International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp:1273-1285 www.ijprajournal.com ISSN: 2456-4494

Experimental evaluation of Jingini on cardiomyopathy: An In vivo study

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Date of Submission: 04-02-2024 Date of acceptance: 15-02-2024

Abstract

Bhavaprakasha advocated the drug *Jingini* [*Lannea coromandelica* (Houtt.) Merr.] in *Hridroga*. Study has been carried out on cardio protective activity of the drug in rats by Doxorubicin induced cardiomyopathy. Study consists of 4 groups and 6 animals in each group. Animals selected based on inclusion and exclusion criteria. Animals in Group I fed with normal diet without any intervention, Group II animals were administered with doxorubicin, Group III animals were administered with doxorubicin and 1000 mg/kg Hydro-alcoholic extract of *Jingini*, Group IV animals were administered with Doxorubicin and 500 mg/kg Hydro-alcoholic extract of *Jingini*. *On* 29th *day* the blood and heart tissue were collected for biochemical parameters and histopathology respectively. Results confirmed that both the treatment groups were effective against cardiomyopathy in dose dependent manner but high dose proved to more effective in protecting cardiac tissue. Histopathology reports confirms the same that low dose, can protect the cardiac tissue for certain extent of tissue damage but high dose can protect the cardiac tissue completely as no tissue damage was found.

Key words: *Jingini*, *Hridroga*, Cardiomyopathy, *Lannea coromandelica*

I. Introduction

In Ayurveda Samhithas, many Yogas and in Nighantus many dravyas are indicated for *Hridroga*. *Jingini* is one among the dravyas mentioned for *Hridroga* in *Bhavaprakasha Nighantu* [1].

Jingini belongs to Anacardiaceae family, found common in deciduous forest throughout India. It is a medium sized to large tree, It's Exudate, leaves, stem bark and tender leaves are used for medicinal purposes. Other indications of *Jingini* other than *Hridroga* are *vrana*, *Atisaara* and *Yoni* roga [2].

Hridaya is considered as vital organ in Ayurveda hence it is included under the Tri Marma. According to Madhava, disease which affects the Hridaya is called as Hridroga [3]. In Ayurvedic classics we can find references for Hridroga, its types, nidana, samprapti, lakshana and chikitsa. In Hridroga Viguna Vataadi doshas does Dooshana of rasa present in hridaya and produces bhaada which leads to lakshana like Vaivarnya, Moorcha, Jwara, Kaasa, Hikka, Swaasa, Aasya vairasya, Trishna, Pramoha, Chardi, Kaphothklesha, Ruja, Aruchi etc.
Cardiovascular diseases are the leading cause of death globally, an estimated 17.9 million people died from CVDs in 2019, representing 32% of the global deaths [4]. Nearly 50% of the patients succumb to death suddenly in childhood or adolescence or undergoing cardiac transplantations are affected bycardiomyopathies [5]. The cardiomyopathies are a diverse group of diseases characterized by myocardial dysfunction that is not related to the usual causes of heart disease, notably coronary atherosclerosis, valvular dysfunction, and hypertension [6].

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp:1273-1285 www.ijprajournal.com ISSN: 2456-4494

Even though many dravyas are mentioned in our Nighantus for Hridroga few are used in clinical practices and proved to be effective, this might lead to exploitation of natural sources of most frequently using drug. *Jingini* is less frequently used in clinical practices but its cardioprotective activity had been proved, got significant results in researches conducted on ischemic heart disease, Myocardial infarction due to reperfusion injury. As one more step ahead, this experimental study is designed to explore its efficacy in cardiomyopathy.

II. MATERIALS AND METHODS

Preparation of the plant material

Collection of the trial drug

The Stem Bark of *Jingini* collected in Sharad rithu from Brahmavara Forest, Udupi, Karnataka.

Drug authentication

The genuinity of the Stem bark of *Jingini* confirmed and authenticated by Dr. Shivamanjunath, Senior scientist, Department of Dravya guna Sri Sri College of Ayurvedic Science and research, Bengaluru.

Preparation of the drug

After collection the stem bark of *Jingini* was washed, 100 grams of herbal drug cut into small pieces and was stored in a solution for microscopic and macroscopic studies. Remaining drug was kept for shade drying. Once the drug was completely dried, the weight of the dried drug was noted. The required quantity of dried drug was coarse powdered by using the Pulveriser in the Department of Rasashastra and Bhaishajya Kalpana laboratory, Sri Sri College of Ayurvedic Science and Research, Bengaluru. Powdered drug was stored in air tight container for conducting physico– chemical, pytochemical analysis also for the purpose of preparation of extract. Cold extraction method was done at Dravyaguna laboratory SSCASR, Bengaluru.

Place of the study

The Experimental study was carried out in Department of Pharmacology, Acharya & BM Reddy College of Pharmacy, Bengaluru.

Source of the animals

The number of Healthy Sprague Dawley Rats weighing 140-200g required for the experiment were procured from Animal house, Acharya & BM Reddy College of Pharmacy, Bengaluru.

