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Impact of *Rauwolfia vomitoria* Root Extracts on Tocopherol, Adenine Deaminase, and Antioxidant Parameters in Adjuvant-Induced Arthritic Rats

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ABSTRACT

This study investigated the effects of ethanol and aqueous root extracts of *Rauwolfia vomitoria Oliv.* on tocopherol, adenine deaminase, and antioxidant parameters in albino rats with induced arthritis. A total of 135 albino rats were utilized, divided into nine groups of 15 rats each. Arthritis was induced by intradermal injection of 0.1 ml Chicken type II collagen-Complete Freund's adjuvant into the left hind paw. Starting on day 10 post-induction, the rats were treated with the extracts at dosages of 400, 600, and 800 mg/kg body weight over a 32-day period. Analysis was performed using spectrophotometric techniques. Arthritic rats showed significantly higher ($P<0.05$) levels of malondialdehyde (MDA) and nitric oxide (NO), and significantly lower ($P<0.05$) levels of glutathione peroxidase, catalase, superoxide dismutase (SOD), reduced glutathione, and tocopherol compared to normal controls. Treatment with *Rauwolfia vomitoria* extracts reversed these changes in a time- and dose-dependent manner. The anti-arthritic efficacy of the extracts was comparable to that of the standard drug indomethacin ($P<0.05$).The findings suggest that ethanol and aqueous root extracts of *Rauwolfia vomitoria* contain compounds that enhance antioxidant levels, reduce oxidative stress, and alleviate arthritic symptoms in adjuvant-induced arthritic rats. This study provides scientific evidence supporting the use of *Rauwolfia vomitoria* root extracts as a potential treatment for arthritis.

Keywords: *Rauwolfia vomitoria*, Tocopherol, Adenine deaminase, Antioxidant potentials, Nitric oxide and Arthritis.

INTRODUCTION

Rheumatoid arthritis is an autoimmune disease with an inflammatory component. Deformations of the bones and cartilage, joint discomfort, oedema, and stiffness in the hands, wrists, and feet are among the symptoms linked to this illness [1]. For the treatment of rheumatoid arthritis, medications such as leflunomide, hydroxychloroquine, methotrexate, and sulfasalazine have been utilized [2]. The latter category includes disease-modifying anti-rheumatic medicines (DEMARDS), however, these medications also have common side effects, such gastrointestinal tract issues, appetite loss, mouth soreness, feeling unwell, diarrhoea, migraines, and hair loss [2],[3]. Novel treatments for rheumatoid arthritis have also been used, including biologics like certolizumab and adalimumab [3]. They also can have adverse effects, such as minor skin responses where injections are made, infections, nausea, fever, and headaches [3]. Due to the difficulty low-income people have affording these medications, a lot of RA sufferers turn to employing plant herbs that grow nearby to control or treat their conditions. Herbal medicine has shown great promise in treating conditions such as rheumatoid arthritis, and as a result, it is now widely accepted in modern culture. Rural residents have had success treating their arthritis with the *Rauwolfia vomitoria* plan. The respiration process may be harmful since it uses oxygen molecules to form reactive oxygen species (ROS), even though it is necessary for the production of energy in

living cells. Oxidative stress is brought on by UV light, pollution, radiation, and metal oxidation which have been linked to a number of illnesses, including inflammatory disorders, cancer, atherosclerosis, pulmonary fibrosis, and ageing [4]. Key transcription factors regulated by cell oxygenation and cytokine stimulation, and nuclear factor-κB are induced in the pathogenesis of RA by synovial perfusion, hypoxia, and re-oxygenation [5]. These mechanisms result in gene expression, which is essential for rheumatoid arthritis-related chronic Synovitis. Herbal remedies have been widely recognized and embraced by researchers for their effective treatment, control, and prevention of diseases [6]. Plant-based chemicals, including their phytochemical components, minerals, vitamins, and other elements, influence the body physiologically and have essential therapeutic effects [6]. In broad terms, plants are used to treat and control diseases because of their low cost, therapeutic efficacy, minimal negative side effects, accessibility, potential for cross-cultural interaction, and economic significance [7]. *Rauwolfia vomitoria* roots, native to Ebonyi State in Nigeria, have been historically used to treat various illnesses, including arthritic conditions, but experimental evidence on their effectiveness remains inconclusive. This led to the aim of this study: to ascertain the impact of *Rauwolfia vomitoria* aqueous and ethanolic root extractson antioxidant potentials, tocopherol, and adenine deaminase levels in complete freund's adjuvant-chicken type II collagen induced arthritic rats.

