International Journal of Pharmacological Research
ISSN: 2277-3312 (Online)
Journal DOI: https://doi.org/10.7439/ijpr **Original Research Article**

Phytochemical and Pharmacological Evaluation of *Artocarpus Philippinensis* Lam. for Anthelmintic Activity

Abhishek Patel*and Amrita Bhaiji

RKDF College of Pharmacy, Bhopal. Behind Hotel Mark, Hoshangabad Road (Narmadapuram Road), Jatkhedi, Misrod, Bhopal SRK University, Bhopal, M.P.462-026, India

Abstract

In the current in vitro study, 10 mg/ml concentration of ethanolic extract of *Artocarpus philippinensis* (Jackfruit) belong to family Moraceae produced a statistically significant anthelmintic activity that is comparable with the conventional anthelmintic agent like Albendazole. This finding is additionally in line with the clinical study that confirmed the efficacy of the plant against nematodes in calves and superior to an in vitro study that reported a moderate level of anthelmintic activity from the rind of A. heterophyllus. A. heterophyllus, is mainly used as an anthelmintic agent in traditional practices. Concordant with this, in EHIA of the present study, the ethanolic extract of *Artocarpus philippinensis LAM* fruit induced a significant egg hatching inhibition of 98.67%, at 1 mg/ml concentration. In which fruit extracts are used as an anthelmintic in *Pheretima posthuma* infestation of sheep. Furthermore, the genus is a rich source of sesquiterpene lactones and flavonoids that might have anthelmintic activity with lowrisk of mammalian toxicity.

Keywords: *Artocarpus Philippinensis LAM,* Albendazole, *Pheretima posthuma*, Anthelmintic, Egg Hatch Test.

***Correspondence Info:**
Mr. Abhishek Patel
RKDF College of Pharmacy,
Bhopal. Behind Hotel Mark,
Hoshangabad Road (Narmadapuram Road), Jatkhedi, Misrod,
Bhopal SRK University, Bhopal, M.P.462-026, India

***Article History:**
Received: 02/09/2025
Revised: 22/09/2025
Accepted: 01/10/2025
DOI: https://doi.org/10.7439/ijpr.v15i1.5875

How to cite: Patel A. and Bhaiji A. Phytochemical and Pharmacological Evaluation of *Artocarpus Philippinesis* for Anthelmintic Activity. *International Journal of Pharmacological Research* 2025; 15(1): e5875. Doi:10.7439/ijpr.v15i1.5875 Available from: https://ssjournals.co.in/index.php/ijpr/article/view/5875

1. Introduction

Helminth infections are one of the most prevalent infectious diseases in developing and developed countries [1]. Globally, an estimated 2 billion people are infected by intestinal nematodes [2]. Anthelmintic drugs are used forthe control of parasitic infection caused by helminths. The demand for new and effective anthelmintic is immense, as the drugs currently employed in the control of helminths is expensive and most of them lose their efficacy in 20 years due to the problem of resistance [2]. It is extremely hard to eradicate helminthiasis because of the close association between these diseases and poverty. The clinicaldevelopment of these common and ubiquitous infections is such that they are generally neglected until they become manifested. Helminth infections are more frequent in hot climates and in places with poor sanitary conditions, the presence of large water tanks containing water and contaminated food are the carriers of parasites. This does not mean, however, that good economic conditions constitute a complete safeguard against such infections. Moreover, individuals from more affluent countries might well acquire such infections during travel to more endemic regions [3]. Until such time as effective vaccines can be discovered, anthelmintic chemotherapy is the only effective, practical and inexpensive way of keeping such infections under control. Helminth infections resultingto diseases such as ascariasis, hookworm infection and schistosomiasis constitute the bulk of the 13 diseases classified as neglected tropical diseases (NTDs) by the WHO [4]. The search for novel anthelmintics has traditionally involved two approaches, like as the empirical and the selective methods [5]. The empirical approach involves the screening of large numbers of chemicals, quite unrelated to

each other, possessing no known anthelmintic activity and screened that one or more of them may exhibit sufficient activity to constitute a chemical lead. This method is most commonly used in large-scale drug development programs [4]. The selective approach involves biological investigation of the activity of chemicals allied structurally to those known to possess activity against a particular organism [6].