Ethical clearance

The Experimental procedure was carried out in accordance with the ethical guidelines for animals proposed by CPCSEA, Government of India. Ethical clearance was obtained from Department of Pharmacology, Acharya & BM Reddy College of Pharmacy, Bengaluru as per the protocol outlined in publication of the committee for the purpose of control and supervision of Experiments on animals' standard guidelines (CPCSEA) and approval was obtained from Institutional Animal Ethics committee (IAEC) with reference no: IAEC/ABMRCP/2023-24/1.

Selection of the animals

Inclusion criteria

- Healthy Sprague Dawley [SD] rats of either sex.
- Sprague Dawley rats weighing 140 – 200 g.

Exclusion criteria

- SD rats which are pregnant.
- SD rats showing the signs of infection before or during the course of study.
- SD rats those who are under other experiments.
- SD rats younger than 45 days.

Dose of the trial drug

High dose and low dose of Hydro-alcoholic extract of stem bark of *jingini* 1000mg/kg and 500 mg/kg body weight respectively were considered as therapeutic dosage for doxorubicin induced cardiomyopathy model.

Route of administration

Drug was administered orally with the help of suitable gastric canula/gavage i.e., rat feeding gavage needle no 18.

Preparation of dosage

The calculation of dosage was done based on the body weight of the SD rats. Solution was prepared from the hydro alcoholic extract of *jingini* in the ratio, for 100 mg of extract 1 ml of distilled water was added. Total amount of hydroalcoholic extract of *Jingini* required for the day was calculated including the volume of distilled water and finely triturated using mortar and pestle to this 2% gum acacia was added to ensure the uniformity in the solution. The solution prepared was administered using rat feeding gavage.

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Preparation of doxorubicin for inducing cardiomyopathy

Doxorubicin was given at dose of 0.25 mg / 100 gram of body weight of Sprague Dawley rats.

Grouping

Table 1: Model – Doxorubicin induced cardiomyopathy

Sl.no	Group	Drug used	Number of rats
1.	G1	Normal control group	06
2.	G2	Disease control group [Doxorubicin, 0.25 mg/100 gm, i.p.]	06
3.	G3	Hydro – alcoholic extract of *jingini* [1000 mg/kg, p.o.]	06
4.	G4	Hydro – alcoholic extract of *jingini* [500 mg/kg, p.o.]	06

Treatment protocol [7]
Animals were divided into 4 groups consisting of 6 Sprague Dawley rats in each, kept in rat cages for entire duration of experiment. All the animals had free access to regular rat chow and drinking water *ad libitium*.
Group 1 is Normal control group receiving regular Rat feed and drinking water.
Group 2 is Disease control receiving regular rat feed and drinking water along with only doxorubicin on 1st, 7th, 14th, 21st and 28th day.

Group 3 is Treatment group receiving regular rat feed and drinking water, Doxorubicin on 1st, 7th, 14th, 21st and 28th day and everyday high dose of 1000 mg /kg body weight of hydro alcoholic extract of *Jingini*.

Group 4 is Treatment group receiving regular rat feed and drinking water, Doxorubicin on 1st, 7th, 14th, 21st and 28th day and everyday low dose of 500 mg /kg body weight of hydro alcoholic extract of *Jingini*.

Assessment criteria

Serum analysis

After the experiment, blood was collected from the retro – orbital plexus after giving thiopental sodium as Anesthesia, blood was collected using glass capillaries and stored in EDTA tubes. Serum was separated from the blood obtained through centrifugation at 5000 rpm for 20 min. The obtained serum was pipetted to eppendorf tubes and was stored in -20 degree Celsius, until further biochemical parameters and analyzed.

- Cardiac markers (CK – MB and LDH) [8]
- Liver function tests (SGOT and SGPT) [8]
- Antioxidants (SOD, CAT) [8, 9]
- MPO [8]
- MDA [8]

Heart tissue analysis [9]

- Antioxidants [SOD (Super oxide dismutase), CAT (Catalase)]
- MPO (Myeloperoxidase)
- MDA (Malondialdehyde)

Infarct size

Histopathology of Heart [7]
In each group one animal was sacrificed and dissected in order to collect the heart. Heart was separated and washed with clean water and then in buffer solution. The heart tissue was stored in formalin filled containers in order to protect heart from decomposition prior to histopathological study.

Statistical analysis
The obtained data was represented in the form of tables and graphs. For assessing the significance of the difference among the groups one way ANOVA with Bonferroni test and Kruskal Wallis for non – parametric data with Dunn's test as post hoc test. The results were expressed in terms of Mean ± SEM, Median P value ≤ 0.05 will be considered as statistically significant. For this purpose, Sigma stat version 3 software is used.

III. RESULTS

Statistical analysis of Biochemical markers

A. Serum

Cardiac markers

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CK-MB

G1 was normal control, did not receive any drug, in which CKMB values found to be 197.503 ± 1.1 IU/L. G2 was Disease control, in which Doxorubicin is induced where CKMB values found to be 381.670 ± 10.2 increased compare to G1. G3 and G4 were treatment groups with High dose (1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of *Jingini*, CKMB values 149.482 ± 3.04 and 283.248 ± 6.98 respectively are reduced in the both the treatment groups which are statistically significant compare to disease control group.