MATERIALS AND METHODS

Materials

Plant Materials

Rauwofia vomitoria roots were sourced from Ndi-Nwali Village in Izzi Local Government Area of Ebonyi State in South-Eastern Nigeria. Professor Kate Nnamani, a botanist at Ebonyi State University in Abakaliki's Department of Applied Biological Sciences, verified the authenticity of the plant. A portion of the root samples were kept at the Department of Applied Biological Science's herbarium.

Animals

The total number of 135 female albino rats were used. These were bought from the department of Animal Science, University of Nigeria Nsukka, Enugu State, Nigeria. The animals were acclimatized for a period of 14 days and were giving free access to food and water.

Methods

Preparation of the plant extracts

Contaminants in the plant samples were washed off under flowing tap and air dried under a shade. The laboratory milling machine was used to grind the plant roots and were sifted using 0.25 mm sieve. Eight hundred grams of *Rauwolfia vomitoria* dried powdered root samples were soaked in 2000 ml of ethanol and deionized water respectively for 48 hours. They were subjected to successive extraction by the use of a water bath at 50^0 C until the solvents were completely removed; the percentage yield was obtained and extracts used for analysis.

Induction of arthritis in albino rats

The method described by [8] was adopted in the induction of arthritis in rats by injecting of 0.1 ml of chicken type II collagen-complete Freund's adjuvant (CFA) into the left hind paw of the rats. The paw size of the rat groups was measured twice weekly before and after adjuvant administration, and paw inflammation severity was assessed using a qualitative scoring system. By day 10, arthritis had fully developed. Rats with no visible swelling were scored 0, mild redness and individual digit inflammation was scored 1, moderate redness and ankle swelling was scored 2, and severe redness and paw inflammation was scored 3. Rats with a score of 3 were considered to have arthritis and were used for subsequent experiments.

Treatment of Rheumatoid Arthritic rats with plant extracts

In all, 135 female rats weighing 150–210 g were used in this study. 9 groups of 15 female albino rats each were formed from the distribution of the rats. The standard drug, indomethacin, was prepared as a solution using normal saline (standard control). Group 1: Negative control (without induction of arthritis and treatment) and received 5 ml/kg normal saline daily. Group 2: (Arthritic control or positive control) induced with arthritis and received 5 ml/kg normal saline daily. Group 3: (Standard control) induced with arthritis and administered 10 mg/kg indomethacin. Groups 4 - 6 were induced with arthritis and received *Rauwofia vomitoria* aqueous root extract at doses of 400, 600 and 800 mg/kg body weight, respectively from the tenth day after induction until the study ended. Groups 7 – 9 were induced with arthritis and were administered *Rauwofia vomitoria* ethanol root extract at 400, 600 and 800 mg/kg body weight from day ten after induction till the end of the study.

Samples preparation and Analysis

Three albino rats from each group (Group 1-9) were sacrificed on days 10, 18, 25 and 32 and blood samples were collected in EDTA anticoagulant bottles. The serum samples were used for the assays of oxidative stress indices which include malondiadehyde (MDA) [9], Nitric Oxide (NO) [10], Super Oxide Dismutase (SOD) [11], Catalase [12], Reduced glutathione (GSH) [13], Glutathione peroxidase (GLX) activity [14], adenosine deaminase, [15] and tocopherol [16].

Statistical Analysis

The Statistical Analysis System (SAS) windows version 9.0 was used to estimate the fundamental statistics, means, standard deviation, and ranges of the observed values. Means ± SD of 12 replicates were used to express the data. When a value was $p<0.05$, it was deemed statistically significant.