The major objective of this approach is increased activity or decreased toxicity through chemical modification of the parent compound. This approach has recently beenused in a drug development program funded by a Primate Foundation [7]. Parasitic worms or helminths cause chronic and sometimes deadly diseases that have a major socio- economic impact worldwide. In humans, the disease caused by the parasitic worms is about 14 million globally, also called neglected tropical diseases (NTD) [8]. In agricultural animals, diseases caused by parasites led to losses of about billions of dollars per year throughout the world.

The Gastrointestinal nematodes (GI), such as hookworms, whipworms, and roundworms affected under 15 years most. Approximately more than 10% of the population is infected by GI nematodes worldwide [9]. As of now, no vaccines are available in the market, so, control ofhelminths lies on the sum of effective drugs, called anthelmintics, but their inadequate use causes serious drug resistance problems worldwide, there is urgent need required for isolating, identifying new anthelmintic drugs, for humans, it lies on chemotherapy. Parasitic nematodes in human are of two types: intestinal nematodes and tissue or blood nematodes [10]. Interest in traditional medicines is not new but has been spurred in recent years by methodological advances in ethnobotanical and pharmacological studies. However, on practical grounds herbal medicines present with problems like misleading botanical identification, adulteration, variability in the application of common standardization procedures and above all limited studies towards ascertaining the correct origin of the drug [11]. Hence, scientific evaluation of herbal drugs with promising therapeutic use is highly essential. The observation, identification, and experimental investigation of the ingredients and the therapeutic effects of indigenous drugs are all interdisciplinary fields of research [12]. A number of plants/extracts are reported to have anthelmintic activity. Most of the studies reported *in vitro* activity and only few studies report *in vivo* activity. So, more research is needed to investigate the molecular mechanism of action of the reported anthelmintic plants/extracts as well as there is a need to either modify existing anthelmintic agents or explore new molecular targets to get next generation anthelmintic agents [13].

Now a days novel anthelmintic targets like lysine deacetylases, KDAC inhibitors, kinase inhibitors are explored. Modification of chemical structure and combination of known anthelmintics is also one of the ways to combat this challenge. Drug repurposing is also an emerging trend in anthelmintic drug discovery [14].

The present work has been taken up to investigate the anthelmintic potential of extracts of crude drugs which have been mentioned in traditional texts and establish a correlation between the phytochemical and pharmacological profile, which has not yet been carried out for aforesaid activities. Hence efforts have been made to assign pharmacognostic, phytochemical and pharmacological standards on a scientific basis [15].

Thus, in the present study phytochemical investigation of *Artocarpus philippinensis* and screening for anthelmintic potential was performed.

2. Materials and Methods

2.1 Collection of Plant Samples:

Artocarpus philippinensis fruit was obtained locally from Bhopal. Fruits were carefully and mechanically separated and washed with water [16]. After dryingin shade, they were powdered and stored. The fruits were successively extracted using Soxhlet extraction method using ether, chloroform and ethanol for 24 hours [17]. The extract obtained was stored in airtight container in a desiccator. Preliminary phytochemical analysis was carried out on the ethanolic extract of *Artocarpus philippinensis* to assess the presence of alkaloids, glycosides, saponins, flavonoids and steroids [18].

2.2 Animals:

Earthworms (Pheretima posthuma) were randomized and allocated into different groups (5 per group). ***Pheretima posthuma*** were kept at a temperature of 24 ± 2ºC and relative humidity of 30-70%. A day with 12:12 light: dark cycle with free access to rodent feed and water [19].

2.3 Preliminary Phytochemical Screening:

The preliminary phytochemical screening was carried out by using solvents petroleum ether, chloroform and alcohol. Ethanolic extracts of *Artocarpus philippinensis* for qualitative identification. Tests for common phytochemicals were carried out by standard methods described in Practical Pharmacognosy [20].

2.4 Acute Toxicity Study:

The acute toxicity studies were carried out for ethanolic extract of *Artocarpus philippinensis* using fixed dose method according to OECD guidelines no. 425 [21].

