sulfasalazine along. The therapeutic effects were assessed based on clinical signs, histopathological findings, and serum levels for (GSH, CAT and SOD). Results showed that Zinc-O-NP for watery extract of P. farcta significantly reduced inflammation and oxidative stress, outperforming sulfasalazine. The combination of nanoparticles with sulfasalazine further enhanced therapeutic effects. These findings suggest a potential safer and more effective approach to IBD treatment. The study showed the potential effect of Zinc-O-NP. of *Prosopis farcta* fruit in combination with sulfasalazine as promising therapeutic approach for IBD, offering enhanced efficacy and safety in compared to conventional treatments. Further research is needed to prove these findings and explore their clinical application in human IBD. Keywords: IBD, induced colitis, Zinc oxide-NP. of PP.F.

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Introduction

IBDs. are chronic gastrointestinal disorders that are raises globally. Crohn's disease and Ulcerative colitis are two forms of IBD. It is a chronic illness that causes inflammation of the colon and rectal area (1). The colon is the big intestine, while the rectum is the end of the gut. Small ulcers that bleed and leak pus may form on the lining of the colon after applying a locally acting agent. The primary goals of conventional IBD treatment, which includes sulfasalazine, corticosteroids, and immune modulators, are to reduce inflammation and preserve remission (2).

The recurring episodes of inflammation that characterize these illnesses cause severe gastrointestinal symptoms as well as systemic consequences. Environmental, microbiological, immunological, and genetic factors are known to impact the disease's pathophysiology, even though the exact cause is still unknown (3). The conventional pharmacological treatments for IBD often include corticosteroids, immunosuppressive drugs, and aminosalicylates like sulfasalazine (4).

Adenosine increases the conversion of anti-inflammatory effects, while ecto-5'-nucleotidase in human micro vascular endothelial cell lines responded to sulfasalazine by converting adenine nucleotides to adenosine, according to previous investigations (5)., Because it causes the colon to release 5-aminosalicylic acid (5-ASA), it has been shown to be an effective first-line treatment for reducing inflammation. However, sulfasalazine, a drug that combines 5-aminosalcylic acid and the antibiotic sulfa pyridine, It has been used to autoimmune diseases including inflammatory bowel disease and rheumatoid arthritis, and to reduce pain and swelling associated with arthritis (6).

According ,to the adverse effects that includes hepatotoxicity, hypersensitivity responses, and gastrointestinal problems also the numerous adverse effects of these medications, that includes skin rashes, headaches, anorexia, dyspepsia, dizziness, nausea, vomiting, bleeding gums, and male infertility (reversible), it may restrict its clinical use (7).

This makes it necessary to look for safer and more efficient treatment alternatives. Recent years have witnessed a growing interest in the possible therapeutic advantages of plant-derived natural substances for inflammatory bowel disease (IBD). Because they had fewer adverse effects than modern drugs, herbal cures were widely utilized throughout the world in antiquity and were recognized by both doctors and patients for their greater therapeutic effectiveness.

Prosopis farcta, often known as Syrian mesquite, is a plant that thrives in arid regions and is valued for its many therapeutic uses. *Prosopis farcta* fruit is particularly rich in bioactive compounds with anti-inflammatory, antioxidant, and antibacterial qualities, including as polyphenols, flavonoids, and alkaloids (8). The constituents of phytotherapeutics should be delivered over an extended duration by using a scientific methodology to enhance patient adherence and minimize the necessity for recurrent administration.

The creation of nanoscale drug delivery systems for herbal remedies has the potential to increase their effectiveness and address problems related to plant medicines. Nanotechnology provides a feasible method to enhance the efficiency of plant-derived chemicals by increasing their stability, bioavailability, and targeted delivery.

Prosopis farcta fruit extract-derived nanoparticles may offer a unique way to reduce intestinal inflammation while lowering systemic side effects. Nevertheless, there are still few studies comparing these plant-based nanoparticles to well-known medications like sulfasalazine in models of experimental colitis.

This study aims to evaluate the therapeutic efficacy of *Prosopis farcta* fruit nanoparticles against conventional sulfasalazine in male rats with experimental design of chemically induced colitis. In this study we investigate the potential of zinc oxide nanoparticles for watery extract of *Prosopis farcta* to reduce inflammation and promote intestinal health by mimicking the clinical features of IBD by using acetic acid to induce colitis, a tried-and-effective method.

The modifying of Novel Drug Delivery Systems (NDDS), for herbal medications could achieve this. By lowering toxicity, improving cumulative bioavailability, and minimizing repeated administration to avoid non-reactions, novel drug delivery techniques improve therapeutic value.

