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Evaluation of Antiarthritic Activity of Cordyline Fruticosa in Arthritic Rat Model

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Abstract

A persistent inflammatory process that causes joint injury and deformity, dysfunction, and and sometimes even death is a hallmark of rheumatoid arthritis, a systemic Autoimmune disorder. Rheumatoid arthritis (RA) is a systemic, autoimmune multisystem illness. that manifests as Pain, synovial membrane inflammation, peripheral joint inflammation, morning stiffness, and tissue deterioration, and reduced joint range of motion. Cordyline fruticosa L also known as cordyline terminalis L belonging from family Agavaceae is commonly referred to as "good luck plant" and "Ti plant. Several different chemicals were found in C. fruticosa, including cholestane glycosides, polyphenols, flavonoids, glucofructan, tannins, alkaloids, steroidal saponins, and phytosterols, according to a phytochemical analysis. Pharmacological studies show that the plant has antimicrobial, antioxidative, and therapeutic properties related to stomach cancer. Following an examination of the literature, plant material was selected, collected, and authenticated. The collected plant material was dried and extracted with methanol as the solvent. The obtained methanolic extract underwent phytochemical study and GC-MS analysis to identify bioactive components. Pharmacological evaluations were carried out both in vitro and in vivo. Protein denaturation assays were used to determine in-vitro anti-inflammatory effects, which included the inhibition of egg albumin and bovine serum albumin. The in vivo anti-arthritic activity was assessed utilizing the Complete Freund's Adjuvant induced arthritis and formaldehyde-induced arthritis models. Various physical, biochemical, haematological, and histological characteristics were assessed, and the results were statistically analysed. The potency of cordyline fruticosa extract in methanol in formaldehyde induced arthritis as well as in complete Freund's adjuvant rats has shown is excellent anti-arthritic activity. It has shown remarkable reduction in joint inflammation, arthritic scores, and paw edema in a dose-dependent fashion. These findings support the use of Cordyline fruticosa to treat inflammatory conditions and show that it can be used as a safe and effective alternative to arthritis treatment.

INTRODUCTION:

Rheumatoid arthritis (RA) is a systemic autoimmune disorder marked with a persistent inflammatory process that results in joint destruction, deformity, and dysfunction capacity, and sometimes even demise. This disorder affects 0.5 - 2% of persons, and is more prevalent in smokers, women and those with a history of the illness.[1] The symptoms of rheumatoid disease, a systemic Immune mediated multisystem illness, include discomfort, inflammation of the synovial membrane, Inflammatory reaction of the peripheral joints, Joint stiffness in the morning, degradation of Articular structures and limited range of motion in joints.[15] In addition to Reactive oxygen intermediates, eicosanoids like leukotrienes, prostaglandins, and cytokines are some of proinflammatory chemicals released by macrophages that cause RA, a disease that can still cause severe functional impairments in addition to cartilage degradation.[1]

Even while a number of categories, including NSAIDs, steroidal anti-inflammatory medications, and immunosuppressants, are already in use. Their use is limited by possible adverse effects. The creation of novel antiarthritic medications that are safe, effective, and less toxic is currently a major concern. Therefore, it is necessary to look for more naturally occurring substitutes so that their therapeutic benefits can be evaluated and increased.[5]

Pannus formation, fibrosis, synovial cell proliferation, and degradation of bone and cartilage are all part of the complex process of RA. This mechanism is mediated via a network of interdependent proteolytic enzymes, prostanoids, cytokines. In addition to the control these mediators generated from macrophages and other immune cells, chronic inflammatory diseases can target the alteration of arachidonic acid metabolism produced by blocking enzymes like COX, LOX.[2]

PLANT PROFILE:

Cordyline fruticosa (L)



Fig : Cordyline fruticosa

Introduction of Plant Cordyline fruticosa:

Known by several names, including Ti plant, Palm Lily, Goodluck Plant, Cordyline fruticosa (L.) belonging to the family Asparagaceae has Foliage that are red, pink, orange. This plant is found throughout the world's tropical and subtropical regions and has purplish stripes and white leaf margins. This plant's roots, cortex, and leaves, for instance, are used as traditional remedies. The leaves are used to induce abortions, heal bleeding hemorrhoids, sore throats, and neck ache. In a similar vein, the roots are used to treat mammary gland infections, laryngitis, and toothaches. Additionally, Coughing, bloody cough diarrhea, Dysentery, high temperature, urinary problems, Urine that contains blood , smallpox, insanity, and skin eruptions are all treated with this medicinal herb. Cholesterol glycosides, polyphenols, flavonoids, glucofructan, tannins, phytosterols, alkaloids, and the steroidal saponins have all been found in Cordyline fruticosa. According to pharmacological reports, the plant contains antioxidant, antibacterial, anti-gastric, and anti-cancer properties.[12]

Cardiovascular disorders, digestive diseases, skin related disease, liver disease, rheumatoid arthritis, and This herb has also been used to cure various other conditions. which is recognized as a traditional medicinal plant. The leaves are utilized for cooking, clothes, sandals, decorations, costumes, and packing. Rhizomes can be baked into a food product that resembles molasses also consumed (Hinkle, 2007). Additionally, the herb has been used traditionally. to treat a number of illnesses: the leaves to cause abortion; the roots are utilized to treat toothaches, Laryngitis with mammary gland infections[3]

Literature review:

Manjusha Choudhary, et al 2014

Manjusha Choudhary described the clinical symptoms and pathological features of rheumatoid arthritis. The symptoms of rheumatoid disorder, a systemic immune-mediated multisystem ailment, include discomfort, swelling of the synovial membrane, inflammation of the peripheral joints, morning joint rigidity, damage to joint tissues and limited joint motion. It is evident that patients have bony outgrowths that limit joint mobility as well as detrimental alterations in the cartilage and bone4 Arthritis can lead to significant disability, which eventually limits a person's quality of life, makes it difficult for them to do daily duties, and results in early death.[5] Arthritis can cause pain or inflammation in any part of the body. One of the most prevalent inflamed conditions, impacting between 0.5 to 1.0% of adults worldwide, repeated three times as many females as males affected.

Kore K.J, et.al,2011

Kore K.J discussed the currently available therapeutic approaches for the management of rheumatoid arthritis and highlighted their limitations. NSAIDs, steroidal anti-inflammatory medications, immunosuppressants, and more types are now in use. Their use is limited by possible adverse effects. The creation of novel antiarthritic medications that are safe, effective, and less toxic is currently a major concern.

P. L. Rajagopal, et.al 2019

P. L. Rajagopal explained the etiology, progression, and clinical manifestations of rheumatoid arthritis. In virtually half of the individuals, rheumatoid arthritis may start gradually and quietly Bearing fatigue, weakness, also widespread musculoskeletal discomfort. These symptoms are probably Caused by IL-1 and TNF. The joints get affected after a few weeks or months. The affected joints are painful, swollen, heated, and especially stiff when they are not moving.