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RESULTS

Table 1 shows the impact of ethanol and aqueous root extracts of *Rauwolfia vomitoria* on the MDA level in rats. The results indicate that the untreated arthritic rats had significant levels of MDA, which is a measure of the peroxidation of lipids caused by the generation of free radicals. MDA levels were observed to be lower ($P<0.05$) in rats treated with indomethacin, *Rauwolfia vomitoria* aqueous extract, and ethanol root extracts at different dosages than in the group of rats without treatment for arthritis (positive control). On day 32 of the therapy, the impact was statistically significant ($P<0.05$). The regular medication and the plant extracts used for therapy had similar results. Table 2 displays the NO generation outcomes. Rats with arthritis had an elevated NO level ($P<0.05$) than the negative control group. When standard drugs and plant extracts were given to the arthritic rats, the level was nearly restored to that of the control group. In rats treated with arthritis, it was shown that 800 mg/kg of aqueous root extract from *Rauwolfia vomitoria* was notably ($P<0.05$) more effective than ethanol extract treatments, particularly on day 32 when it came to returning the NO level to normal. Tables 3-6 provide the results of the activities of glutathione peroxidase, SOD, GSH, and catalase. In the present study, the arthritic rat groups had a decreased level ($P<0.05$) of SOD, GSH, glutathione peroxidase, and catalase activities than the normal control group. The study found that administering varying dosages of indomethacin and *Rauwolfia vomitoria* aqueous and ethanol root extracts considerably normalized the levels of SOD, GSH, glutathione peroxidase, and catalase in arthritic rats in a time-dependent manner. Day 32 of the therapy was when the most significant effect was observed. The GSH activity of the rats treated with arthritis was shown to be reversed more effectively ($P<0.05$) by 600 mg/kg body weight *Rauwolfia vomitoria* aqueous root extract than by the standard drug. Table 7 presents the findings of the root extracts' impact on adenine deaminase. All of the arthritic rats had notably higher levels of adenine deaminase ($P<0.05$). However, the use of plant extracts on the arthritic rats resulted in a substantial ($P<0.05$) decrease in adenine deaminase levels, attaining that of the normal control group by day 32 of the experiment. Table 8 presents the tocopherol level result. When compared to arthritic rats treated with plant extracts, the tocopherol level in the positive control group (induced but not treated) animals decreased considerably ($P<0.05$) on days 25 and 32 reversing the tocopherol level to near normal was more effective when 800 mg/kg body weight of *Rauwolfia vomitoria* aqueous aqueous and ethanol root extracts were administered as a treatment.

DISCUSSION

Rats group that was induced RA without treatment had elevated level of MDA, according to the findings of this study (Table 1). Likewise, the RA rats had extremely elevated nitric oxide (NO) levels. In the groups comprising those rats with untreated RA, MDA levels steadily increased until day 32 of the study. But, treatment indomethacin (standard RA drug) and the root extracts of *Rauwolfia vomitoria* in ethanol and aqueous solutions decreased ($P<0.05$) the MDA level. The effects of the root extracts on the MDA level were comparable to those of the standard drug. Although, nitric oxide is a crucial chemical mediator produced by nerve cells, macrophages, and endothelial cells; they are involved in the regulation of several physiological processes, the body suffer when it is released uncontrollably into the cells [17]. The arthritic rats' NO levels were considerably ($P<0.05$) lowered ($P<0.05$) when indomethacin, as well as the aqueous and ethanol root extracts of *Rauwolfia vomitoria*, were administered. Numerous medical illnesses are primarily caused by oxidative stress and the damage it causes [18]. The adjuvant used to induce RA in this study was responsible for increasing the amount of reactive oxygen species released but, when the root extracts were administered to the treatment group rats, the effect was reversed because, the root extracts contain bioactive compounds which break down peroxides, singlet and triplet oxygen by absorbing and neutralizing free radicals like MDA and NO [17], [18]. Tables 3-6 show the outcome of antioxidant (GSH, SOD, catalase, and glutathione peroxidase) concentrations. Cells and tissue structures are shielded from oxidative damage and free radicals by antioxidants like GSH, SOD, catalase, and glutathione peroxidase. They also help to regulate immunological function and detoxify xenobiotics, peroxides, and free radicals. In this study, the arthritic rat groups had lower levels ($P<0.05$) of SOD, GSH, and catalase activities than the normal control group which align with the study of [19]. Administration of indomethacin and *Rauwolfia vomitoria* aqueous and ethanol root extracts at varying dosages to the arthritic rats normalised ($P<0.05$) the activities of SOD, GSH, and catalase. The highest activities of these enzymes were observed on day 32 of the treatment. The standard drug was apparently less efficacious ($P<0.05$) than 600 mg/kg body weight *Rauwolfia vomitoria* aqueous root extract in restoring GSH activity. Catalase activity was notably ($P<0.05$) boosted by *Rauwolfia vomitoria* root extracts, indicating increased hydrogen peroxide breakdown to water and oxides. The oxygen radical (O_2-) steady state level is decreased by superoxide dismutase. In order to shield cells and tissues from superoxide radicals and other peroxides such lipid peroxides, superoxide dismutase enzyme acts as a catalyst for the dismutation of superoxide radicals into peroxides and molecular oxygen [20]. It is possible the decreased level of superoxide dismutase enzyme activity was caused by increased superoxide anion generated after induction of RA [20]. However, on administration of ethanol and aqueous root extracts of *Rauwolfia vomitoria* there was a significant ($P<0.05$) increase in the activity of glutathione peroxidase, which reduces peroxides to water and concurrently oxidises glutathione (GSH) to glutathione disulphide (GSSG), which is an antioxidant [21]. The presence of certain antioxidant molecules in the root extracts of *Rauwolfia vomitoria* may have contributed to its anti-oxidative and radical scavenging properties by increasing the activity of enzymes such as glutathione peroxidase, catalase, and superoxide