Nanotechnology and its nanoscale drug delivery plant types have a bright and promising future. It is now essential to incorporate nano carriers like NDDS into the outdated medical system in an effort to combat more chronic illnesses, including cancer, diabetes, asthma, and others. Creating Novel Drug Delivery Systems (NDDS) for herbal phytochemical components, is one method to accomplish this (9), (10).

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Combining natural bioactive substances with nanotechnology has become a viable therapy option for inflammatory illnesses in recent years. By improving therapeutic solubility, stability, and increasing absorption and enabling tailored distribution to inflammatory regions, nanoparticles reduce systemic adverse effects (11), (12), *Prosopis farcta* is a the plant that have a rich phytochemical profile, that contains flavonoids, alkaloids, and phenolic compounds. It is widely distributed in arid and semi-arid regions" When it is transformed into nanoparticles, its bioactive ingredients might have more therapeutic potential for the treatment of IBD.

In addition, studies are trying to test a herbal substitute (fruits of *Prosopis farcta*) in the form of nanoparticles instead of its conventional extract, which is thought to have fewer adverse effects than the conventional medication (sulfasalazine). When colitis is generated in male rats, 1 ml of 4% acetic acid is injected intrarectally, approximately 3 cm from the anal margin, exposing the rodents to acetic acid (13).

Materials and methods : -

Preparation of *Prosopis farcta* fruit

P. farcta fruits were collected from Tikrit city, from herbal medicine sellers 2024. The plant was identified by an expert (botanical) from the department of seed authentication in the ministry of agriculture of Iraq.

The fruit of *Prosopis farcta* were washed with distal water to remove dusts, and then drayed at room temperature then weighing and after that it was grinded to produced its powder in the Veterinary School laboratory / Tikrit University.

Preparing extract of *Prosopis farcta* fruit using Soxhlet extraction

To extract bioactive compounds from Prosopis farcta using Soxhlet extraction method according to (14).

Synthesis of Znic oxide nanoparticles

To produce ZnO nanoparticles, we used sol-gel synthesis method which is widely used for ZnO nanoparticles due to its simplicity and control over particle size. The procedure that used were Sol-Gel method, (15).

Green synthesis of Znic oxide nanoparticles for the watery extract of *Prosopis farcta* Fruit

The green synthesis of Zinc Oxide Nanoparticle for Prosopis farcta Fruit according to (16).

Fabrication of the zinc oxide nanoparticle of aqueous extract of prosopisfarcta

To fabricate ZnO-N-PP.F., disperse the ZnO nanoparticles in the concentrated extract under stirring to ensure uniform coating or integration. Dry the resulting composite at low temperature (<50°C) or freeze-dry it, depending on the application (17). The ZnO@Extraction hybrid is ready for use in antibacterial, catalytic,or sensing applications.

cm-1. The stretching vibration of the OH groups surrounding the ZnO nanoparticles was responsible for the large peak at 3372 cm-1(18).

XRD interpretation of Zn-O-Nano particle of extract of *Prosopis farcta*

The powder X-ray diffraction (XRD) examination was recorded using an X-ray diffractometer with Cu Ka radiation (wavelength: 0.15406 nm) at a step size of 0.05° and a counting duration of 20 minutes, as shown in figure (1). With a space group of P63mc and a JCPDS number of 01-07-02-07, the zinc oxide nanoparticle extract of *Prosopis farcta* fruit pattern fully matches the hexagonal phase of zinc oxide, according to the qualitative examination of this sample. 32.02°, 34.80°, 36.61°, 47.94°, 56.91°, 63.27°, 66.75°, 68.19°, 69.46°, 72.90°, and 77.26° are the principal diffraction angles of the ZnO nanostructure, and they correspond to the (100), 022), (101), (102), (110), (103), (200), (112), (201), (004), and (202) reflections (19).

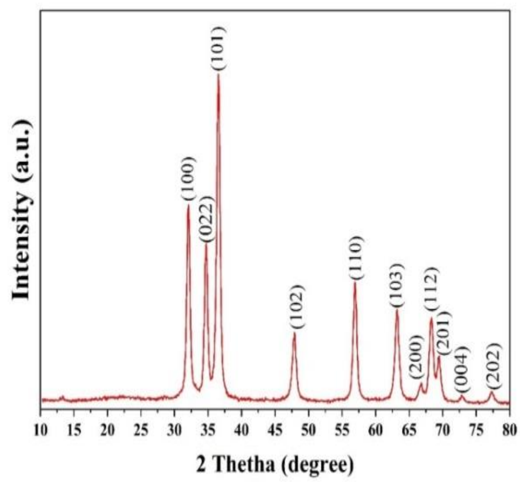

Figure (1): X-ray diffractograms of Zn-O-N of extract of Prosopis farcta samples.