Stephanie Djuichou Nguemnang, et.al.2019

Stephanie Djuichou Nguemnang explained the significance of the Complete Freund's Adjuvant (CFA)-induced arthritis model and its pathological progression in experimental rheumatoid arthritis. Research on the effects of numerous pharmaceuticals frequently uses Animal models of Freund's complete adjuvant-induced polyarthritis (CFA) rational information about rheumatoid arthritis. In fact, injecting zymosan into the rats' knee joints results in erosive synovitis with enhanced vascular permeability, neutrophil infiltration, the during the acute phase, edema and exudates develop followed by lymphocyte, macrophage infiltration, pannus formation, fibroblastic reaction typical chronic rheumatoid synovitis in the chronic phase. CFA is an immunogenic adjuvant derived from a suspension of heat-killed Mycobacterium tuberculosum or Mycobacterium butyricum. When administered at the base of the animal's tail, it causes polyarthritis to develop in a two-phase cycle of time: the first phase, which manifests as an acute local inflammatory reaction, appears in a few hours and disappears after three to five days; and the second phase, which appears after two weeks and corresponds to a chronic systemic response.

Sharmin NAHER 1 et, al

Sharmin Naher reported that MCFL administered at doses up to 3200 mg/kg did not produce any signs of acute oral toxicity or mortality in experimental mice. Mice treated with dosages at concentrations up to 3200 mg/kg of MCFL did not exhibit any aberrant behavior or death during the 14-day observation period. A comparable outcome was attained for the control group. This

suggests that the studied doses (200, 400, and 800) do not cause acute oral toxicity in experimental animals.

Romuald Tematio Fouedjou et al 2023

Romuald Tematio Fouedjou reviewed the traditional uses, phytochemical constituents, and pharmacological activities of Cordyline species. Traditional medicine has historically used cordyline species to treat a variety of illnesses, including diarrhea, a high fever, and a bloody cough. This genus has roughly 26 recognized species names that are found all over the world. Eight species of Cordyline have yielded a total of 98 isolated chemicals that are classified as flavonoids, spirostane, furostane, and cholestane glycosides and may be responsible for the majority of traditional therapeutic uses. A few of these Significant antioxidant, antiproliferative, antibacterial, and hypolipidemic properties have been demonstrated by both pure substances and extracts from some Cordyline species.

Elfita1 et al 2021

Elfita described the traditional medicinal uses, botanical characteristics, and phytochemical constituents of Cordyline fruticosa. One of the medicines that people use to treat infectious diseases is the decoction of Cordyline fruticosa stem. People know Cordyline fruticosa as a medicinal plant. It has been used for a time to treat many diseases. These diseases include cough bloody urine, diarrhoea, cardiovascular disease, digestive disorders, skin infections, liver cancer, arthritis and neuritis. People use Cordyline fruticosa to treat all these diseases because it has healing properties. The Cordyline fruticosa plant is very useful, for our health. The scientific name of cordyline plant is Cordyline fruticosa (L) A Chev, with synonyms being Cordyline terminalis (L) Kunth and Cordyline fruticosa Backer which is a plant belonging to the monoyledoneae class. It is usually grown as ornamental plants in the forest and is used to form hedges and borders for tea plantations. The compounds present in Cordyline fruticosa are saponins, tannins, flavonoids, polyphenols, steroids, polysaccharides, calcium oxalates, and iron.

Material and methods:

Plant collection and Authentication

The fresh plant material of Cordyline fruticosa were collected from a local area Turukwadi – Kokrud, Maharashtra during December 2025 Authentification of the plant were carried out by the Department of botany of Prof. Dr. N. D. Patil Mahavidyalay, Malkapur – Perid

Extraction of plant materials

The plant leaves was collected, washed and dried under shade. The dry material was crushed to coarse powder. About 60 g of powder weighed and placed in a Soxhlet thimble. Approximately 500-1000 mL methanol added into the round bottom flask. The Soxhlet device was built and heated to 40-65°C.The extraction continued for 4 Days until solvent became colourless. The extract filtered and concentrated using water bath below 45°C The dried extract was weighed and stored in airtight container at 4°C for further study.

Experimental animals-

In the current investigation, Wistar albino female rats weighing 150-250 grams were used. After the period of two weeks, the animals were reused after washing periods from each group. Animal aprotocol was approved with approval nymber (SNTK/IAEC/2025/20) with the permission from IAEC of Shree Santkrupa College of Pharmacy Ghogaon (1110/PO/Re/S/07/CCSEA).

In vitro studies:

Egg Albumin Protein Denaturation:

The 5 mL reaction mixture included 2 mL of sample (200- 1000 µg/mL), 2.8 mL of PBS (pH 6.4) and 0.2 mL of egg albumin (from a fresh hen's egg) a comparable quantity of double-distilled water was used as control. Mixture were then heated to 70 degrees Celsius for five minutes after being incubated at 37 degrees Celsius for fifteen minutes. Using the vehicle as blank, absorbance was measured after cooling at 660 nm The reference medications, diclofenac Sodium at 200- 1000 µg/mL, was handled similarly in order to determine absorbance.

Bovine Serum Albumin Protein Denaturation Denaturation:

Dissolve 1 g of BSA in 100 mL phosphate buffer (pH 6.4). In separate test tubes, mix 0.5 mL of test sample or standard solution, 0.5 mL of 1% BSA solution. For control, mix 0.5 mL phosphate buffer + 0.5 mL BSA Incubate all tubes at **37°C** for 15–20 minutes to allow protein-sample interaction. Using the vehicle as blank, absorbance was measured after cooling at 660 nm The reference medications, diclofenac Sodium at 200- 1000 µg/mL, was handled similarly in order to determine absorbance. The formula was employed to figure out percentage inhibition of protein denaturation: **% inhibition = absorbance of control - absorbance of test / absorbance of control x 100**

In vivo Screening methods:

(CFA) Inducing Arthritis Induction of Arthritis:

The complete Freund's Adjuvant (CFA) was used in arthritic rats for testing the antiarthritic potential of MCFL. In this regard, 0.1 ml of CFA was administered into the hind paws of each rat to induce arthritis. (Except of the normal control group) Four groupings of animals were divided (n = 6) and housed separate cages. Standard drug was diclofenac orally given 10mg/kg. The test substance MCFL was orally given for 28 days by dissolving 400 mg/kg dose in distilled water.

.Group I: Arthritic received 5 ml/kg for normal saline as a control; Group II: Arthritic received 0.1 ml for CFA (Subplanter Injection) as a disease control. Groups III: Standard treated with Diclofenac sodium 10 mg/kg after intraplantar injection of 0.1mL CFA, from the first to the 28th day. Groups IV: Treatment with 400mg/kg MCFL after intraplantar injection of 0.1ml CFA, from the 1st to the 28th day.