LDH

G1 was normal control, did not receive any medicine, in which LDH values found to be 309.483 ± 20.3. G2 was disease control, in which Doxorubicin is induced where LDH values found to be 1054.917 ± 35.2 increased compare to G1. G3 and G4 were treatment groups with high dose (1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of *Jingini*, LDH values 551.783 ± 45.4 and 935.183 ± 25.1 respectively are reduced in both the treatment groups which are statistically significant in high dose group, compare to disease control group.

Liver function tests

SGOT

G1 was normal control, did not receive any medicine, in which SGOT values found to be 139.83 ± 3.28. G2 was disease control in which Doxorubicin is induced where SGOT values found to be 170.83 ± 3.19 increased compare to G1. G3 and G4 were treatment groups with high dose(1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of jingini, SGOT Values 138.16 ± 4.02 and 163.66 ± 5.09 respectively are reduced in both the treatment groups but statistically significant in high dose group, compare to disease control group.

SGPT

G1 was normal control, did not receive any medicine, in which SGPT values found to be 71.66 ± 2.31. G2 was disease control in which Doxorubicin is induced where SGPT values found to be 86.50 ± 2.93 increased compare to G1. G3 and G4 were treatment groups with high dose(1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of jingini, SGPT Values 52.66 ± 6.85 and 70.16 ± 4.09 respectively are reduced in both the treatment groups but statistically significant in high dose group, compare to disease control group.

Antioxidants

SOD

G1 was normal control, did not receive any medicine, in which SOD values found to be 0.77 ± 0.117. G2 was disease control in which Doxorubicin is induced where SOD values found to be 0.45 ± 0.096 decreased compare to G1. G3 and G4 were treatment groups with high dose (1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of *Jingini*, Serum SOD values 0.98 ± 0.011 and 0.65 ± 0.102 respectively increased in both the treatment groups but statistically significant in high dose group, compare to disease control group.

CAT

G1 was normal control, did not receive any medicine, in which CAT values found to be 3.64 ± 0.132. G2 was disease control in which Doxorubicin is induced where CAT values found to be 2.68 ± 0.083 decreased compare to G1. G3 and G4 were treatment groups with high dose (1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of *Jingini*, serum CAT values 3.25 ± 0.189 and 2.51 ± 0.486 respectively low dose shows decrease in CAT values but High dose shows increase in the CAT levels which is statistically significant compare to disease control group.

MPO

G1 was normal control, did not receive any medicine, in which MPO values found to be 505.10. G2 was disease control in which Doxorubicin is induced where MPO values found to be 538.60 increased compare to G1. G3 and G4 were treatment groups with High dose(1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of *Jingini*. Serum MPO values 449.10 and 494.30 respectively, reduced in both the treatment groups but statistically significant in high dose group, compare to disease control group.

MDA

G1 was negative control, did not receive any medicine, in which MDA values found to be 0.94 ± 0.17. G2 was disease control in which Doxorubicin is induced, where MDA values found to be 1.45 ± 0.17 increased compare to G1. G3 and G4 were treatment groups with high dose (1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of *Jingini*, Serum MDA values 0.72 ± 0.09 and 1.25 ± 0.22 respectively are reduced in both the

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treatment groups but statistically significant in high dose group compare to disease control group.

B. Heart tissue

SOD

G1 was normal control, did not receive any medicine, in which SOD values found to be 0.28 ± 0.09. G2 was disease control in which Doxorubicin is induced, where SOD values found to be 0.19 ± 0.07 increased compare to G1. G3 and G4 were treatment groups with high dose(1000mg/kg) and low doses (500 mg/kg) of Hydro alcoholic extract of jingini, tissue SOD values 1.15 ± 0.20 and 0.56 ± 0.60 respectively are increased in both the treatment groups but statistically significant in high dose group compare to disease control group

CAT

G1 was normal control, did not receive any medicine, in which CAT values found to be 1.80 ± 0.22. G2 was disease control in which Doxorubicin is induced, where CAT values found to be 0.83 ± 0.22 decreased compare to G1. G3 and G4 were treatment groups with high dose(1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of jingini, tissue CAT values 2.30 ± 0.12 and 0.99± 0.26 respectively were increased in both the treatment groups but statistically significant in high dose group compare to disease control group.

MPO

G1 was negative control, did not receive any medicine, in which MPO values found to be 444.23 ± 22.7. G2 was disease control in which Doxorubicin is induced, where MPO values found to be 547.86 ± 26.51 increased compare to G1. G3 and G4 were treatment groups with high dose(1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of jingini, tissue MPO Values 449.23 ± 11.76 and 477.76 ± 9.48 respectively are decreased in both the treatment groups but statistically significant in high dose group compare to disease control group

MDA

G1 was negative control, did not receive any medicine, in which MDA values found to be 1.64 ± 0.11. G2 was disease control in which Doxorubicin is induced, where MDA values found to be 2.22 ± 0.20 increased compare to G1. G3 and G4 were treatment groups with high dose(1000mg/kg) and low doses (500 mg/kg) of hydro alcoholic extract of *Jingini*, tissue MDA values 1.39 ± 0.16 and 1.86 ± 0.13 respectively are decreased in both the treatment groups but statistically significant in high dose group, compare to disease control group.

Infract size

G1 was negative control, did not receive any medicine, in which there is no infarct. G2 was disease control in which Doxorubicin is induced, where infarct size found to be 0.88 increased compare to G1. G3 and G4 were treatment groups with high dose(1000mg/kg) and low doses (500 mg/kg) of Hydro alcoholic extract of *Jingini*, Infarct size 0.76 and 0.86 respectively reduced in both the treatment groups but statistically insignificant compare to disease control group.