FESEM analysis

The SEM is a tool in nanotechnology that produces images or objects as little as 10 nm through electron bombardment. Shape, size, and placement of particles can be studied by using figure (2), FESEM (16).

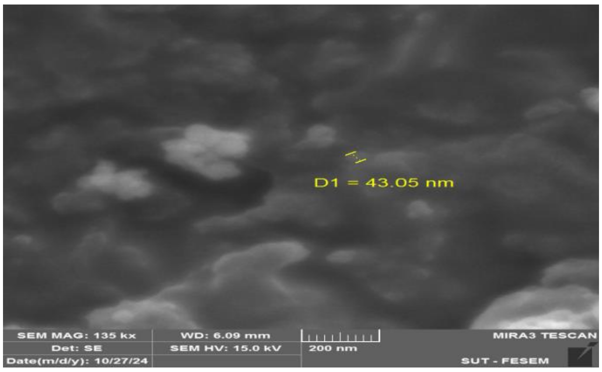

Figure (2) FESEM Analysis for Zinc-O-N@EX.PP.F

FTIR

By identifying changes in functional groups, the Fourier transform infrared (FTIR) method of spectroscopy can identify shifts in the overall makeup of biomolecules. FTIR measures the rotation and vibration of molecules affected by infrared radiation at a specific wavelength. By detecting structural variations in molecular binding between entities, this technique can provide information regarding the presence of their interactions figure (3). The most often used FTIR-based techniques for characterisation are transmittance FTIR, attenuated total reflectance (ATR–FTIR), and micro-spectroscopy FTIR (20).

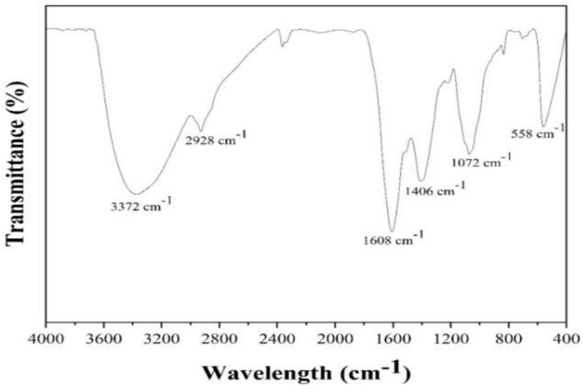

Figure (3). The FTIR spectrum of ZnO@Extract sample.

Animal

Housing: Sixty nine (69) healthy adult male rats (white Albino rats), aged 6–8 weeks, weighing 200 -250 g, were used. Housing Conditions: Rats were housed in groups of 5 animal per cage in a standard plastic cages with stainless steel wire. The animal room was maintained at a temperature of 22 ± 2°C with a relative humidity of 50–60%, and a 12-hour light/dark cycle, then the animals were acclimatized for at least 14 days prior to experimentation. Rats had been feeding a plate type feed that have processed locally and given tap water. All procedures were conducted in accordance with institutional animal care and use guidelines and approved by the relevant Ethics Committee for Animal Experimentation (include approval number if available).

Experimental Design

G1 (n10) control positive treated with Acetic acid- 4% 1.5 ml intra rectally.
G2 (n10) control negative, given normal saline orally.
G3 (n10) Given prosopis farcta hydrochloric a dose of 400mg/Kg B.W orally.
G4 (n10) Treatment group with ZnO – NP of prosopis farcta (fruit) 400mg/Kg B.W. orally.
G5 (n10) ZnO-NP of (prosopis farcta fruit, 400 mg/kg B.W. in combination with sulfasalazine 100 mg/Kg B.W.), orally.
G6 (n10) Treatment group with sulfasalazine orally 100 mg/kg.

Induced colitis for pilot study

Before embarking on the experiment, we conducted a pilot study to demonstrate the ability of acetic acid to cause colitis. This was done by taking 9 animals and giving them different concentrations of acetic acid, at doses of 1.5 ml 3%, 4%, and 5%, alternately, in the rectum. After five days, the animals were killed. The 4% dose of acetic acid proved the ability to cause colitis, and for this reason it was chosen as a suitable dose to cause inflammation that agreed with the study (21).