Formaldehyde Inducing Arthritis:

Six animal groups (n = 6) were used. The vehicle was used in Group I: Arthritic animals were used as control and given normal saline 5ml/kg; Group II: Arthritic animals were used as disease control and given 0.1ml Formaldehyde (Subplanter injection) Group III: Normal animals treated with Diclofenac sodium 10 mg/kg after intraplantar injection of 0.1mL Formalaldehyde Group IV: Administrated with MCFL 400mg/kg, Likewise, following an intraplantar 0.1 ml formaldehyde injection, starting on day 1 and day 3

Measurement of rat paws edema:

To measure paw oedema, a digital vernier calliper was utilized on days 3, 5, 7, 14, 21 and 28 on alternate days, and a digital balance was used to record the body weight of each group. Measurement of rat paw edema in CFA-induced arthritic model; A) Normal control (normal saline 5mL/kg) B) Disease Control C) Standard (diclofenac sodium 10 mg/kg) D) MCFL 400mg/kg.





Haematological Profile:

Blood collection from the retro-orbital plexus was done. The blood collected was transferred into EDTA containing tubes. After blood collection, some haematological tests are performed in order to establish the levels of Hb gm/dl, RBC count, and WBC count. The serum was obtained after the centrifugation of the remaining blood samples for 20 minutes at 3000 rpm in a room temperature.

Histopathological analysis:

The hind paws were also removed for histological investigation and preserved in 10% formalin. Tissue sections were dissolved and processed with eosin and a solution of A binocular microscope was then used for the microscopic analysis. Acute and chronic inflammation, granulation tissue, and cartilage degradation were evaluated in both CFA and Formaldehyde induced arthritis

Biochemical Parameter:

Alkaline Phosphate (ALP)

Serum alkaline phosphatase (ALP) levels were measured as a biochemical marker to assess changes in bone metabolism and joint damage associated with arthritis. The reduction/normalization of ALP levels following therapy implies that the test extract has a preventive effect against arthritic alterations.

C- reactive protein (CRP)

CRP or reactive protein A blood test known as C-reactive protein (CRP) is performed to determine the level of CRP in the bloodstream. The liver reacts to inflammation by releasing a substance called CRP. Inflammation, which can be caused by a variety of situations such as infections, acute illnesses, and chronic problems, is indicated by elevated blood levels of CRP.

Analysis of Statistics

The values that are shown in in vivo research are shown as Mean ± SEM. For statistical analysis, Graphpad Prism 9.0 was used, along with a one-way ANOVA and the Dunnett Test.

RESULT:

Preliminary Phytochemical Investigation of methanolic extract of Cordyline fruticosa leaves

Tests using phytochemical analysis verify that the methanolic Cordyline fruticosa extract of contains alkaloids, glycosides, phenolic compounds, tannins, phytosterols, teriterpenoids, flavonoids, and saponins.

Preliminary Phytochemical Investigation of Ethanolic extract of Cordyline fruticosa leaves

Test for Alkaloids		
Sr. No.	**Test Name**	**Result**
1.	Wagner's test	+
2.	Hager's test	+
3.	Dragendroff's test	+
4.	Mayer's test	-
Test for Glycosides		
1.	Borntrager's test	-
2.	Keller- killiani test	+
3.	Legal test	+
Test for Phenolic compound		
1.	Lead acetate test	-
2.	Gelatin test	+
Test for Tannins		

1.	Ferric Chloride test	+
2.	Bromine water test	-

Test for Flavonoids		
1.	Aqueous sodium hydroxide test	+
2.	Sulphuric acid test	+
3.	Shinoda's test	-
4.	Lead acetate test	+
5.	Alkaline reagent test	+
Test for Phytosterol and Triterpenoids		
1.	Leiberman-Burchard test	+
2.	Salkowski test	+
Test for Amino acid		
1.	Ninhydrin test	+
2.	Nitric acid test	-
Test for Saponins		
1.	Forth test	+
Test for protein		
1.	Biuret test	-
2.	Millon's test	-
3.	Xanthoproteic test	-
Test for Carbohydrate		
1.	Barfoed's test	-
2.	Molish's test	-
3.	Seliwanoff's Test	-
4.	Benedict's test	-
5.	Fehling's test	-

Impact on the denaturation of egg and bovine serum albumin:

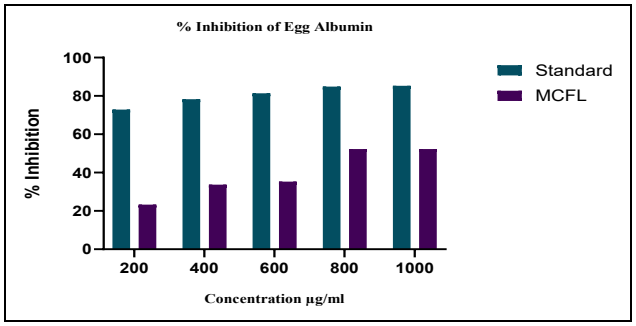
Anti-inflammatory activity in vitro of Sample cordyline fruticosa was analyzed through protein denaturation technique, where the effectiveness of substances in inhibiting the denaturation of proteins by heat was examined because protein denaturation is one of the mechanisms in inflammation.

The standard drug, Diclofenac sodium, showed strong inhibitory activity with percent inhibition ranging from 72.87% to 85.27% across concentrations of 200–1000 µg/ml, confirming the reliability of the assay.

Protein Denaturation by egg albumin method

Sr. no.	**Sample**	**Conc. µg**	**O. D**			**Mean**	**Percent inhibition**
			I	**II**	**III**		
1	Control		0.82	0.89	0.87	0.860	
2	Standard Diclofenac sodium	200	0.25	0.24	0.21	0.233	72.87
		400	0.19	0.18	0.19	0.187	78.29
		600	0.15	0.17	0.16	0.160	81.40
		800	0.13	0.14	0.12	0.130	84.88
		1000	0.11	0.18	0.09	0.127	**85.27** **
3	MCFL	200	0.67	0.65	0.66	0.66	23.26
		400	0.58	0.57	0.56	0.57	33.72
		600	0.51	0.54	0.62	0.56	35.27
		800	0.37	0.42	0.44	0.41	52.33
		1000	0.41	0.44	0.38	0.41	**52.33** **