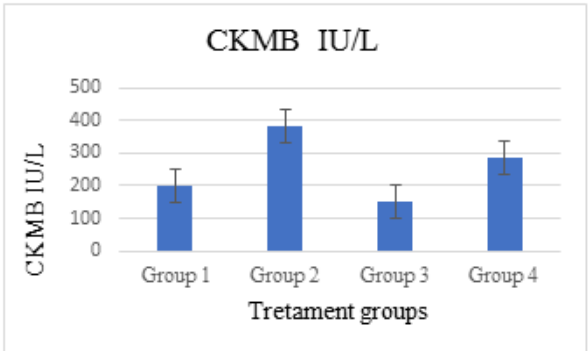

Fig 1 : Average values of CKMB

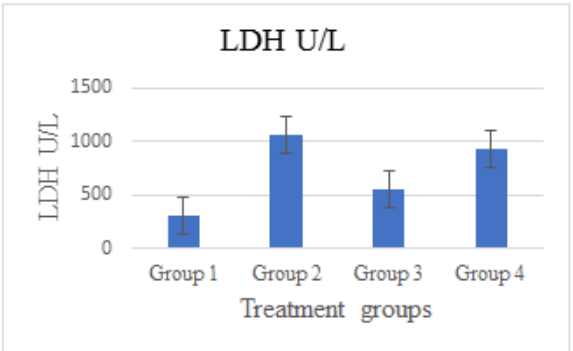

Fig 2: Average values of LDH

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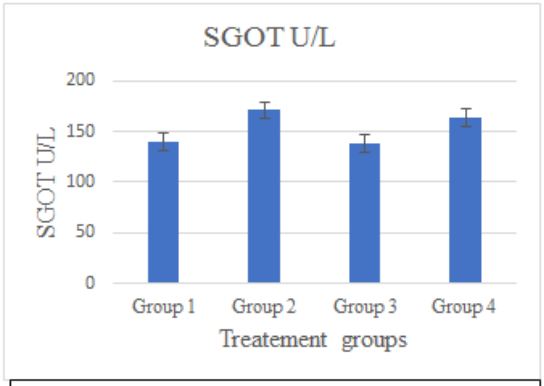