2.5 In vitro anthelmintic activity:

2.5.1 Adult motility assay:

Approximately 6–8 adult *Pheretima posthuma* specimens were utilized to evaluate the anthelmintic potential of extracts by performing an adult motility assay (AMA) [22]. Each plant extract was tested at varying concentrations (10, 5, 2.5, and 1.25 mg/mL), with solutions prepared in phosphate-buffered saline (PBS). The experiments were organized into six distinct groups[23].

Groups I and II were administered the crude ethanol extract derived from the fruits of *Artocarpus philippinensis* respectively.

Groups III and IV received 0.25 mg/mL of albendazole (used as the positive control) and PBS (used as the negative control), respectively. The inhibition of motility was considered indicative of worm mortality or paralysis.

To determine the motility inhibition capacity of the extracts, observations were recorded at regular time intervals up to the seventh hour post-treatment. Worms exhibiting no motility were transferred to lukewarm PBS for 10 minutes; in cases where motility was restored, the worms were regarded as alive, whereas those failing to recover were counted as dead [24].

2.6 Egg hatch test (EHT):

The egg hatch test (EHT) has been validated as an in vitro method for detecting albendazole (ABZ) resistance in Fasciola hepatica. In this study, intra- and inter-assay variations of the EHT were quantified by assessing the coefficient of variation across different fluke isolates and time points. To establish reliability, EHT results were compared with those obtained from the controlled efficacy test, considered the gold standard for in vivo anthelmintic efficacy assessment[25].

The EHT was further applied to investigate intra-herd variability in ABZ resistance among calves infected with identical fluke isolates. To streamline the procedure, key aspects of the original protocol were refined, such as optimizing incubation periods and using eggs collected directly from faeces. Analysis revealed that the highest consistency in intra-assay and inter-assay results was achieved when eggs incubated with ABZ were collected up to eight weeks post gallbladder harvest—the recommended deadline for egg analysis. A uniform ABZ concentration of 0.5 µm yielded optimal results.

Findings indicated that incubation duration was critical: extended incubation (15 days) led to changes in ovicidal activity, which could impact resistance classification. The ABZ concentration of 0.5 µm is proposed as a discriminative threshold for resistance detection, reflecting a close correlation between EHT results and those of corresponding in vivo assays at this dose[26].

2.7 Egg Hatch Test:

The *in vitro* egg hatch test (EHT) utilised fluke eggs were extracted from the gallbladders of infected animals by aspirating bile with a 10 ml syringe and a 19G needle. Collected bile was washed repeatedly with tap water, and eggs were isolated by sedimentation, then stored at 4°C in darkness until further use.

Albendazole (ABZ; ≥99% purity, Sigma-Aldrich, St. Louis, MO, USA) was dissolved in pure methanol to prepare working solutions at concentrations of 500, 50, and 5 µm. To obtain these, ABZ was diluted with methanol, and 10 µl of each working solution (or methanol for controls) was added to the egg suspensions (~200 eggs in 1 ml water). This resulted in treatment concentrations of 5, 0.5, and 0.05 nm/ml, with a final methanol concentration of 1% (v/v) in all samples [27].

For each concentration, experiments were performed in triplicate (3-5 replicates per group). Control eggs received 10 µl methanol in 1 ml water only. Following treatment, eggs were incubated in darkness at 25°C for 12 hours. After incubation, eggs were washed three times with tap water to remove residual drug, then maintained in darkness at 25°C for an additional 15 days.

After this period, eggs were exposed to light for 2 hours to induce miracidia hatching. After light exposure, 1 ml of 10% (v/v) buffered formalin was added to prevent further hatching. The numbers of hatched (miracidium emerged) and unhatched (undeveloped) eggs were counted using an optical microscope (DM IL, Leica, Germany). Embryonated eggs were limited to a maximum of 10% of total "hatched eggs". In each tube, 90-110 eggs were assessed to estimate the proportion hatched [28].