dismutase (SOD) as shown in Tables 3-6. The level of GSH was observed to be increased in the RA induced rat groups receiving *Rauwolfia vomitoria* root extracts. Functionally, GSH is a cofactor for detoxifying enzymes such as GPx, which help to regenerate oxidized versions of antioxidant vitamins C and E while preventing lipid oxidative damage by lowering lipid peroxides [22]. Our findings in this study demonstrate that an imbalance between oxidants and the antioxidant system was caused by type II collagen-induced CFA in RA. The administration of root extracts of *Rauwolfia vomitoria* reversed this imbalance to a nearly normal level, presumably because the root extract contains vital antioxidants. According to [23], the treatment of *Rauwolfia vomitoria* aqueous root extract restored the considerable suppression of serum DPPH radical scavenging activity and the decrease in total antioxidant power by CCl4 and the results of our study are consistent with their findings. All of the arthritic rats had increased levels of adenine deaminase ($P<0.05$) (Table 7). The enzyme known as adenosine deaminase (ADA) releases ammonia during the conversion of adenosine to deoxyadenosine and inosine to deoxyinosine. Adenosine deaminase levels in the blood are elevated, which suggests that cellular immunity is being stimulated. This has been noted in cases of rheumatoid arthritis, lymphoblastic leukaemia, acute hepatitis, and infection with the human immune deficiency virus. According to reports, the monocyte/macrophage cell system is one of the main producers of the common type of adenosine deaminase in blood [24]; [25]. On day 32, the treatment with the root extracts had the most significant effect, lowering the adenine deaminase levels to those of the normal control group by a significant ($P<0.05$) margin. Similarly, the tocopherol level in the arthritic rats in this study was notably ($P<0.05$) lower than the values observed in the normal control group (Table 8). Arthritis symptoms reported to have been successfully managed with the use of vitamin E in conjunction with other medications [26]. Administering aqueous and ethanol root extracts of *Rauwolfia vomitoria* to the arthritic rats has shown to be equally beneficial as conventional indomethacin therapy, particularly when administered at a dose of 800 mg/kg body weight. Furthermore, reduced serum levels of α tocopherol, β carotene, and selenium have been documented by [27], before the diagnosis of rheumatoid arthritis, and low antioxidant values may be a risk factor or a marker for the illness[28]; [5]. In conclusion, it is possible that the phytochemicals reported in our earlier study of *Rauwofia vomitoria* ethanol and aqueous root extracts boosted the antioxidant level of the arthritic rats, reduced oxidative stress markers, and reversed the arthritic conditions that the adjuvant-induced arthritic rats had established. Therefore, the current study offers scientific proof that the ethanol and aqueous root extracts of *Rauwolfia vomitoria* could be used to treat RA.

AUTHORS' CONTRIBUTIONS

Conceptualization, NNE and OOU.; methodology, DEU.; validation, PMA and PCA.; formal analysis, DEU; writing AND original draft preparation, COO.; writing, review and editing, JNA.; supervision, PMA.; project administration, NNE. All authors have read and agreed to the published version of the manuscript.

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Table 1: Effect of *Rauwolfia vomitoria* (RV) aqueous and ethanol root extracts on MDA level of adjuvant-induced arthritic rats