n=3



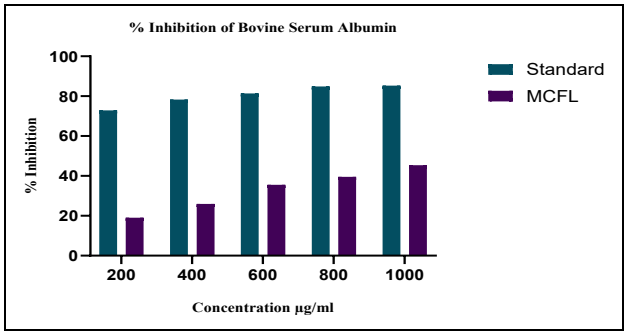
The in vitro anti-inflammatory activity of MCFL was evaluated using the egg albumin protein denaturation method, which assesses the ability of compounds to inhibit heat-induced denaturation of proteins an important mechanism involved in inflammation. The standard drug, Diclofenac sodium, exhibited strong inhibitory activity with percent inhibition ranging from 72.87% to 85.27% across concentrations of 200–1000 µg/ml, confirming the reliability of the assay. MCFL demonstrated a concentration-dependent increase in anti-inflammatory activity. At 200 µg/ml, the sample showed 23.26% inhibition, which increased to 52.33% at 800 and 1000 µg/ml. The reduction in absorbance values with increasing concentration supports its protein-stabilizing ability. However, the activity

plateaued at higher concentrations (800–1000 µg/ml), indicating that maximum inhibitory effect may have been reached.

Protein Denaturation by Bovine Serum Albumin method

Sr. no.	Sample	Conc. µg/ml	O. D			Mean	Percent inhibition
			I	II	III		
1	Control		0.82	0.89	0.87	0.860	
2	Standard Diclofenac sodium	200	0.25	0.24	0.21	0.233	72.87
		400	0.19	0.18	0.19	0.187	78.29
		600	0.15	0.17	0.16	0.160	81.40
		800	0.13	0.14	0.12	0.130	84.88
		1000	0.11	0.18	0.09	0.127	**85.27****
3	MCFL	200	0.65	0.62	0.64	0.63	79.07
		400	0.59	0.58	0.57	0.64	25.97
		600	0.52	0.53	0.51	0.58	32.56
		800	0.48	0.47	0.46	0.52	39.53
		1000	0.43	0.48	0.47	0.47	**45.35****

n=3



The standard drug, Diclofenac sodium, showed strong inhibitory activity with percent inhibition ranging from 72.87% to 85.27% across concentrations of 200–1000 µg/ml, confirming the reliability of the assay. Sample–VS exhibited variable results across the tested concentrations. Although a percent inhibition of 79.07% is reported at 200 µg/ml, the corresponding mean O.D. value (0.18) appears inconsistent with the recorded absorbance values, suggesting a possible calculation or typographical error. At higher concentrations (400–1000 µg/ml), Sample–VS demonstrated a gradual increase in inhibition from 25.97% to 45.35%, indicating a dose-dependent trend. The decrease in absorbance values with increasing concentration supports its ability to inhibit protein denaturation.

CFA Induced Arthritis:

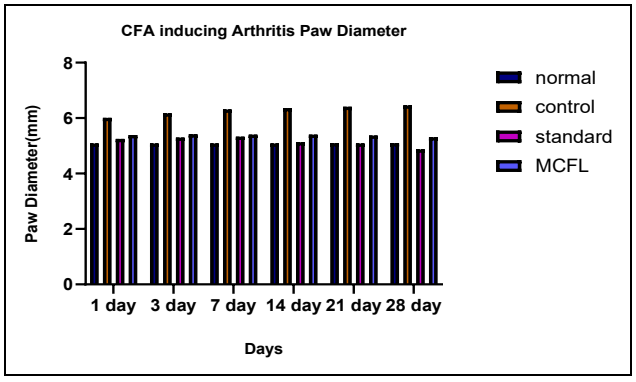
Physical Parameters:

CFA - induced arthritic paw:

In comparison with the standard control rats, the volume of Rat paw of CFA induced arthritic control rats is much bigger. As compared with the arthritic rats, the paw edema volume in rats was remarkably decreased through the administration of 400 mg/kg of Cordyline fruticosa and 10 mg/kg of Diclofenac sodium

Cordyline fruticosa Leaves Extract impact on the diameter of the CFA-induced arthritic paw:

Treatment groups	Day 1	Day 3	Day 7	Day 14	Day 21	Day 28
Normal Control	5.08±0.11	5.08±0.11	5.08±0.11	5.08±0.11	5.10±0.11	5.10±0.11
Disease Control	6.01±0.14	6.17±0.15	6.31±0.13	6.36±0.14	6.41±0.13	6.46± .12
Diclofenac Sodium 10mg/kg	5.25±0.20	5.30±0.19	5.33±0.18	5.13±0.27	5.10±0.24	5.08±0.22
Methanolic extract Cordyline fruticosa 400mg/kg	5.39±0.14	5.42±0.13	5.40±0.14	5.40±0.14	5.37±0.14	5.31±0.13



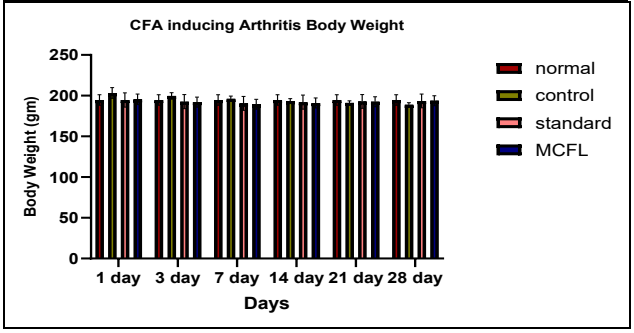
The results (n = 6) are presented as mean ± SEM." To compare the normal control and illness control groups, one-way ANOVA was used, followed by Dunnett's test. A p-value of <0.05 was considered statistically significant. On days

14,21 and 28, animals treated with Cordyline fruticosa leaf extract (400 mg/kg) and Diclofenac Sodium (10 mg/kg) had significantly smaller paw diameters ($p < 0.001$) than the disease control group.

Body Weight Changes:

It is evident from the data collected for this study that the degree of weight reduction and the level of joint inflammation are closely related. The arthritic rats lost a significant amount of weight for the first week following adjuvant injection. In contrast, no weight loss was observed in the normal control. In the case of MCFL and standard groups, there a minor reduction in body weight from days 0 to 7; however, during days 14 to 28, there was an increase in body weight.