Results were expressed as the mean percentage of hatched eggs ± standard deviation (SD). Ovicidal activity for each dose was calculated as a percentage using the provided formula. FID was used as a Detector. For all samples, the injection volume was 0.1 µl.

$$\textbf{Ovicidal activity (\%)} = \frac{\%\ eggs\ hatched\ in\ control - \%\ eggs\ hatched\ after\ drug\ incubation}{\%\ eggs\ hatched\ in\ control} \times 100$$

2.8 Egg recovery:

The ability of the extracts to inhibit egg hatching was conducted according to the procedure described. Eggs were washed thrice with distilled water and adjusted to a concentration of 100-200 eggs/ml using the McMaster technique. The suspension was centrifuged for 5 minutes at 1500 rpm and the supernatant was discarded. Approximately, 100 eggs in 200 μl of distilled water were pipetted into each well of a 48-well micro titer plate.

To each of the test wells, 200μl of each plant extract at concentrations of 0.1, 0.25, 0.5, and 1 mg/ml was added to a final volume of 400 μl per well.

Similarly, 200μl of Albendazole (99.8% pure standard reference) at a concentration of 0.25 mg/ml was used as a positive control, while distilled water (200 μl) was used as a negative control[29].

The experiment was conducted in duplicates for each concentration and replicated three times. In this assay, all plates were incubated at 37°C for 48 hr. A drop of Lugol's iodine solution was added to each well to stop further hatching, and all the unhatched eggs and L1 larvae in each well were counted under a dissecting microscope. Finally, percent inhibition of egg hatching was calculated:

Percent inhibition = $100(1 - P_{test}/P_{control})$, where P = number of eggs hatched in EHIA.

2.9 Test Procedure:

Egg suspension of (0.2 ml; 100 eggs) was distributed in a 24-well multi-well plate (Flow Laboratories) and mixed with the same volume ofdifferent concentrations (0.25 to 8 mg /ml) of plant extract. The positive control wells received different concentrations (0.09 to 3.0 µg/ml) of oxfendazole (Systamex—ICI Pakistan, Ltd., 2.265%, w/v) in place of plant extracts while negative control wells contained thediluent and the egg solution. The eggs were incubated inthis mixture at 27°C. After 48 hours, two drops of Lugol's iodine solution were added to stop the eggs from hatching. All the eggs (dead and embryonated) and hatched larvaein each well were counted.

There were three replicates for each treatment and control.

2.10 Measurements:

Observation of clinical signs and/or death was measured daily. The body weight of the sheep was recorded weekly. Faecal egg counts per gram of faeces (EPG) were performed on each animal on days 0, 3, 6, 9, 12 and 15 post-treatment (PT) and were evaluated for the presenceof worm eggs by salt floatation technique. The eggs were counted by the McMaster method .

Egg count percent reduction (ECR) was calculated using the following formula:

ECR (%) = {(pre-treatment EPG – post-treatmentEPG)/pre-treatment EPG} × 100

2.11 Statistical analysis:

For egg hatch test, probit transformation was performed to transform a typical sigmoid dose response curve to linear function. The extract concentration required to prevent 50%, *i.e.*, lethal concentration 50 (LC_{50}) of hatching of eggs was calculated from this linear regression (for y = 0 on the probit scale).

The data from adult motility assay and *in vivo* experiments were statistically analyzed using SPSS software.

The results were expressed as mean ± standard error of mean (SEM).

Table 1: Estimation of Phytochemical analysis of *Artocarpus philippinensis LAM.* fruit extract

S. No.	Chemical Constituents	Tests	PEE	CE	EE
1.	Alkaloids	Dragendorff's Test	+	+	+
		Wagner's Test	+	+	+
		Hager's Test	+	+	+
		Wagner's Test	+	+	+
2.	Carbohydrates	Fehling's Test	+	+	+
		Molish's Test	+	+	+
		Benedict's Test	+	+	+
3.	Cardiac glycosides	Baljet Test	+	+	+
		Legal Test	+	+	+
4.	Anthraquinone glycosides	Modified Borntrager's test	+	+	+
		Borntrager's test	+	+	+
5.	Proteins & amino acids	Biuret Test	+	+	+
		Millons test	+	+	+
		Ninhydrin test	+	+	+
6.	Fixed oil	Stain Test	+	+	+
7.	Phytosterols triterpenoids	Liebermann-Burchard Test	+	+	+
		Salkowaski test	+	+	+
8.	Flavonoid	Shinoda test	+	+	+
9.	Tannins	Lead acetate	+	+	+
		5% Fecl3	+	+	+
10.	Saponins glycosides	Foam test	+	+	+
		Haemolytic test	+	+	+

PEE= Petroleum Ether Extract, CE = Chloroform Extract, EE= Ethanol Extract.