Fig 3: Average values of SGOT

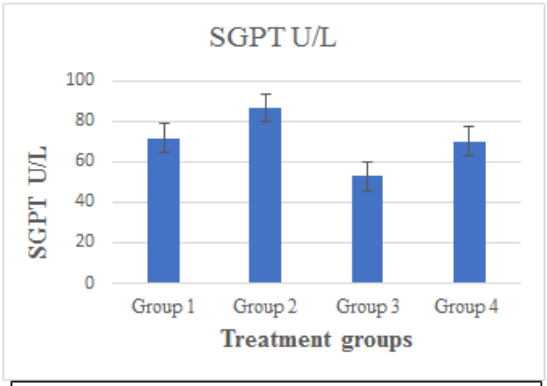

Fig 4: Average values of SGPT

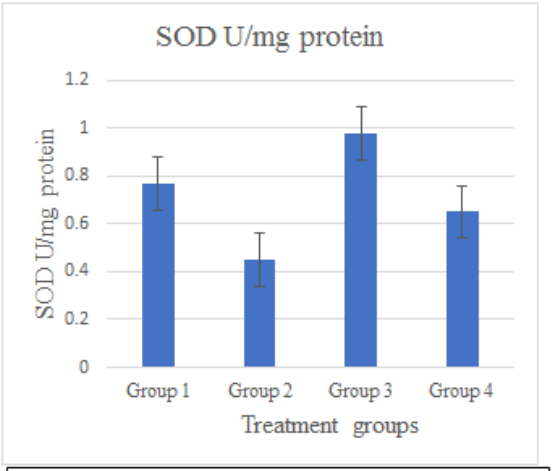

Fig 5: Average values of SOD

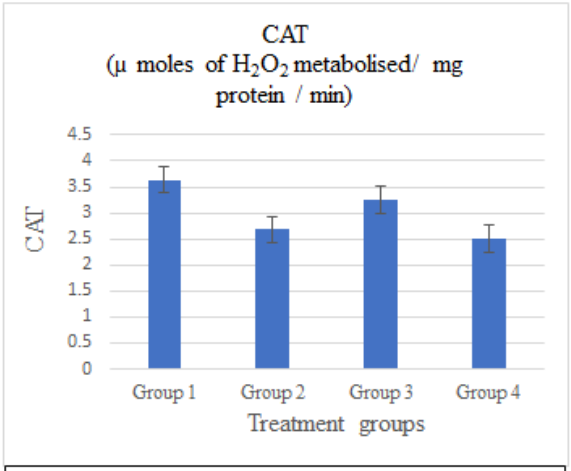

Fig 6: Average values of CAT

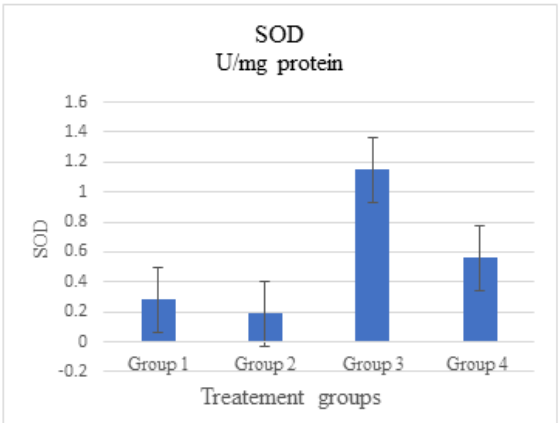

Fig 9: Average values of SOD

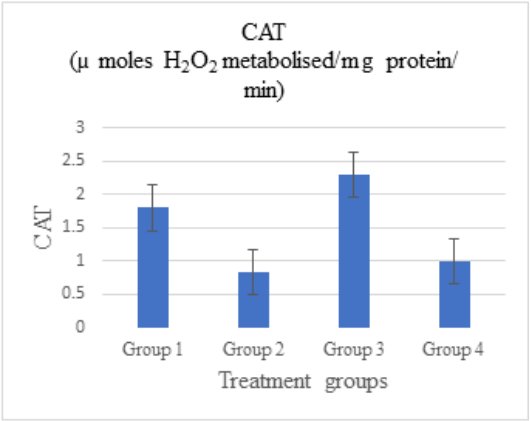

Fig 10: Average values of CAT

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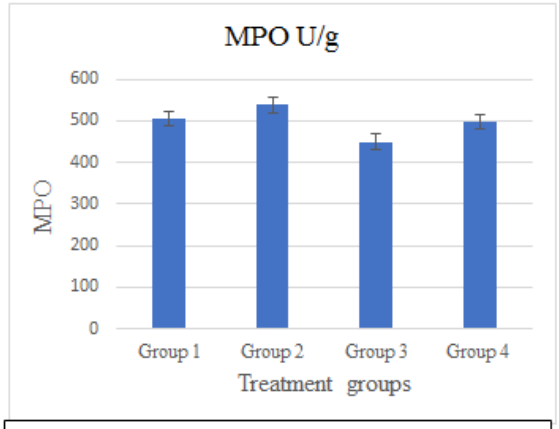