Treatment groups	**1st day**	**3rd day**	**7th day**	**14th day**	**21th day**	**28th day**
Normal Control	194.67 ± 6.51	194.67 ± 6.51	194.67 ± 6.51	194.67 ± 6.51	194.67 ± 6.51	194.67 ± 6.51
Disease Control	203.33 ± 4.43	199.67 ± 3.90	196.17 ± 3.22	193.50 ± 2.95	191.17 ± 2.55	188.83 ± 2.48
Diclofenac Sodium 10mg/kg	194.67 ± 8.70	192.67 ± 8.61	190.50 ± 8.49	192.00 ± 8.65	192.83 ± 8.44	193.50 ± 8.43
Methanolic extract Cordyline fruticosa 400mg/kg	195.50 ± 6.45	192.17 ± 6.15	189.50 ± 5.99	191.00 ± 6.10	192.50 ±6.21	193.83 ± 6.15

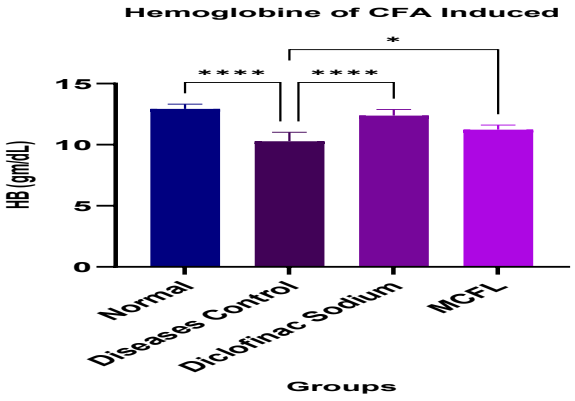


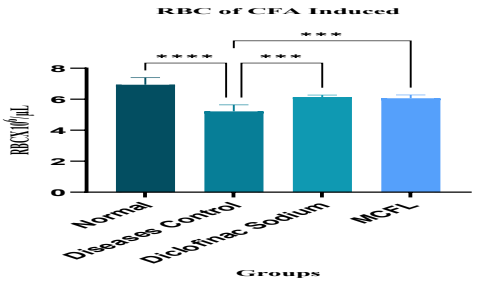
The data is presented as the mean ± SEM of six rats in each group. Comparing the condition-regulating group to the normal group, as well as the drug-treated group to the disease control group. A P value < 0.05 was considered extraordinary. The significance criteria are $p<0.05$, $p<0.01$, and $P<0.001$, respectively. The Dunnet test and one-way ANOVA are used for comparison.

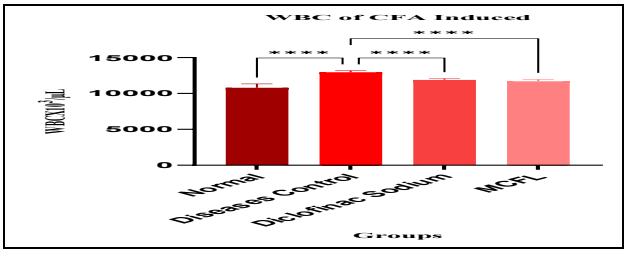
Hematological parameter:

On day 28 heamatological parameters are analysed. When comparing the healthy control rats with the arthritic rats, there was a significant i) reduction in the RBC count and haemoglobin and ii) an increase in the WBC count. Adjusted haematological alterations in both the developing & established phases of adjuvant induced arthritis have been significantly restored by the medication treatment.

Treatment groups	**Haemoglobin gm/dl**	**WBC X10^3 mm3**	**RBC X 10^3 mm3**
Normal Saline	12.93 ± 0.16	10788.33±252.17	6.93 ± 0.18
Disease Control	10.54 ± 0.23	12768.00±175.59	5.22 ± 0.16
Diclofenac Sodium 10mg/kg	12.73 ± 0.21	12388.00 ±313.43	6.14 ± 0.05
Methanolic extract Cordyline fruticosa 400mg/kg	11.37 ± 0.18	12806.00±303.91	6.06 ± 0.08



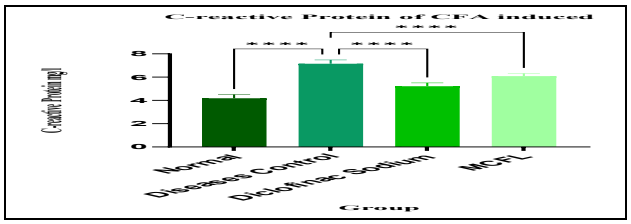


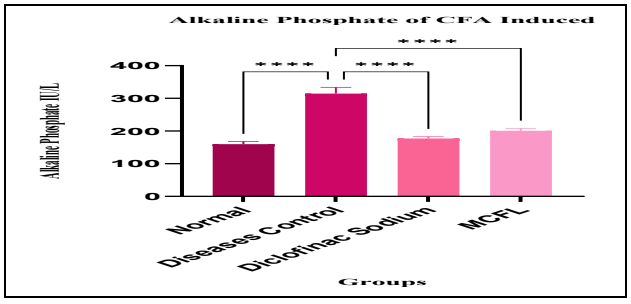


Biochemical Parameter:

Changes brought on by CFA According to the biochemical parameter results, There was a substantial ($p<0.05$) difference between the illness control group and the normal group. CRP increases, with the former occurring more slowly. The ALP is higher in disease control alkaline phosphate than in treated alkaline phosphate ($P<0.001$).

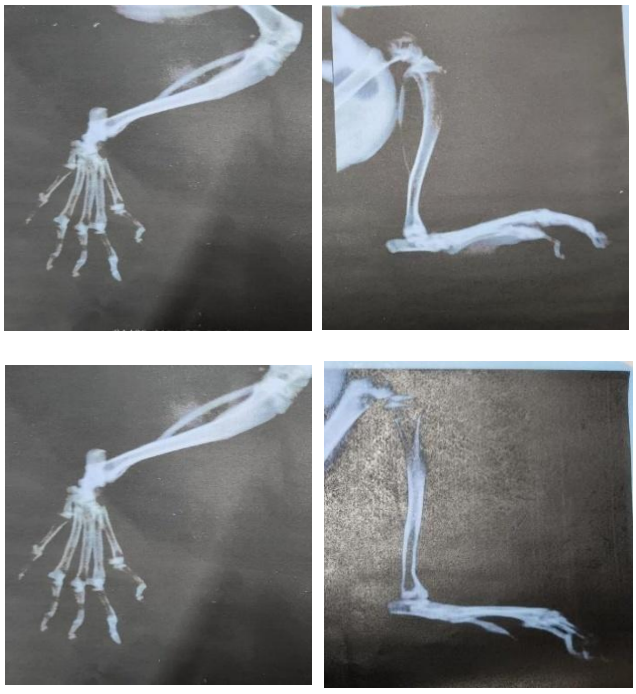
Treatment group	C–reactive Protein test (CRP)	Alkaline phosphate test (ALK)
Normal Control	4.18 ± 0.12	159.83 ± 3.28
Disease Control	7.15 ± 0.13	314.33 ± 8.39
Standard Diclofenac Sodium10 mg/kg	5.22 ± 0.11	177.00 ± 2.44
Methanolic extract Cordyline fruticosa 400mg/kg	6.08 ± 0.09	200.67 ± 3.07





Radiological analysis:

Radiological analyses were conducted on all groups, and the results showed that the standard groups had less joint swelling and no visible signs of joint deformation, whereas the arthritic control group saw considerable joint space decrease (inter tarsal joints), cartilage degradation, Bone erosion and joint deformity. The 28-day MCFL 400 mg per kg treatment resulted in less soft-tissue constriction and swelling of joint gaps than the negative control, indicating a considerable prophylaxis against bone loss. the negative control, indicating a considerable prophylaxis against bone loss.