Design of study:

A 60 male rate were taken, and they divided in a random way to (6 groups), after fasting for 24 hour, five groups of them were given 4% acetic acid under sedation and at a dose of 1.5ml per animal intra rectally by using lubricated feeding tube, for 4 days except control negative group, the group 1 (C.G.+) lived without treatment. group 2 (G.C-) that considered control negative group and were given tap water without treatment, group 3, (G. Ex.PP.F.) have been treated from the day 5 after inducing colitis by giving them watery extract of *Prosopis farcta* at the dose 400 mg/kg. orally for 15 days. Group 4 were given Zinc oxide Naoparticle for the watery extract of *Prosopis farcta* fruit at dose of 400mg/Kg from the day 5 after inducing colitis orally for 15 days, group 5 (GN.S.) were given zinc oxide nanoparticle plus sulfasalazine at doses of 400mg/ Kg.Bw. and 100mg/ Kg. orally for 15 days after inducing colitis. The last group 6 (G.S) were given sulfasalzine alone at the dose 100mg/Kg. orally for 15 days after induced colitis. At the day 20 all the animals where anesthetized by using chloroform, then the blood were withdrawn directly from the heart by using 5ml syringe. The withdrawn blood were used to study the biochemical results, then the blood where collected in gel tube then putted in centrifuge at 3000 rpm for 30 minute then the serum were separated to the biochemical parameters such as antioxidants (CAT , SOD and GSH). After that the animals were dissected from the thoracic region to study the gross appearance for the pathological changes and small pieces of the large intestine have been taken (cecum and colon) for histopathological studies.

Plan of Study (Assays):
Biochemical parameters

It Includes serum ant- oxidant enzymes such as catalase (CAT), superoxide dismutase (SOD), and glutathione (GSH) levels

Measuring Serum Catalase (CAT) level

Sinha: described as a simple colorimetric assay for catalase, in which the decomposition of peroxide is estimated spectrophotometrically by a complex reaction with dichromate/acetic acid reagent without using the optimized conditions which takes into account the effects of pathologic, i.e. icteric, lipemic, hemolytic and diabetic sera. Therefore we reported a modified method which combines the spectrophotometric assay of hydrogen peroxide with an optimized serum catalase determination.

Principle Catalase activity was determined in the serum for the male rats, for all groups according to (22).

Measuring serum Glutathione (GSH) Levels

The total serum (glutathione S-transferase) GST activity was determined by a photometric method according to (23).

Measuring Serum Superoxide dismutase (SOD) Using ELISA kit (enzyme activity)

Measuring serum superoxide dismutase (SOD) using the instruction of the manufactured company for ELISA according to (24).

Pathological study
Microscopic examination

The tissues were fixed with a (10%) tampon formaldehyde solution. Immediately after removal, the specimens of (1 x 1 x 1) cm dimensions including the spleen, liver, lung, heart and brain. The specimens were washed with tap water after 72 hours of fixation, and then processing took place regularly by upgrading the alcoholic concentration from 70% to 100% in every single hour to removed water, by extracting xylol from water and by infiltrating the samples with a 58 °C semi-liquid paraffin wax, then covering the tissue with the specimens Hematoxylin and Eosin (H&E) darkened all tissues and histopathological changes were seen under a light microscope (25).

Statistical Analysis:

The statistical study of data is done using the Social Science Statistical Program and in one and two ways to identify substantial differences using ANOVA. Then using modern P<0.05 LSD test to identified group differences (26).

Results and Discussion
Pathological study
Microscopic Examination of Control (-) Group, Placebo

The main microscopic lesions in the colon of animal from (Control negative) shows normal appearance of epithelialize mucosa, simple tubular gland (g), normal cellular loose connective tissue of lamina propria & submucosa, figure (4) for the same group show Microphotograph of colon (Control negative) shows normal appearance of lining cells of simple tubular gland normal cellular loose connective tissue of lamina propria, no necrosis no ulceration, no inflammatory cells infiltration, and its agree with the normal control group in the study, (27) and (28).