Groups	DAY10(nmol/g protein)	DAY18(nmol/g protein)	DAY25(nmol/g protein)	DAY32(nmol/g protein)
1	3.21 ± 0.17^{b}	3.20 ± 0.08^{d}	3.19 ± 0.01^{f}	3.32 ± 0.23^{b}
2	3.85 ± 0.05^{a}	4.03 ± 0.03^{a}	5.30 ± 0.01^{a}	6.46 ± 0.08^{a}
3	3.74 ± 0.03^{a}	3.65 ± 0.12^{b}	3.61 ± 0.03^{b}	3.43 ± 0.18^{b}
4	3.77 ± 0.44^{a}	$3.57\pm0.37^{c,b}$	$3.44\pm0.01^{d,c}$	3.34 ± 0.76^{b}
5	3.78 ± 0.77^{a}	$3.54\pm0.50^{c,b}$	$3.43\pm0.08^{d,c}$	3.31 ± 0.84^{b}
6	$3.72\pm0.83^{b,a}$	$3.52\pm0.18^{c,b}$	$3.38\pm0.10^{d,e}$	3.35 ± 0.89^{b}
7	3.75 ± 0.01^{a}	$3.55\pm0.02^{c,b}$	3.49 ± 0.08^{c}	3.32 ± 0.18^{b}
8	$3.73\pm0.01^{b,a}$	$3.51\pm0.08^{c,bc,b}$	$3.41\pm0.05^{d,c}$	3.33 ± 0.00^{b}
9	3.74 ± 0.04^{a}	$3.49\pm0.07^{c,b}$	$3.37\pm0.06^{d,e}$	3.32 ± 0.01^{b}

MDA level of adjuvant induced arthritic rats treated with *Rauwolfia vomitoria* ethanol and aqueous root extracts. The data are shown as mean ± SD (n=12) and significant difference at $P<0.05$. Where, RV= *Rauwolfia vomitoria*. 1= Negative control, 2= positive control, 3= Standard control, 4= 400 mg/ kg RV aqueous extract, 5= 600 mg/kg RV aqueous extract, 6= 800 mg/kg RV aqueous extract, 7= 400 mg/kg RV ethanol extract,8= 600 mg/kg RV ethanol extract, 9= 800 mg/kg RV ethanol extract, Means with the same letter are not significantly different.

Table 2: Effect of *Rauwolfia vomitoria* (RV) aqueous and ethanol root extracts on NO level of adjuvant induced arthritic rats.

Groups	DAY 10 (nmol/ml)	DAY 18 (nmol/ml)	DAY 25 (nmol/ml)	DAY 32 (nmol/ml)
1	13.30±0.08^{c}	13.40±0.28^{g}	13.60±0.02^{h}	13.80±0.84^{I,h}
2	23.80±2.04^{a}	25.70±0.11^{a}	32.30±0.47^{a}	45.60±0.76^{a}
3	20.60±0.76^{b}	19.70±1.64^{e,d}	16.80±0.00^{g,f,e}	14.50±0.62^{h,g,f}
4	21.90±1.36^{ba}	20.80±0.03^{c,b,d}	18.20±1.83^{d,c}	16.89±0.16^{c}
5	21.10±0.00^{b}	20.60±0.57^{c,b,d}	17.80±0.35^{d,c,e}	15.80±0.05^{d}
6	20.90±0.25^{b}	18.40±1.03^{f}	16.80±0.72^{g,f,e}	14.70±0.16^{e,h,g,f}
7	21.80±1.56^{b,a}	21.20±0.09^{c,b}	19.60±1.77^{b}	18.70±0.07^{b}
8	21.90±0.01^{b,a}	21.40±0.06^{b}	19.60±0.04^{b}	17.40±0.08^{c}
9	20.70±0.01^{b}	19.80±0.38^{e,d}	17.10±0.23^{f,e}	14.80±0.08^{e,g,f}

NO level of adjuvant induced arthritic rats treated with *Rauwolfia vomitoria* ethanol and aqueous root extracts. The data are shown as mean ± SD (n=12) and significant difference at P<0.05. Where, RV= *Rauwolfia vomitoria.* 1= Negative control, 2= positive control, 3= Standard control, 4= 400 mg/ kg RV aqueous extract, 5= 600 mg/kg RV aqueous extract, 6= 800 mg/kg RV aqueous extract, 7= 400 mg/kg RV ethanol extract,8= 600 mg/kg RV ethanol extract, 9= 800 mg/kg RV ethanol extract, Means with the same letter are not significantly different.

Table 3: Effect of *Rauwolfia vomitoria* (RV) aqueous and ethanol root extracts on peroxidase level of adjuvant induced arthritic rats.