Histopathological Analysis:

Ankle joint histopathology results obtained from the normal control group showed that their joints were structurally normal without any cartilage degradation and without evidence of the infection or any other abnormalities. On the other hand, diseased control mice showed some evidence of pannus formation, synovial hyperplasia, cartilage destruction, and joint space injury. Synovial hyperplasia significantly improved in the group receiving diclofenac and MCFL treatment. According to the investigation's findings, MCFL can lessen paw edema joint histopathology.

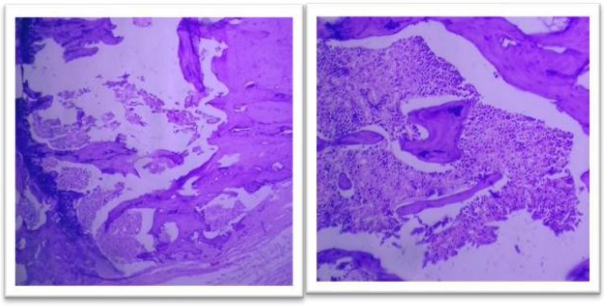


Fig no. A Fig no. B

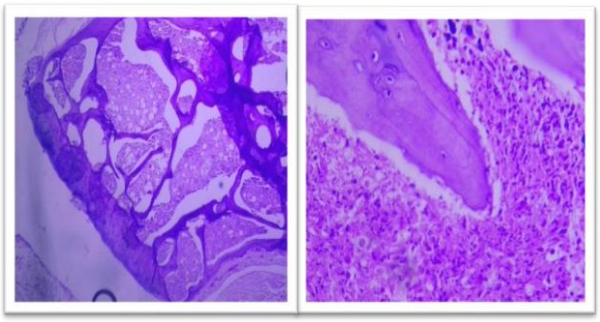


Fig no. C Fig no. D

A) Normal control (B) Disease control (C) Diclofenac (10 mg/kg) & (D) MCFL (400 mg/kg) are the possible outcomes.

Pathophysiology of the joint: A) normal control B) disease control C) 10 mg/kg of Diclofenac Sodium D) 400 mg/kg of MCFL.

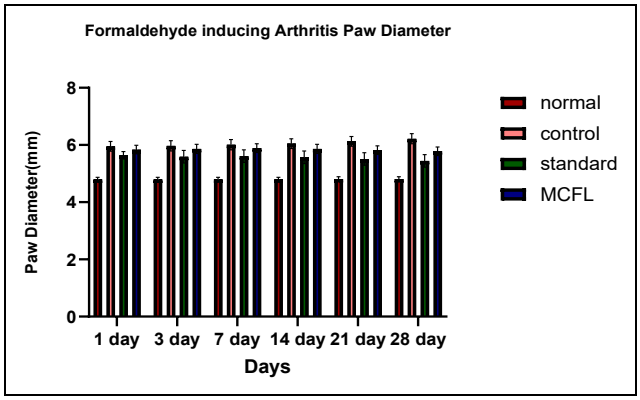
Formaldehyde Induced Arthritis:

The physical parameter:

Formaldehyde-induced paw diameter is affected by Cordyline fruticose Leaves Extract:

Treatment groups	1st Day	3rd Day	7th Day	14th Day	21st Day	28th Day
Normal Control	5.01± 0.07	5.01± 0.07	5.01± 0.07	5.01± 0.07	5.03 ± 0.08	5.03 ± 0.08
Disease Control	5.95± 0.17	5.97± 0.18	6.01± 0.18	6.05± 0.17	6.13 ± 0.17	6.22 ± 0.18
Diclofenac Sodium 10mg/kg	5.64 0.13	5.59 0.22	5.61 0.22	5.57 ± 0.22	5.51 ± 0.22	5.44 ± 0.22
Methanolic extract Cordyline fruticosa 400mg/kg	5.84± 0.15	5.86± 0.16	5.89± 0.15	5.86± 0.16	5.82 ± 0.15	5.78 ± 0.15

During the monitoring period, the paw edema of all the animals increased. Rats treated with CFA-induced paw edema demonstrated a substantial ($p < 0.001$) progressive rise in paw edema in the disease control group compared to the normal group because the same paw got formaldehyde for the third time. On day 14, diclofenac sodium (10 mg/kg) generated a significant ($P<0.001$) reduction in paw diameter. When paws treated with MCFL (400 mg/kg) and 10 mg/kg were compared to the CFA control group, paw edema decreased dramatically, particularly on days 21 and 28.



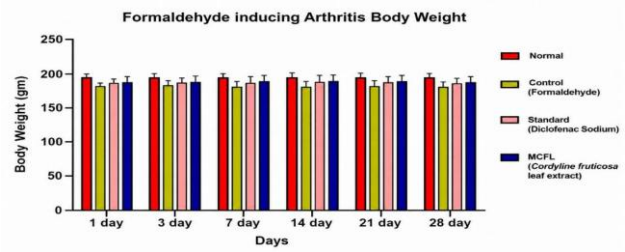
Mean±S.E.M is shown for each set of six rats. The normal rats are compared with the disease control

rats and the diseased rats treated with drugs. The significant value for a P value is 0.05. The levels of significance are p<0.05, p<0.01, and p<0.001. Apply the Dunnett test for one-way ANOVA

Changes in body weight:

Throughout the following few days, there were no great differences observed in body weights of all groups of animals, whereas the disease control group witnessed a fall in body weight from days 3 to 28. In the case of MCFL and standard groups, there was a minor reduction in body weight from days 0 to 7; however, during days 14 to 28, there was an increase in body weight.

Treatment groups	Day 1	Day 3	Day 7	Day 14	Day 21	Day 28
Normal Control	182.00 ± 5.86	182.00 ± 5.86	182.00 ± 5.86	182.00 ± 5.86	183.00 ± 6.08	183.00 ±6.08
Disease Control	200.83 ± 4.85	197.00 ± 6.14	193.83 ± 5.26	195.50 ± 5.16	192.17 ± 5.20	176.67 ± 15.20
Diclofenac Sodium 10mg/kg	213.33 ± 11.50	210.67 ± 11.13	209.00 ± 10.47	210.17 ± 10.54	211.50 ± 11.10	212.00 ± 11.41
Methanolic extract Cordyline fruticosa 400mg/kg	177.17 ± 7.17	175.00 ± 7.13	173.00 ± 6.98	174.33 ± 7.03	175.17 ± 7.17	176.33 ± 7.12



Mean ± standard error values from each group of 6 rats are shown, compared between those who were under medication and disease controls and those who were normally kept. The results are compared using a two-way ANOVA by use of a Dunnet test with a P-value significance of 0.05. Significant levels are indicated at P<0.05, p<0.01 and P<0.001.