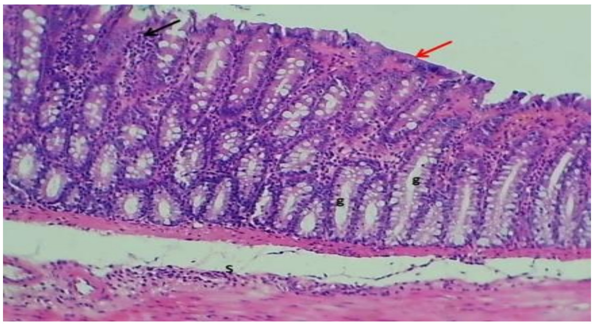

Figure (4) Group (C-) (H&E.100x) normal colon for male rat

Microscopic Examination of Control (+) Group

The main microscopic lesions in the colon of animal treated with acetic acid 4% were characterized by severe pseudomembranous colitis with very thick fibrinous exudate and inflammatory infiltrates figure (5) for the same group show shows severe pseudomembranous hemorrhagic colitis with fibrinous exudate , necrosis with depletion of tubular glands, eroded mucosa with ulcerations, necrosis associated with neutrophils, macrophages infiltration, edema, goblet cell hyperplasia, lymphoid follicular congestion and its agree with the study results of control (+) group in (28), (30).

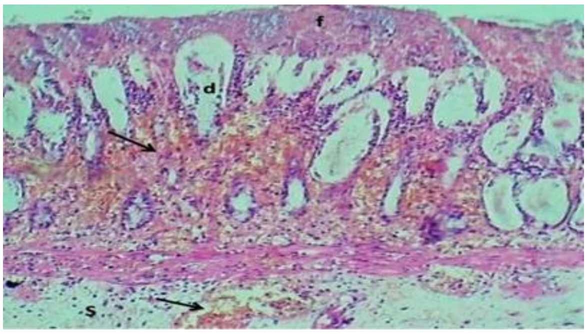

Figure (5) Induced colitis for male rat (H&E.100x)

Microscopic Examination of colon for treatment group with Watery extract (Ex. of PP.F.) fruit after inducing colitis,

The main microscopic lesions in the colon of animal, treated with (Ex. of PP.F.) after inducing colitis in figure (6) shows normal mucosal lining cells, normal cellular loose connective tissue of lamina propria, normal tubular glands, no inflammatory cells infiltration, no edema, no necrosis and these agree with treatment group after inducing colits (28), (31) that the intestinal glands, goblet cells, and muscle external were found to be normal, also (32), said that the chemical composition of Prosopis farcta (Leguminoseae or Fabaceae) fruits protects against chemically induced colitis.

Figure (6) (H&E X100) treatment with (EX.PP.F.) after induced colitis

The microscopic examination of colon for treatment group with (Zinc-O-N@Ex-PP.F)

The main microscopic lesions in the colon of animal, treated with (Zinc-O-N@Ex-PP.F) in figure (7) shows normal mucosal lining cells with mild hyperplasia of lining cells of tubular glands and its agree with the study (33) and this may be inflammatory, infiltrates with severe mucosal hemorrhage (29), submucosal due to short duration of treatment period which was only 14 days (duration of treatment after the fifth day of inducing colitis, and agree with the study (34) that showing preserved structures of colon layers with presence of inflammatory cells infiltrates within lamina propria after 15 days of treatment.


Figure (7) (H&E X100) treatment with (Zinc-O-N@Ex.PP.F) after inducing colitis

Microscopic examination of colon for treatment group with (Zinc-O-N@Ex-PP.F in combination with SSZ.)

The main microscopic lesions in the colon of animal, treated with (Zinc-O-N@Ex-PP.F in combination with SSZ.) in figure (8) shows normal mucosal lining cells with mild hyperplasia of lining cells of tubular glands & vascular congestion this is mostly return to the short duration of treatment period which was only 14 days. that colitis considered one of the chronic disease and its cure with sulfasalazine may require 4 to 6 weeks (35).even though there is healing but its incomplete.

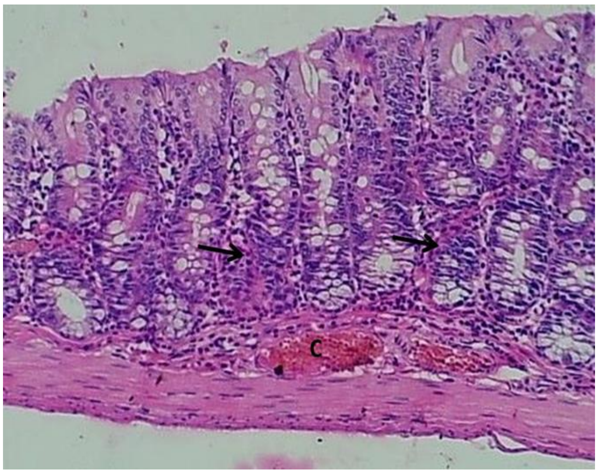

Figure (8) (H&E X100) treatment with (Ex.@Zinc-O-NP. +SS.Z.) after inducing colitis

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Microscopic examination of colon for treatment group with (SSZ.)