Groups	Extracts Dose Level (mg/kg)			N	N^0 PEE	N^0 CE	N^0 EE
	PEE	CE	EE				
Group 1	100	100	100	6	0	0	0
Group 2	200	200	200	6	0	0	0
Group 3	500	500	500	6	0	0	0
Group 4	1000	1000	1000	6	0	0	0
Group 5	2000	2000	2000	6	1	2	1
Control	1ml dH_2O	1ml dH_2O	1ml dH_2O	6	0	0	0

PEE = Petroleum Ether Extract, CE =Chloroform Extract, EE =Ethanolic Extract.

Treatment	Concentration (mg/ml)	15 M	30 M	45 M	60 M	75 M	90 M	105 M
A.heterophyllus Fruit extract	10	4.00±0.58	5.67±0.33	6.67±0.33	7.67±0.33	8.67±0.33[e]	9.67±0.33	10.00±0.00
	5	2.00±0.58	3.33±0.33	4.67±0.33	6.00±0.58	7.67±0.33	9.00±0.00	10.00±0.00
	2.5	1.67±0.33	3.33±0.33	4.67±0.33	6.33±0.67	8.33±0.33	9.33±0.33	10.00±0.00
	1.25	0.33±0.33	1.00±0.58	2.00±0.58	4.00±0.58	5.00±0.58	6.67±0.33	7.67±0.33
Albendazole	0.25	4.00±0.58	5.67±0.33	8.33±0.33	9.67±0.00	10.00±0.00	10.00±0.00	10.00±0.00
PBS	0.00 0.00	0.00±0.00	0.00±0.00	0.00±0.00[c]	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00

Data represents mean ±SD; one-way analysis of variance ANOVA followed by Tukeys multiple comparison test (n=5)
Values are compared with control animals, p<0.05. *P<0.01, **P<0.001, ***P<0.0001.

3. Results and discussion

3.1 Phytochemical Screening:

Phytochemical evaluation indicated the presence of alkaloids, flavonoids, saponins, cardiac glycosides, triterpenoids, phenolic and tannins in the *Artocarpus Philippinensis LAM.* fruit extract.

3.2 Acute Toxicity Study:

The acute toxicity study was conducted and the mice were exposed up to a dose of 2000 mg/kg dose level, so that $1/20^{th}$, $1/10^{th}$ and $1/4^{th}$ (i.e. 100 mg/kg, 200 mg/kg and 500 mg/kg orally) was selected for anthelmintic action. For anthelmintic action of petroleum ether extract, chloroform extract and ethanolic extract of fruit of *Artocarpus Philippinensis LAM.* was equipped in distilled water for oral route of administration.

3.3 Anthelmintic Activity:

3.3.1 Adult Motility Test:

The present study indicated that allconcentrations of ethanolic fruit extracts of *Artocarpus Philippinensis LAM.* produced a relatively comparable anthelmintic activity with the conventional anthelmintic agent like albendazole. The anthelmintic activity of plant extracts increased with time. Accordingly, after 7 hr exposure of adult *Pheretima posthuma* to the highest concentration (10 mg/m) of extracts, both plants produced a significant ($p < 0.05$) mortality of adult *Pheretima posthuma*. Albendazole, on the other hand, killed all parasites within 5 hr at a concentration of 0.25 mg/ml.

3.4 Egg Hatching Inhibition Assay:

Fruits of *Artocarpus Philippinensis LAM.* induced a significant egg hatching inhibition effect in a concentration-dependent manner. Ethanolic extract of fruit of *Artocarpus Philippinensis LAM.* exhibited a 98.67% and 88.3% inhibition, respectively, at 1 mg/ml concentration. Furthermore, the egg hatch inhibitory efficacy profile of *Artocarpus Philippinensis LAM* extracts, as a percentage of eggs unhatched at the end of the observation period, is asfollows:

49.33 and 46.33% at concentration 0.1 mg/ml,
60.67 and 54.33 at 0.25 mg/ml,
72.67 and 68.33 at 0.5 mg/ml, and
94.63 and 90.33 at 1 mg/ml concentration of extracts, respectively.