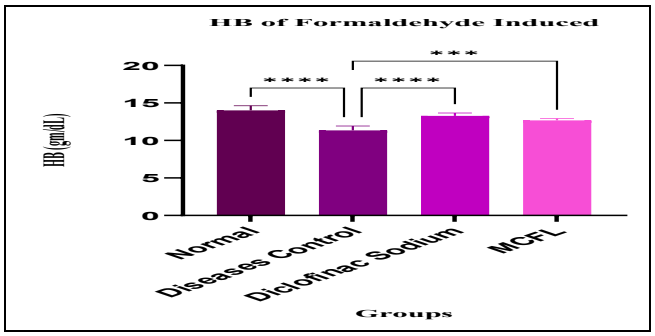
Hematological evaluation:

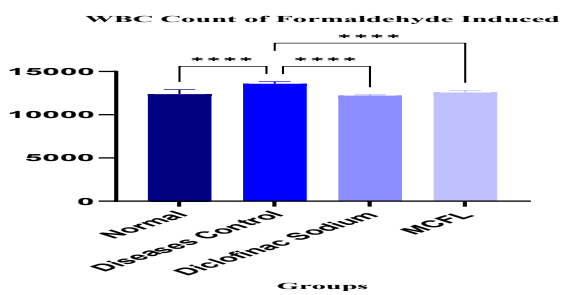
Arthritic rats induced by formaldehyde, hematological values showed variation. There was a statistically significant reduction in WBCs (P<0.01) and RBCs (P<0.001) in rats exposed to MCFL at dose 400 mg/kg compared with the diseased control rats

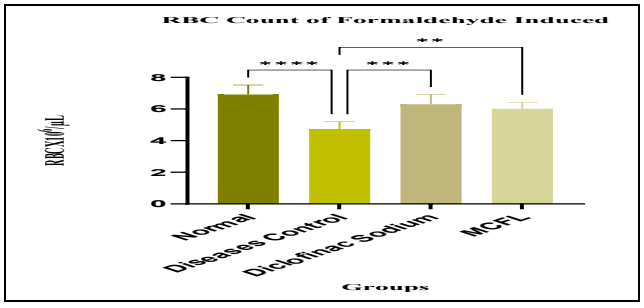
Formaldehyde Induced Arthritis

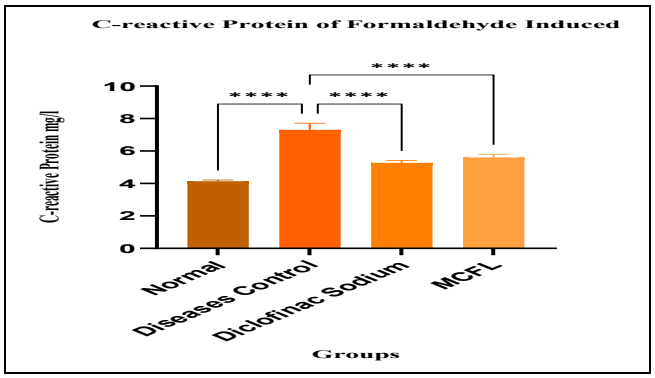
Hematological Parameter: Hb count, WBC count, RBC count

Treatment groups	Haemoglobin gm/dl	WBC X 10^3 mm^3	RBC X 10^6 mm^3
Normal Control	14.00 ± 0.26	12386.83± 243.49	6.92 ±0.24
Disease Control	11.34 ± 0.24	13586.33± 97.84	4.73 ± 0.12
Diclofenac Sodium 10mg/kg	13.27 ± 0.15	13221.67± 30.63	5.75 ± 0.07
Methanolic extract Cordyline fruticosa 400 mg/kg	12.67 ± 0.10	13429.67± 45.86	5.45 ± 0.07







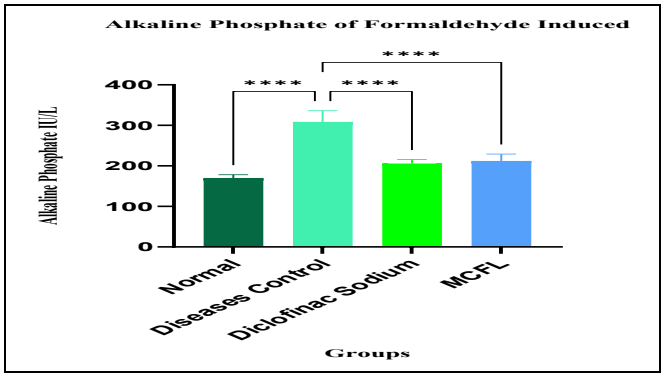


Mean ± SEM has been used for comparing the treated group with disease control group and normal group where n = 6. Where P value < 0.05 is considered significant, which is true since p<0.05, p<0.001, and p<0.001 have fulfilled the requirements. Comparison has been made by applying one way ANOVA and Dunnet test.

Biochemical Parameters:

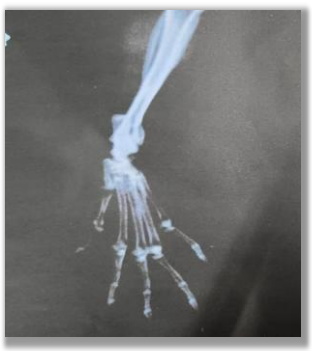
The results of biochemical parameters revealed significant difference (P<0.001) between normal group and disease control group, with the CRP of the latter developing more slowly. Effect of Cordyline fruticosa on Formaldehyde-Induced Changes in biochemical Parameter: C-Reactive Protein test, Alkaline Phosphate test P<0.05) Alkaline phosphate (ALP) levels in disease control are higher than in treatment (P<0.001).