Groups	DAY10 (U/L)	DAY18 (U/L)	DAY25 (U/L)	DAY32 (U/L)
1	66.00±1.41^{a}	65.15±0.02^{a}	65.24±0.59^{a}	65.00±1.51^{a}
2	41.10±0.71^{f,d,e}	41.26±0.02^{g}	36.29±1.70^{f}	36.05±0.17^{e}
3	45.35±13.79^{c,d,e}	43.10±0..00^{e,g,f}	53.96±0.21^{b}	54.38±0.76^{b,a,c}
4	37.95±0.64^{f}	42.77±0.00^{g,f}	43.45±0.75^{e}	47.62±1.15^{d}
5	43.94±1.67^{c,f,d,e}	45.49±0.01^{e,d}	48.49±0.85^{c,d}	51.54±0.93^{d,c}
6	45.17±0.258^{c,d,e}	49.47±0.02^{c,b}	50.55±0.61^{c,b}	53.42±0.81^{b,d,a,c}
7	38.97±0.47^{f,e}	43.15±0.61^{e,g,f}	44.62±0.27^{e,d}	48.67±1.22^{d,c}
8	44.68±1.18^{c,d,e}	45.66±0.10^{e,d}	48.98±0.24^{c}	52.35±0.35^{d,c}
9	45.50±0.71^{c,d}	49.53±0.89^{c,b}	50.80±0.13^{c,b}	53.89±0.40^{b,a,c}

Peroxidase activity of adjuvant induced arthritic rats treated with *Rauwolfia vomitoria* ethanol and aqueous root extracts. The data are shown as mean ± SD (n=12) and significant difference at P<0.05. Where, RV= *Rauwolfia vomitoria.* 1= Negative control, 2= positive control, 3= Standard control, 4= 400 mg/ kg RV aqueous extract, 5= 600 mg/kg RV aqueous extract, 6= 800 mg/kg RV aqueous extract, 7= 400 mg/kg RV ethanol extract,8= 600 mg/kg RV ethanol extract, 9= 800 mg/kg RV ethanol extract, Means with the same letter are not significantly different

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Table 4: Effect of *Rauwolfia vomitoria* (RV) aqueous and ethanol root extracts on SOD level of adjuvant-induced arthritic rats.

Treatments	DAY10(U/mg protein)	DAY18(U/mg protein)	DAY25(U/mg protein)	DAY32(U/mg protein)
1	78.91±5.02^{a}	78.96±6.36^{a}	78.88±5.07^{a}	78.67±2.20^{a}
2	40.15±2.04^{e}	42.25±0.78^{f}	33.73±0.58^{e}	31.88±0.96^{e}
3	74.25±2.57^{b,a}	75.15±2.42^{b,a}	77.72±0.28^{a}	77.75±0.15^{b,a}
4	51.02±5.13^{d}	57.41±2.81^{e}	60.50±0.42^{d,c}	60.81±0.01^{d}
5	68.42±0.01^{b}	69.85±0.49^{d}	72.99±1.20^{b,a}	75.54±0.62^{c,b,a}
6	73.73±0.96^{b,a}	73.36±0.65^{c,b}	73.77±0.6^{b,a}	74.17±1.10^{c}
7	51.96±5.20^{d}	60.06±1.36^{e,d}	60.81±7.90^{d,c}	61.50±0.03^{d}
8	71.83±1.70^{b}	72.73±1.59^{c,b}	74.83±0.07^{b,a}	75.10±0.17^{c,b}
9	74.61±1.40^{b,a}	74.34±0.76^{c,b}	75.04±0.11^{b,a}	75.40±0.14^{c,b}

Super oxide dismutase activity of adjuvant induced arthritic rats treated with Rauwolfia vomitoria ethanol and aqueous root extracts. The data are shown as mean ± SD (n=12) and significant difference at P<0.05. Where, RV= Rauwolfia vomitoria. 1= Negative control, 2= positive control, 3= Standard control, 4= 400 mg/ kg RV aqueous extract, 5= 600 mg/kg RV aqueous extract, 6= 800 mg/kg RV aqueous extract, 7= 400 mg/kg RV ethanol extract,8= 600 mg/kg RV ethanol extract, 9= 800 mg/kg RV ethanol extract, Means with the same letter are not significantly different

Table 5: Effect of *Rauwolfia vomitoria* (RV) aqueous and ethanol root extracts on catalase level of adjuvant-induced arthritic rats.