4. Conclusion

In the current in vitro study, 10 mg/ml concentration of ethanol extract of fruit of *Artocarpus Philippinensis LA*M. produced a statistically significant anthelmintic activity that is comparable with the conventional anthelmintic agent, Albendazole.

This finding is additionally in line with the clinical study that confirmed the efficacy of the plant against nematodes in calves and superior to an in vitro study that reported a moderate level of anthelmintic activity from the rind of *A.heterophyllus*.

References

[1]. Gupta A.K, Tandon N, *et al*. Review on Indian Medicinal Plants. *Indian Council of Medical Research*, New Delhi: 2004,182-200.
[2]. Afzal S, Batool M, Ch B.A, Ahmad A, Uzair M, Afzal K, *et al*. Immunomodulatory, Cytotoxicity, and Antioxidant Activities of Roots of *Ziziphus mauritiana*. *Pharmacogn Magazine*. 13(2), 2017, S262–S265.
[3]. Agati G, Azzarello E, Pollastri S, Tattini M, *et al*. Flavonoids as antioxidants in plants: location and

functional significance. *Plant Science*. 196, 2012, 67–76.

[4]. Ahamad M.S, Siddiqui S, Jafri A, Ahmad S, Afzal M, Arshad M, *et al*. Induction of apoptosis and antiproliferative activity of naringenin in human epidermoid carcinoma cell through ROS generation and cell cycle arrest. *PLoS One*, 9, 2014.

[5]. Ahmed M, Saeed F. Evaluation of Insecticidal and Antioxidant activity of selected Medicinal plants. Journal of Pharmacognosy & Phytochemistry. 2(3), 2013, 153-158.

[6]. Ajazuddin, Saraf S. Evaluation of physicochemical and phytochemical properties of Safoof-E-Sana, a Unani polyherbal formulation. *Pharmacognosy Research*. 2, 2010, 318-222.

[7]. Ong B.T, Nazimah S.A.H, Osman A, Quek S.Y, Voon Y.Y, Hashim D. M, *et al*. Chemical and flavour changes in jackfruit (*Artocarpus Philippinensis Lam*.) cultivar J3 during ripening. *Postharvest Biology and Technology*. 40, 2006, 279−286.

[8]. Owolarafe T.A, Salawu K, Ihegboro G.O, Ononamadu C.J, Alhassan A.J, Wudil A.M, *et al*. Investigation of cytotoxicity potential of different extracts of *Ziziphus mauritiana (Lam)* leaf *Allium cepa* model. *Toxicology Report*. 30(7), 2020, 816- 821.

[9]. Panseeta P, Lomchoey K, Prabpai S, Kongsaeree P, Suksamrarn A, Ruchirawat S, Suksamrarn S, *et al*. Antiplasmodial and antimycobacterial cyclopeptide alkaloids from the root of *Ziziphus mauritiana*. *Phytochemistry*. 72, 2011, 909–915.

[10]. Patel R.M, Patel N.J. In-vitro antioxidant activity of coumarin compounds by DPPH, superoxide and nitric oxide free radical scavenging methods. *Journal of Advanced Pharmacy Education and Research*. 1, 2011, 52-68.

[11]. Ajiboye B.O, Ojo O.A, Adeyonu O, Imiere O, Olayide I, Fadaka A, Oyinloye, B.E, *et al*. Inhibitory effect on key enzymes relevant to acute type-2 diabetes and antioxidative activity of ethanolic extract of *Artocarpus Philippinensis* stem bark. *Journal of Acute Disease*. 5(5), 2016 423–429.

[12]. Aksoy L, Kolay E, Ağılönü Y, Aslan Z, Kargıoğlu M, *et al*. Free radical scavenging activity, total phenolic content, total antioxidant status, and total oxidant status of endemic Thermopsisturcica. *Saudi Journal of Biological Sciences*. 20, 2013, 235-239.