Treatment group	C – reactive Protein test (CRP)	Alkaline phosphate (ALP)
Normal Control	5.42±0.07	223.80± 8.09
Disease Control	7.30 ± 0.16	308.33± 11.37
Standard	5.39±0.09	187.17± 2.04
Methanolic extract Cordyline fruticosa 400mg/kg	5.77±0.06	195.50± 1.26

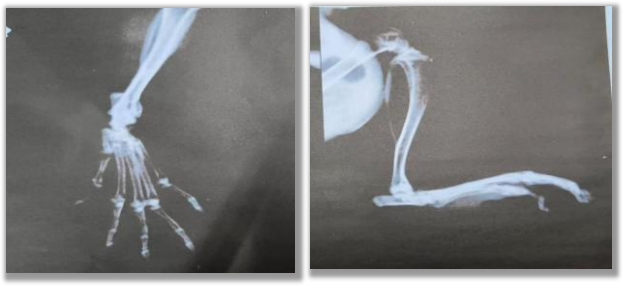


Radiological analysis :

The radiological assessment was done to all groups, and from the findings, it is clear that the standard groups had minimal swelling and no evidence of joint deformations. However, in the arthritic control group, there were evident reductions in joint spaces (inter tarsal joints), cartilage breakdown, bone erosion, formity. There was less soft tissue constriction and swelling of joint gaps during the 28 days of treatment with MCFL at 400 mg/kg compared to the negative Furthermore, there was not able differences between the extract group and disease control.







Histopathological analysis: [43]

The histological examinations of the ankle joint reports, which show significant bone degradation in the disease control group in addition to neutrophil infiltration, inflammation, and the emergence of pannus joint space damage. The treatment groups that received 400 mg/kg of Cordyline fruticosa and 10 mg/kg of Diclofenac Sodium exhibited joint inflammation accompanied by decreased neutrophil infiltration, as well as a decrease in pannus development and bone resorption

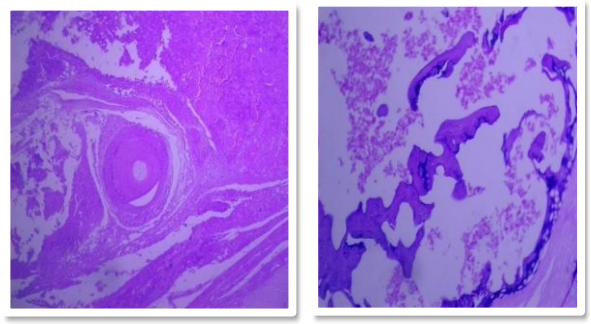


Fig A Fig B

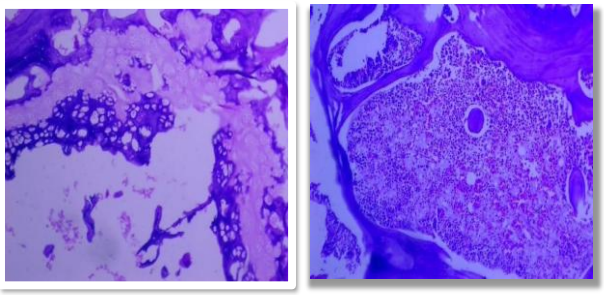


Fig C Fig D

DISCUSSION:

Cordyline fruticosa showed significant anti-inflammatory activity using in -vivo and in-vitro studies. The methanolic extract of Cordyline fruticosa underwent preliminary phytochemical screening, which demonstrated the presence of a variety of bioactive phytoconstituents such as flavonoids, phenolic compounds, tannins, saponins, steroids, and glycosides. From the literature survey it was found that these phytochemicals have anti-inflammatory, antioxidant, and other pharmacological activities.

The GC-MS study of Cordyline fruticosa extract identified a number of bioactive chemicals with proven anti-arthritic activity:

- D-Limonene (Peak 7) reduces inflammatory cytokines including TNF-α and IL- 1β. It may help lessen joint inflammation caused by arthritis.
- Alpha-Tocopheryl Acetate (Peak 72): A strong antioxidant that reduces oxidative stress and inflammation, both of which contribute to arthritis progression
- γ-Sitosterol (Gamma-Sitosterol) (peak73) is one of the most powerful antiarthritic phytosterols. Inhibitors of inflammatory mediators have been shown to reduce joint inflammation and protect cartilage tissues.
- Pentadecanone (peak 59): Some ketone derivatives have anti-inflammatory capabilities, which may add to the extract's overall anti-arthritic potential.

The current study concludes that Cordyline fruticosa has moderate antiinflammatory activity in vitro, as measured by the egg albumin denaturation method and Bovine Serum Albumin denaturation method. The sample demonstrated a concentration-dependent rise in

inhibition, with a maximum of 52.33% at higher concentrations, much lower than Diclofenac sodium. Cordyline fruticosa has moderate anti-inflammatory activity in vitro, as shown by the protein denaturation technique. The sample showed a dose dependent rise in inhibition, with a maximum of 45.35% at 1000 µg/ml, much lower than Diclofenac sodium. These findings suggest that Cordyline fruticosa has significant in-vitro anti-inflammatory properties.

Overall, the data indicate that cordyline's fruticosa has strong anti-inflammatory activity. In this study, we investigated how the methanolic extract of Cordyline fruticosa t

reated rheumatoid arthritis. We conducted two animal studies: one in which arthritis was produced by CFA and the other by formaldehyde in rats. Both investigations found that the methanolic extract of Cordyline fruticosa is effective at treating arthritis.

In the CFA-induced arthritis and formaldehyde induced arthritis investigation, we discovered that rats treated with Cordyline fruticosa extract exhibited less edema in their paws than rats with arthritis. This is comparable to what occurs in persons with rheumatoid arthritis.

The rats with arthritis lost more weight than the rats. The rats treated with Cordyline fruticosa extract initially lost weight, but after 14 days began to gain weight, which was better than the rats with arthritis. The study shows that Cordyline fruticosa has anti-inflammatory activities and can help with arthritis.

X-ray pictures revealed that treated animals had greater joint space and stronger bones. They also experienced more bone deterioration and growths than those who did not receive therapy. We also measured the thickness of their paws every day to gather more precise data on swelling.The treated animals' paws were less swollen than those in the control group.This confirmed that cordyline fruticosa possesses anti-inflammatory properties. Checking paw thickness every other day let us determine how effective the medication was in reducing swelling.The treated animals had edema and stronger bones.They had more joint space and less bone degeneration. The disease control group showed bone growths and degeneration. The x-ray images confirmed these findings.The treatment was effective, in reducing inflammation. Cordyline fruticosa showed anti-inflammatory properties.

Histopathological examination of treated animals revealed decreased joint injury and inflammatory cell infiltration. This demonstrates that Cordyline fruticosa preserves joint tissues and may slow the degenerative processes associated with arthritis. The histological analysis demonstrated that the treated joints saw less cartilage degradation, synovial hyperplasia, and pannus formation than the control group. These findings are crucial because they demonstrate that the plant extract can protect against the structural damage common to arthritis

CONCLUSION

The present study demonstrated that cordyline fruticosa leaves extract showed significant anti-arthritic activity in both In vitro protein denaturation assay and complete Freund’s adjuvant induced and formaldehyde induced arthritic models. The extract showed remarkable reduction in joint inflammation, arthritic scores, and paw edema. Further studies are required for the isolation and identification of active constituents and to evaluate their individual pharmacological potential.

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