Groups	DAY10 (U/ mg protein)	DAY 18 (U/ mg protein)	DAY 25 (U/ mg protein)	DAY 32 (U/ mg protein)
1	1.94 ± 0.03^{a}	1.84 ± 0.01^{a}	1.87 ± 0.09^{a}	1.91 ± 0.07^{a}
2	1.07 ± 0.05^{d}	0.88 ± 0.01^{e}	0.57 ± 0.00^{g}	0.42 ± 0.01^{f}
3	1.18 ± 0.04^{cb}	$1.31\pm0.05^{b,d}$	1.79 ± 0.01^{b}	1.88 ± 0.00^{ba}
4	1.09 ± 0.01^{b}	$1.20\pm0.00^{d,e}$	1.46 ± 0.00^{e}	$1.58\pm0.01^{e,d}$
5	1.11 ± 0.02^{c}	$1.32\pm0.01^{b,d,c}$	1.49 ± 0.01^{e}	$1.68\pm0.20^{e,b,d,c}$
6	1.09 ± 0.01^{c}	$1.50\pm0.04^{b,d,a,c}$	$1.63\pm0.01^{d,c}$	$1.72\pm0.01^{e,b,d,a,c}$
7	1.10 ± 0.04^{c}	$1.70\pm0.03^{b,a,c}$	1.76 ± 0.00^{b}	$1.85\pm0.01^{b,a,c}$
8	1.17 ± 0.02^{b}	$1.21\pm0.01^{d,e}$	1.37 ± 0.01^{f}	1.51 ± 0.04^{e}
9	1.07 ± 0.01^{c}	1.27 ± 0.01^{d}	1.47 ± 0.01^{e}	$1.62\pm0.03^{e,d}$

Catalase activity of adjuvant induced arthritic rats treated with *Rauwolfia vomitoria* ethanol and aqueous root extracts. The data are shown as mean ± SD (n=12) and significant difference at $P<0.05$, RV= *Rauwolfia vomitoria.* 1= Negative control, 2= positive control, 3= Standard control, 4= 400 mg/ kg RV aqueous extract, 5= 600 mg/kg RV aqueous extract, 6= 800 mg/kg RV aqueous extract, 10= 400 mg/kg RV ethanol extract,11= 600 mg/kg RV ethanol extract, 12= 800 mg/kg RV ethanol extract, Means with the same letter are not significantly different

Table 6: Effect of *Rauwolfia vomitoria* (RV) aqueous and ethanol root extracts on GSH level of adjuvant induced arthritic rats.

Groups	DAY10 (Umol/l)	DAY18 (Umol/l)	DAY25 (Umol/l)	DAY32 (Umol/l)
1	26.44±2.37^{a}	26.82±0.59^{a}	26.75±0.02^{a}	25.98±0.08^{b}
2	22.88±0.71^{b}	19.18±0.62^{f}	16.35±0.18^{f}	10.17±1.43^{f}
3	18.56±0.86^{c}	21.98±0.39^{d,c,e}	22.03±0.41^{e}	22.38±0.76^{e}
4	18.38±0.66^{c}	18.52±0.44^{g}	22.82±0.02^{d}	25.92±1.40^{b,a}
5	17.21±2.33^{c}	21.73±0.58^{e}	23.87±0.18^{c}	29.92±0.39^{a}
6	18.24±1.54^{c}	22.18±0.57^{d,c}	23.94±0.16^{c,b}	25.03±0.95^{b,a,c}
9	23.80±0.03^{b}	23.95±0.69^{b}	24.18±0.47^{c,b}	26.01±1.11^{b}
7	18.38±0.69^{c}	18.53±0.42^{g}	22.83±0.00^{d}	25.91±1.42^{b,a}
8	17.21±2.34^{c}	21.78±0.49^{d,e}	22.89±1.22^{d}	24.87±1.60^{b,c}
9	18.24±1.53^{c}	22.22±0.59^{c}	23.94±0.14^{c,b}	23.23±1.61^{e,d}

GSH activity of adjuvant induced arthritic rats treated with Rauwolfia vomitoria ethanol and aqueous root extracts. The data are shown as mean ± SD (n=12) and significant difference at $P<0.05$. Where, RV= Rauwolfia vomitoria. 1= Negative control, 2= positive control, 3= Standard control, 4= 400 mg/ kg RV aqueous extract, 5= 600 mg/kg RV aqueous extract, 6= 800 mg/kg RV aqueous extract, 7= 400 mg/kg RV ethanol extract,8= 600 mg/kg RV ethanol extract, 9= 800 mg/kg RV ethanol extract, means with the same letter are not significantly different

Table 7: Effect of *Rauwolfia vomitoria* (RV) aqueous and ethanol root extracts on adenine deaminase level of adjuvant induced arthritic rats.