Fig 7: Average values of MPO

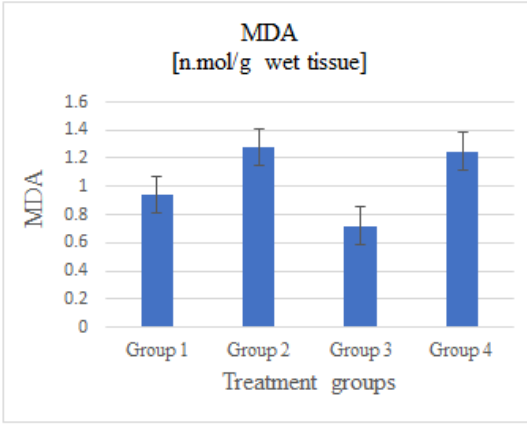

Fig 8: Average values of MDA

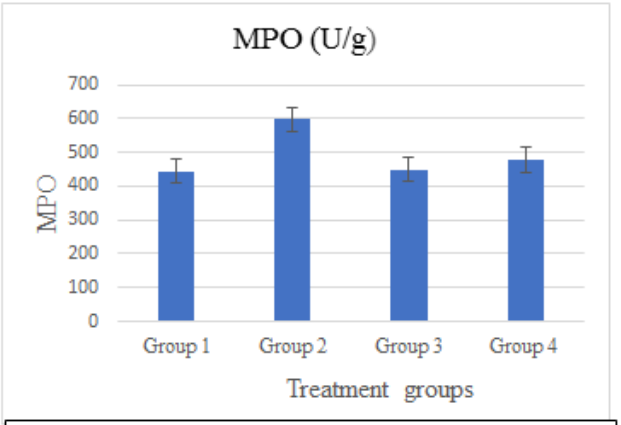

Fig 11: Average values of MPO

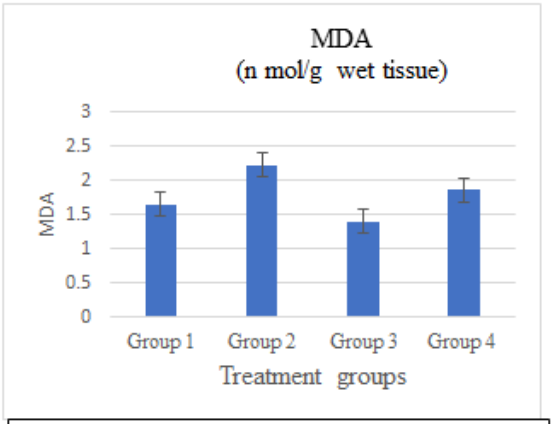

Fig 12: Average values of MDA

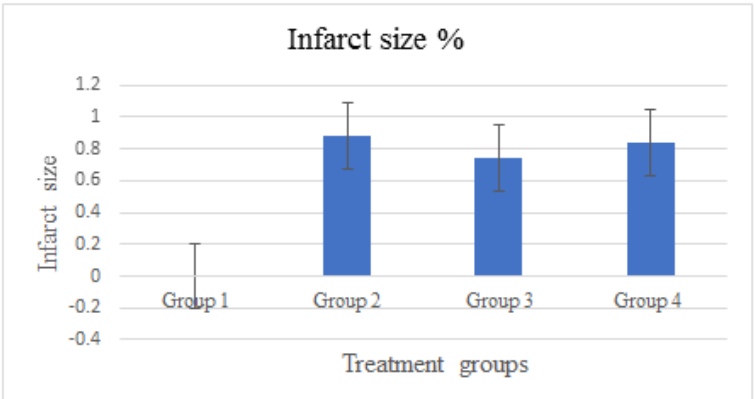

Fig 13: Infarct size

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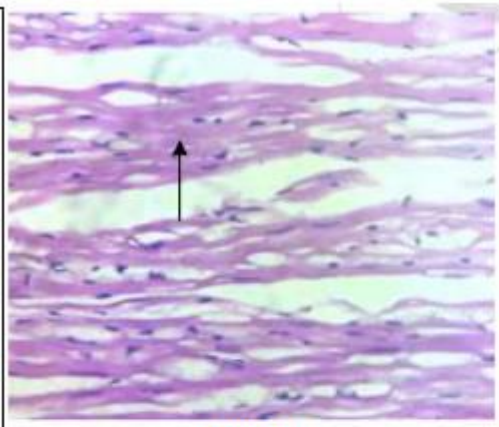
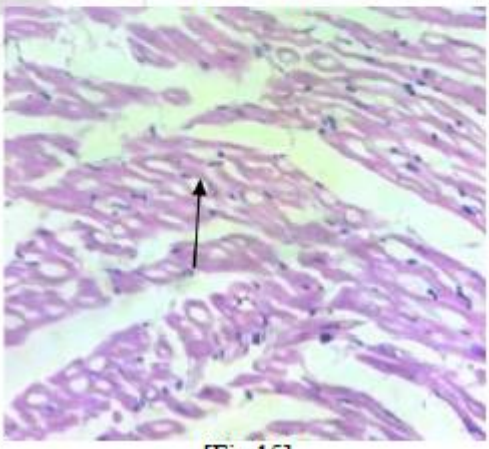
Table 2: Histopathology of heart

Group – 1 [Normal control]	Section studied from the myocardium shows intact arrangement of the cardiac muscle fibers. These cardiac muscle fibers show intact integrity of myocardial cell membrane, myofibrillar structure with striations and continuity with adjacent myofibrils [Fig. 14 Arrow].	 [Fig 14]
	The interstitial space appears intact. The vascular spaces amidst these cardiac muscle fibers appear unremarkable [Fig. 15 Arrow].	 [Fig 15]

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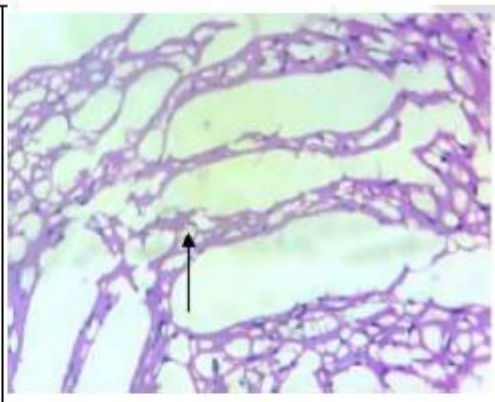
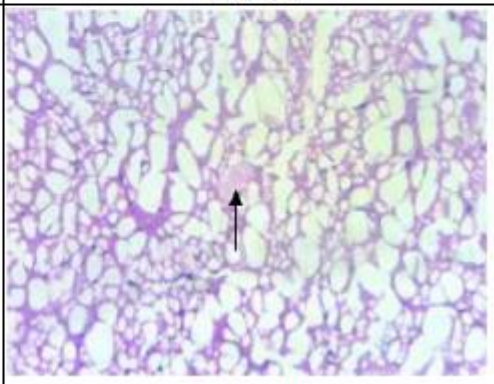
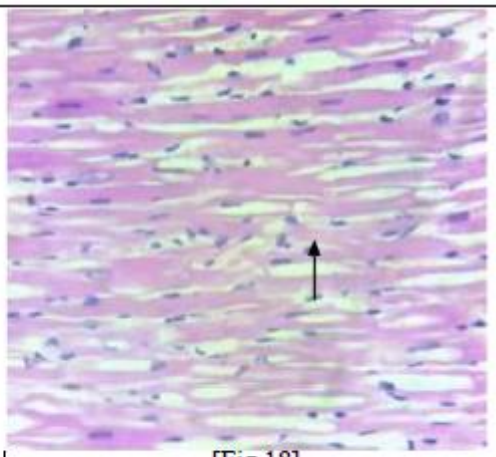
Group – 2 [Disease control]	Section studied from the myocardium shows distorted architecture of cardiac muscle fibers. These cardiac muscle fibers show necrosis [Fig.16 arrow] comprising of loss of integrity of myocardial cell membrane, myofibrillar structure with loss of striations and loss of continuity with adjacent myofibrils.	 [Fig 16]
	The interstitial space shows hemorrhage and vascular spaces appear congested at places [Fig 17 arrow]	 [Fig 17]
Group – 3	Section studied from the myocardium shows intact arrangement of the cardiac muscle fibers. These cardiac muscle fibers show intact integrity of myocardial cell membrane, myofibrillar structure with striations and continuity with adjacent myofibrils [Fig 18 arrow]	 [Fig 18]