The main microscopic lesions in the colon of animal, treated with (SSZ.) in figure (9) shows normal mucosal lining cells (red arrow) with atrophy of tubular glands and infiltration of lymphocytes (black arrows) & vascular congestion and this agree with the study (36) (37), says that SSZ. group showing apparent normal histological appearance but still some distortion is seen, mild inflammatory with inflammatory cells, and the study. Also cure with sulfasalazine may require 4 to 6 weeks (35).

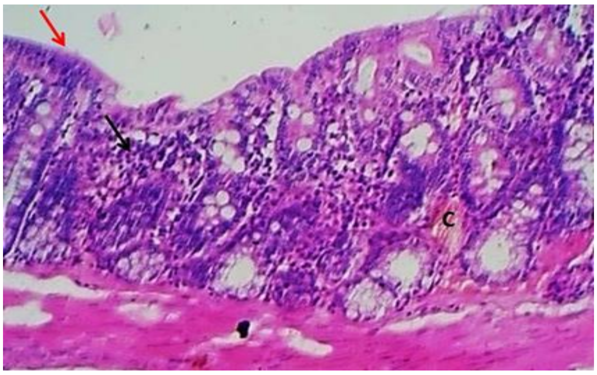

Figure (9) (H&E X100) treatment with sulfasalazine after inducing colitis

Table(1) Serum GSH Activity by Groups

Group N= 10	GSH Level mmol/ml
G.C+	0.87
G.C−	1.92
GEx-PP.F	1.888
G.ZnNPP.F.	1.976
G. NS.	0.908
G.S.	1.848

Serum GSH Activity by Groups in the Units of mmol/ml.

Glutathione (GSH) is a key intracellular antioxidant that plays a crucial role in neutralizing reactive oxygen species (ROS) and maintaining redox balance. In the present study, GSH levels were assessed to evaluate oxidative stress and the antioxidant effects of various treatments following colitis induction with 4% acetic acid in rats.

Serum GSH levels in control (+) group, induced colitis by 4% acetic acid in comparing to control (-) group, the healthy group (placebo):

The (GC+) control positive group, induced colitis with 4% acetic acid showed a dramatic decrease in GSH (0.87 mmol/ml) compared to the healthy control (GC− = 1.92 mmol/ml), indicating oxidative stress due to inflammation and this results agree with the study (38).

The depletion of glutathione (GSH) the major antioxidant; its depletion in the colitis group confirms its consumption in neutralizing reactive oxygen species (ROS) during inflammation (39) (30).

All treatment groups (G.Ex.PP.F., GZn-O-N-@EX.PF, GZn-O-N@EX.PP.F.+SZ. and G.SZ.) demonstrate that serum GSH levels have been considerably raised to levels close to normal, nearly matching those of the healthy group.

Thus, this study suggests that all treatments have antioxidant or anti-inflammatory qualities that aid to restore the redox balance in the serum of rats.

Comparison Among Treatments:

G.Zn-O-N-@EX.PP.F. was (1.976 mmol/ml) > G.Zn-O-N@EX.PP.F.+SSZ. (1.908 mmol/ml) > GEX.PP.F. (1.888 mmol/ml) > G.SZ. (1.848 mmol/ml).

The maximum GSH level was achieved by synthesized zinc oxide nanoparticles for the watery extract of *Prosopis farcta* (GZnN-PF), which was (1.976 mmol/ml) that was marginally higher than the healthy control group. This implies a greater antioxidant action, most likely due to the potential synergy between plant phytochemicals and Zinc oxide, is a well-known antioxidant and anti-inflammatory (40), (41).

Nanoparticle delivery system, might improve bioavailability and cellular uptake.

Using sulfasalazine alone (G.S), although it improved GSH compared to untreated colitis (control +), its effect was modest compared to nanoparticle-based groups. This supports the potential limitations of standard therapy and the promise of nanomedicine and phytotherapy (42), (28).

The results of rats serum GSH levels showed that colitis drastically reduces GSH levels, but treatments—especially those involving Prosopis farcta-derived nanoparticles—significantly restore antioxidant capacity. GZnN-@PP.F. shows the most promising therapeutic potential, potentially exceeding traditional treatment efficacy.