[13]. Alberg A.J, Samet J.M. Epidemiology of lung cancer. Chest. 123(1), 2003, 21S-49S.

[14]. Alhakmani F, Kumar S, Khan S. A. Estimation of total phenolic content, in -vitro antioxidant and anti-inflammatory activity of flowers of *Moringa oleifera*. *Asian Pacific Journal of Tropical Biomedicine*. 3, 2013, 623-627.

[15]. Ali M. Textbook of Pharmacognosy, CBS Publishers and Distributors: New Delhi: 1997, 67-68.

[16]. Amin A.R, Kucuk O, Khuri F.R, *et al*. Perspectives for cancer prevention with natural compounds. *Journal of ClinicalOncology*. 27, 2009, 2712–2725.

[17]. Amos C.I, Pinney S.M, Li Y, *et al*. A susceptibility locus on chromosome 6q greatly increases lung cancer risk among light and never smokers. *Cancer Research*. 70, 2010, 2359–2367.

[18]. Anonymous. The Wealth of India: A dictionary of Indian raw materials and industrial products publication and information directorate, vol. A, 1985, 445-453.

[19]. Anonymous. The Wealth of India, Raw material. Vol XI X-Z, Council of Industrial and Scientific Research, New Delhi : 1989, 111-124.

[20]. Anonymous. The Ayurveda Pharmacopoeia of India. The Controller of Publications, Control Lines. New Delhi: Ministry of Health and Family Welfare, Department of Indian Systems of Medicines and Homeopathy, Government of India. 1(2), 2001.

[21]. Anonymous. The Ayurvedic Pharmacopoeia of India. 1st Ed. Government of India, Ministry of Health and Family Welfare, Department of Ayush, New Delhi. 17. Anonymous. (2016). In-vitro Antioxidant Assays. *Progress in Drug Research*.71, 2008, 57- 72.

[22]. Arun E.T, Shimizu K, Kondo R, *et al*. Structure–activity relationship of prenylsubstituted polyphenols from *Artocarpus Philippinensis* as inhibitors of melanin biosynthesis in cultured melanoma cells. *Chemistry and Biodiversity*. 4, 2007, 2166- 2171.

[23]. Arung E.T, Yoshikawa K, Shimizu K, Kondo R, *et al*. Isoprenoid-substituted flavonoids from wood of *Artocarpus Philippinensis* on B16 melanoma cells: Cytotoxicity and structural criteria. *Fitoterapia*. 81(2), 2010, 120-123.

[24]. Asati V, Mahapatra D.K, Bharti S.K, *et al*. PI3K/Akt/mTOR and Ras/Raf/MEK/ERK signaling pathways inhibitors as anticancer agents: structural and pharmacological perspectives. *European Journal of Medicinal Chemistry*. 109, 2016, 314- 341.

[25]. Atanasov A.G, Waltenberger B, Pferschy-Wenzig E.M, *et al*. Discovery and resupply of pharmacologically active plant- derived natural products: A review. *Biotechnology Advances*. 33(8), 2015, 1582-1614.

[26]. Azad A.K, Jones J.G, Haq N, *et al*. Assessing morphological and isozyme variation of jackfruit (*Artocarpus Philippinensis Lam*.) in Bangladesh. *Agro forestry Systems*. 71, 2007, 109-125.

[27]. Baliga A.R, Shivashankara R, Haniadka J, Dsouza Bhat H.P, *et al*. Phytochemistry, nutritional and pharmacological properties of *Artocarpus Philippinensis Lam. (jackfruit):* A review. Food Research International. 44(9), 2011, 1800–1811.

[28]. Bhatia A, Mishra T. Hypoglycaemic activity of *Ziziphus mauritiana* aqueous ethanol seed extract in alloxan induced diabetic mice. Pharmaceutical Biology. 48, 2010, 604- 610.

[29]. Blainski A, Lopes G.C. de Mello J.C.P, *et al*. Application and Analysis of the Folin-Ciocalteu Method for the Determination of the Total Phenolic Content from *Limonium brasiliense* L. Molecules. 18, 2013, 6852-6865.