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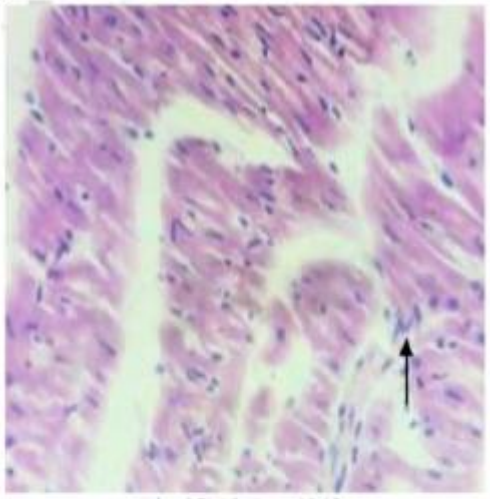
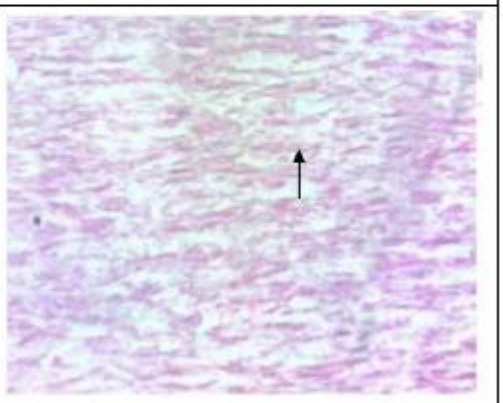
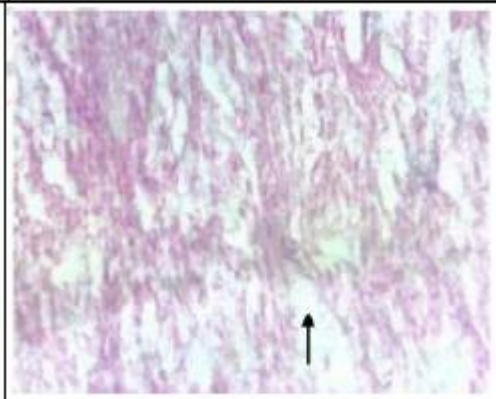
[1000mg/kg p.o.]	The interstitial space appears intact. The vascular spaces amidst these cardiac muscle fibers appear unremarkable [Fig 19 arrow]	 [Fig 19]
Group – 4 [500 mg/kg p.o.]	Section studied from the myocardium shows focally distorted cardiac muscle fibers. Some of the cardiac muscle fibers show necrosis consisting of loss of integrity of myocardial cell membrane, myofibrillar structure with loss of striations and loss of continuity with adjacent myofibrils [Fig 20 arrow].	 [Fig 20]
	The interstitial space at focal areas appears edematous with mild inflammatory infiltration [Fig 21 Arrow] The vascular spaces appear intact amidst these cardiac muscle fibers.	 [Fig 21]

IV. Discussion

Doxorubicin induced cardiomyopathy model

The model chosen in the present study is doxorubicin induced cardiomyopathy. It has been shown that doxorubicin (DXR), an anthracycline antibiotic with broad activity against many malignancies, has limited clinical usage owing to its cardiotoxicity. Doxorubicin causes myocardial damage via the formation of free oxygen radicals, oxidative damage to membrane lipids and other

International Journal of Pharmaceutical research and Applications
Volume 9, Issue 1, Jan.-Feb. 2024, pp:1273-1285 www.ijprajournal.com ISSN: 2456-4494

cellular components which leads to blood pressure and heart rate changes as well as loss of contractility. The effect of doxorubicin on myocardium are disruption of myocyte structure, including damage to the microtubules, vacuolization, sarcomere disruption, dilatation of the sarcoplasmic reticulum, mitochondrial injury and loss of myofibrils. As this a commonly available model hence chosen for the study.[8]

Phytochemicals

The phytochemical analysis of hydro alcoholic extract was done, found positive for alkaloids, flavonoids, saponins, tannins, carbohydrate, steroid. When quantification of the phytochemicals was done, the percentage of tannins and flavones were high, both in powder and hydroalcoholic extract of *Jingini*.

Tannins are having cardioprotective, antioxidant and anti-inflammatory actions [10] and **Flavonoids** were reported to have antioxidant and anti-inflammatory action [11]. **Alkaloids** exhibits antioxidant, anti-inflammatory, antiarrhythmic and anti-hypertensive action, can prevent and/or manage the oxidative stress and inflammation [12]. **Phenols** are having cardioprotective, antioxidant and anti-inflammatory activities [13]. **Saponins** have cardioprotective and antioxidant activity. **Polyphenols** reported to reduce infarct size, having antioxidant and anti-inflammatory activity [13].