Table (2) Serum CAT Activity by Groups

Group N= 10	CAT Level mmol/ml
G.C+	**0.33**
G.C−	**0.824**
GEx-PP.F	**0.79**
G.ZnNPP.F.	**0.806**
G. NS.	**0.78**
G.S.	**0.744**

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Serum CAT Activity by Groups in the Units of mmol/ml:

Serum CAT level for male rats in (GC+) control positive group (induced colitis by 4% acetic acid) in comparing to the control (-) group (healthy group), It show a dramatically reduction in control (+) colitis group (GC+ = 0.33 mmol/ml) in compared to the healthy group, control (-) (GC- which was = 0.824 mmol/ml). It means that the antioxidant defense mechanism is overpowered by the oxidative stress brought on by colitis, which results in catalase depletion (43). All treated groups (G.Ex.PP.F., GZn-O-N-@EX.PF, GZn-O-N@EX.PP.F.+SZ. and G.SZ.) revealed a notable recovery in serum CAT activity, almost catching up to the healthy group's values, so it suggests that, directly scavenging ROS or by up regulating endogenous antioxidant enzymes like CAT, these therapies reduce oxidative stress.

Comparison of Treatments:

The result for GZn-O-N-@EX.PF was (0.806) which is > GEX.PP.F. (0.79) ≈ , GZn-O-N@EX.PP.F.+SSZ. and G.SSZ. was (0.78) > G.SSZ (0.744 mmol/ml). The treatment GZn-O-N-@EX.PF again shows the highest restoration of catalase activity, so that suggesting the combination: Will, enhances bioavailability and efficacy of the active compounds via nanoparticle delivery (44), (45). Possibility of synergism between zinc (a known enzyme cofactor) and *Prosopis farcta* phytochemicals.(46), (47). GEX.PP.F. and GZn-O-N-@EX.PF were the same, demonstrating that P. farcta, whether in extract or nano form, has a positive impact and that G.Zn-O-N@EX.PP.F.+SSZ doesn't significantly outperform the single agents in this case (unlike GSH results). Wile the G.SSZ. (sulfasalazine alone), shows the lowest improvement in comparing to other treatment groups that agree with the study (48), again indicating the potential limitations of standard therapy in restoring oxidative balance.

Colitis causes a marked reduction in catalase activity which is exacerbated by upregulated oxidative stress. CAT activity is recovered significantly in Prosopis farcta fruit extract and its ZnO nanoparticles (symbolized in this study as Zn-O-N@Ex.PP.F.) treated plants. The G.Zn-O-N-@EX.PP.F. made the strongest antioxidant impact, suggesting that it could be used as a nanophytotherapeutic agent. The therapeutic synergy of plant-based and nanotechnology-enhanced therapies is supported by these findings, which supplement the GSH data.

Table (3) Serum SOD Activity by Groups

Group N= 10	SOD Level pg/ml
G.C+	**80.894**
G.C−	**231.9**
GEx-PP.F	**211.51**
G.ZnNPP.F.	**218.21**
G. NS.	**200.52**
G.S.	**184.71**

Serum SOD Activity by Groups in the Units of pg/ml

Serum SOD level for male rats (GC+) control positive group (induced colitis by 4% acetic acid) in comparing to the control (-) group (healthy group)

The control (+) group (colitis group) (GC+ = 80.894) demonstrated a marked decrease in serum SOD activity compared to the healthy group control (-) and was (GC- = 231.9 pg/ml) (49). This confirms that oxidative stress that belongs to colitis leads to significant suppression of serum SOD level, and reduced the tissue's capacity to neutralize superoxide radicals (50), (30).

Effect of Treatments:

All treatments: GEx-PP.F, G.ZnNPP.F., G. NS. And, G.S.) demonstrated a significant improvent in serum SOD activity compared to the untreated colitis group (51), which indicates that all treatments helped to restore antioxidant defense, either by reducing ROS production or enhancing endogenous antioxidant enzymes (52), (53).

Comparative Efficacy of Treatments:

Serum SOD level for G.ZnNPP.F. was (218.21 pg/ml) > GEx-PP.F. (211.51 pg/ml) > G. NS. (200.52 pg/ml) > G.S. (184.71 pg/ml). The treatment grouop (G.ZnNPP.F.) also shows the highest SOD restoration, very close to the healthy control. This reinforces the trend observed with GSH and CAT, (53), (54), which is suggesting: that, the synthesized ZnO nanoparticles by using Prosopis farcta enhanced antioxidant activity more effectively than other component alone, that agree with this study (55). The reason for the beneficial results with the nanoparticle formulation is likely the enhanced delivery and cellular uptake, leading to higher enzyme levels or protection against oxidation. Serum SOD activity was improved by G.N.S. (combined therapy) but not more than that of G.ZnNPP. F. alone. This may be due to a lack of synergy when combining with sulfasalazine for SOD in particular, and possibly may be due to some deleterious effects of

SSZ. that may cause oxidative stress that agree with (56), (57).