Groups	DAY 10 (mg/dl)	DAY 18 (mg/dl)	DAY 25 (mg/dl)	DAY 32 (mg/dl)
1	0.52 ± 0.00^{h}	0.52 ± 0.01^{i}	0.52 ± 0.01^{g}	$0.52\pm0.00^{d,e}$
2	0.79 ± 0.00^{a}	0.78 ± 0.01^{a}	0.85 ± 0.01^{a}	0.89 ± 0.01^{a}
3	$0.75\pm0.01^{e,d,c}$	0.63 ± 0.00^{h}	0.52 ± 0.01^{g}	0.50 ± 0.01^{g}
4	$0.755\pm0.01^{b,d,c}$	0.64 ± 0.00^{f}	0.58 ± 0.00^{b}	0.53 ± 0.00^{c}
5	$0.75\pm0.01^{*,d,c}$	0.63 ± 0.00^{h}	0.55 ± 0.00^{d}	$0.52\pm0.01^{d,c}$
6	$0.74\pm0.01^{e,d}$	0.63 ± 0.01^{g}	$0.53\pm0.01^{f,e}$	$0.51\pm0.01^{f,e}$
7	$0.72\pm0.02^{g,f}$	0.63 ± 0.00f	$0.53\pm0.00^{f,g}$	$0.52\pm0.00^{d,c}$
8	$0.74\pm0.01^{e,d,c}$	0.63±0.00h	0.52 ± 0.00^{g}	$0.52\pm0.00^{d,c}$
9	$0.74\pm0.01^{e,d}$	0.65±0.00c	0.52 ± 0.00^{g}	$0.51\pm0.01^{f,e}$

Adenine deaminase activity of adjuvant induced arthritic rats treated with *Rauwolfia vomitoria* ethanol and aqueous root extracts. The data are shown as mean ± SD (n=12) and significant difference at P<0.05. Where, RV= *Rauwolfia vomitoria.* 1= Negative control, 2= positive control, 3= Standard control, 4= 400 mg/ kg RV aqueous extract, 5= 600 mg/kg RV aqueous extract, 6= 800 mg/kg RV aqueous extract, 7= 400 mg/kg RV ethanol extract,8= 600 mg/kg RV ethanol extract, 9= 800 mg/kg RV ethanol extract, means with the same letter are not significantly different

Table 8: Effect of *Rauwolfia vomitoria* (RV) and ethanol root extracts on tocopherol level of adjuvant induced arthritic rats.

Treatments	DAY 10 (mg/dl)	DAY 18 (mg/dl)	DAY 25 (mg/100g)	DAY 32 (mg/100g)
1	0.93 ± 0.04^{a}	0.95 ± 0.06^{a}	0.94 ± 0.07^{a}	0.98 ± 0.03^{a}
2	$0.78\pm0.05^{f,c,e,d}$	0.68 ± 0.10^{d}	0.61 ± 0.01^{c}	0.55 ± 0.09^{e}
3	0.86 ± 0.01^{b}	$0.90\pm0.08^{b,a}$	0.93 ± 0.00^{a}	$0.96\pm0.01^{b,a,c}$
4	$0.77\pm0.00^{f,e}$	0.82 ± 0.00^{c}	0.84 ± 0.00^{b}	0.87 ± 0.10^{d}
5	$0.77\pm0.08^{f,e,d}$	0.81 ± 0.01^{c}	0.85 ± 0.00^{b}	0.89 ± 0.01^{d}
6	$0.81\pm0.01^{f,c,e,b,d}$	0.82 ± 0.09^{c}	0.84 ± 0.06^{b}	0.88 ± 0.06^{d}
7	0.75 ± 0.01^{f}	0.83 ± 0.00^{c}	0.84 ± 0.00^{b}	0.86 ± 0.08^{d}
8	$0.77\pm0.07^{f,e}$	0.81 ± 0.09^{c}	0.87 ± 0.00^{b}	0.88 ± 0.01^{d}
9	$0.81\pm0.01^{f,c,e,b,d}$	0.82 ± 0.10^{c}	0.86 ± 0.06^{b}	0.88 ± 0.07^{d}

Tocopherol level of adjuvant induced arthritic rats treated with *Rauwolfia vomitoria* ethanol and aqueous root extracts. The data are shown as mean ± SD (n=12) and significant difference at $P<0.05$. Where, RV= *Rauwolfia vomitoria*. 1= Negative control, 2= positive control, 3= Standard control, 4= 400 mg/ kg RV aqueous extract, 5= 600 mg/kg RV aqueous extract, 6= 800 mg/kg RV aqueous extract, 7= 400 mg/kg RV ethanol extract, 8= 600 mg/kg RV ethanol extract, 9= 800 mg/kg RV ethanol extract, means with the same letter are not significantly different.

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