Mode of action of *Jingini* in Hridroga

In *Hridroga* due to *nidana* like *Ati guru Aahara*, *Adhyashana* etc. *Agnimandhya* occurs which in turn leads to *Saama rasa dhatu Utpatti* [*Kapha* and *Medho utpatthi*] further *Srothorodha* takes place which causes *Hridroga*. *Nidana sevana* leads *to Jaataragni mandhya and dosha dushti* in turn it causes *rasa dushti* [*Kapha* and *Medho vriddhi*]. *Kashaya Pradhana rasa of Jingini* can help in *Kleda dushti* due to its *Shoshana karma*. When *Dushta rasa* takes *Sthaanasamshraya* in *Hridaya leads to Margavarodha* by *sangha*. *Teekshna guna* present in *Jingini* can counters the *Srotho sangha* due to its *Srotho vivarana karma*. *Margavarodha* can lead to *Tridosha prakopa* which can lead to *Hridaya baadha (Hridroga).* At this stage of *tridosha prakopa*, it can be countered by the *Kashaya, Madhura rasa* and *Ushna veerya* of *Jingini.*

Assessment criteria and mode of action of phytochemicals

The parameters considered for assessment of effect of *Jingini* on cardiomyopathy were CKMB, LDH, SGOT, SGPT and Antioxidants like SOD, CAT, inflammatory marker MPO, lipid peroxidation marker MDA of Serum and Heart tissue. Doxorubicin induces oxidative stress, which leads to lipid peroxidation and makes the enzymes **CKMB, LDH, SGOT** and **SGPT** leaks to blood stream, due to which increased values of all these parameters can be seen in disease control group. Higher percentage of tannins present in *Jingini* known to have cardioprotective, antioxidant and anti-inflammatory actions. Antioxidant activity of tannins is exhibited by protecting cellular oxidative damage, including lipid peroxidation, inhibition of the generation of superoxide radicals which contributes towards the reduction in **CKMB, LDH, SGOT** and **SGPT** in both the treatment groups [8, 11]. To regulate oxidative stress created by mitochondrial ROS due to doxorubicin, mitochondria employ an intricate network of ROS scavenging systems that co-ordinately work to mitigate this stress. These systems include superoxide dismutase (SODs), which convert the highly reactive superoxide radical into hydrogen peroxide, which is then further detoxified by catalase. Tannins present in *Jingini* plays an important role in increasing these ROS scavenging systems [**SOD** and **CAT**] in the treatment groups and thus protects the myocytes [14, 11]. Myeloperoxidase (**MPO**) is a member of the superfamily of heme peroxidases which is mainly expressed in neutrophils and monocytes. Elevated **MPO** levels in circulation are associated with inflammation and increased oxidative stress, induced by Doxorubicin, which can lead to lipid peroxidation. A major reactive by-product of lipid peroxidation is malondialdehyde (**MDA**). Flavonoids present in *Jingini* might be able to inhibit the release of myeloperoxidase or its activity in treatment groups which was responsible for decreased **MPO** values resulted in reduced production of active oxygen species which in turn reduced **MDA** values [15, 16, 11]

Infarct size provides a useful diagnostic and prognostic index based on the extent of myocardial damage produced by doxorubicin. Tannins, flavonoids exhibit antioxidant activity, antioxidant superoxide dismutase can prevent myocardial necrosis due to oxygen radicals which leads to reduction of infarct size in treatment groups. [17, 18]

Histopathology of heart

Cardiac muscle Fibre distortion, necrosis of myocardial cell membrane, Heamorrhage in interstitial spaces and congested vascular spaces

International Journal of Pharmaceutical research and Applications
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observed in doxorubicin induced group, these changes are reduced in 500 mg/kg group but 1000 mg/kg group can retain the normal myocyte structure without any changes, which can be attributed to cardioprotective action of Tannins.

V. CONCLUSION

Jingini [*Lannea coromandelica*], indicated in *Hridroga* in *Nighantu* like *Bhavaprakasha Nighantu*, *Kaiyyadeva Nighantu*. *Kashaya*, *Katu* and *Madhura rasa*, *Snigdha* and *teekshna guna*, *Ushna veerya*, *Katu Vipaka* is attributed to *Jingini* plays an important role in interference with Hridroga samprapti. Analysis done for its genuinity, purity and presence of phytochemicals. On quantification of phytochemicals tannins and flavones were found in higher percentage, which reported for their antioxidant, anti-inflammatory activity. In trial drug groups, the improvement in the parameters like CKMB, LDH, SGOT, SGPT, Antioxidants SOD and CAT, reduction in inflammatory marker MPO, lipid peroxidation marker MDA values and infarct size suggests the drug is effective on cardiomyopathy which is supported by histology of Heart.

FURTHER SCOPE OF THE STUDY

As per literature doxorubicin can induce dilated cardiomyopathy, Efficacy of *Jingini* in other types cardiomyopathy need to be established. As cardioprotective activity of *Jingini* is proved and its effectiveness in the cardiovascular diseases like atherosclerosis, myocardial reperfusion injury, cardiomyopathy are significant further studies can be done on other cardiovascular diseases experimentally and clinical studies can be done in diseases where *Jingini* proven effective experimentally. Standardization of *Jingini* need to be done so that new cardioprotective drug will be addon to the market.

ACKNOWLEDGEMENT

I would like to convey my whole hearted regards to Principal, Acharya and BM Reddy College of Pharmacy, Bangalore, for permitting me to utilise the Animal house and Lab facilities of the College.

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