The treatment group with Sulfasalazine alone (G.S.) shows modestly lower serum SOD activity than herbal-based or nanoparticle treatments, indicating that, it may be less effective against oxidative stress at this level.

Conclusion:

The suppression of serum SOD activity to a significant level in chemically induced colitis reflects the devastating oxidative stress associated with colitis (38). All therapy groups aided in the restoration of systemic SOD levels, however the ZnO nanoparticles emanated from Prosopis farcta (G. ZnNPP. Markedly, F+) behaved as the most potent, almost approximating the healthy control. These results highlight the enhanced antioxidant potential of phytotherapy mediated through nanoparticles, (58), (59) supporting its potential as an advanced therapeutic option in colitis management. Orally administration of aqueous extract for *Prosopis farcta* fruit and Zinc oxide nanoparticle of aqueous extract of *Prosopis farcta* for about 15 days, have reduced the oxidative stress through increasing the serum level of anti-oxidant enzymes (GSH, CAT and SOD) level thus reducing the inflammation (colitis) to the minimum and promoting the regeneration of epithelium cells after inducing colitis with 4% acetic acid. Also the combination of Zinc oxide nanoparticle for *Prosopis farcta* with sulfasalazine shows reduction in colitis.

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تقييم الشكل النانوي لثمرة البجنجل مع العلاج التقليدي (السلفاسالازين) في علاج التهاب القولون المستحث كيمائيا في ذكور الجرذان: دراسة مقارنة

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الملخص

تقنية النانو مكنت من عملية ايصال الادوية الى الخلايا المختلفة. يفتقر التهاب الامعاء للعلاجات المثالية بسبب الاثار الضارة للادوية التقليدية. تقدم تقنية النانو والعلاجات ذات المصدر النباتي، نظاما مستهدفا في توصيل الدواء الى المكان المحدد، مما قد يقلل من الاثار الجانبية وعدد مرات اعطاء الدواء وبالتالي تقليل مصاريف العلاج. تظهر ثمرة البجنجل والذي هو نبات طبي ذو خصائص مضادة للاكسدة والالتهاب والذي قد يكون علاجا واعدا لمرض الامعاء الالتهابي. حيث قيمت هذه الدراسة اثار اوكسيد النانوي المصنع للمستخلص المائي لثمرة البجنجل في نموذج لجرذان مستحدث فيها التهاب القولون وتم مقارنة العلاج مع دواء السلفاسالازين، حيث هدفت هذه الدراسة الى تقييم فاعلية جسيمات اوكسيد الزنك النانوي لمستخل ثمرة البجنجل بمقارنت فعاليته مع السلفاسالازين في علاج التهاب القولون المستحدث كيميائيا في الجرذان. ومن اجل هذا تم تحضير 69 جرذا وتم تقسيمها الى 6 مجاميع حيث تضمنت مجموعة استحداث الالتهاب (كونترول موجب) وتركت بدون علاج ومجموعة كونترول سالبة ومجموعة استحدث فيه الالتهاب ومن ثم تم اعطاءها علاجات مختلفة عن طريق التجريع الفموي، ومن ضمنها العلاج باوكسيد الزنك النانوي للبجنجل ومن ثم تركيبها مع السلفاسالازين ومجوعة عولجت بفقط بدواء السلفاسالازين.

ومن ثم تم تقييم التاثيرات العلاجية بناء على العلامات السريرية ومستويات انزيمات الاكسدة (الجلوتاثيون والكاتاليز والسوبر اوكسايد) في المصل والفحصوات النسيجية المرضية لاجزاء من القولون. حيث اظهرت النتائج لجسيمات اوكسيد الزنك النانوي لثمرة البجنجل انخفاض ملحوظ في الالتهاب والاجهاد التاكسدي وكانت نتائجه العلاجية اقوى من السلفاسالازين. وقد عزز دمج السلفاسالازين مع الجسيمات النانوية تأثيرات علاجية بشكل اكبر. وتشير هذه النتائج الى نهج اكثر فاعلية واكثر امانا في منهج علاج التهاب الامعاء بالمقارنة مع العلاجات التقليدية الاخرى، لذا هناك حاجة للمزيد من الدراسات والابحاث للتأكد من صحة هذه النتائج وتطبيقها في علاج داء التهاب الامعاء في الانسان.

الكلمات المفتاحية: داء التهاب الامعاء، التهاب القولون المستحدث، اوكسيد الزنك النانوي لثمرة البجنجل (الخرنوب).