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SCREENING OF PHYTOCHEMICALS AND INSECTICIDAL POTENTIALITY OF THE ULATKAMBOL, ABROMA AUGUSTA EXTRACTIVES

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A B S T R A C T

The chloroform, methanol, ethyl acetate, and acetone extracts obtained from the fruit shell, leaves, root bark, root wood, seed, stem bark, and stem wood of Abroma augusta were evaluated against Tribolium castaneum adults using a residual film assay. The potency of the chloroform extracts, based on the observed mortality of adult beetles, ranked in descending order as follows: seed (257.2156 µg/cm²) > leaf (438.459 µg/cm²) > root wood (639.031 µg/cm²) > root bark (1234.363 µg/cm²) > stem wood (1272.258 µg/cm²) > fruit shell (1752.395 µg/cm²). For the methanol extracts, seed (407.568µg/cm2) > leaf (529.930µg/cm2) > stem wood (1104.856µg/cm2) > fruit shell (2314.99 µg/cm2) > root bark (3389.414 µg/cm2) >root wood (4017.242µg/cm2) extracts. For the ethyl acetate extract, seed (587.074 µg/cm2) > leaf (668.952 µg/cm2) > root wood (1128.608 µg/cm2) > stem wood (1258.099 µg/cm2) > root bark (1580.342 µg/cm2) > fruit shell (1853.586 µg/cm2) extracts. For the acetone extract, seed (579.534 µg/cm2) > fruit shell (611.689 µg/cm2) > root wood (672.290 µg/cm2) > stem wood (1552.904 µg/cm2) > leaf (1566.299 µg/cm2) > root bark extracts (1804.709 µg/cm2) 48 h of exposure. No changes in the results were observed due to prolonged exposure, except for a proportional increase in mortality. However, significant mortality was observed within just 30 minutes of exposure, highlighting the exceptional potential of these dose-mortality experiments.

The whole plant was found to contain several alkaloids and secondary metabolites, including steroids, triterpenes, flavonoids, megastigmanes, benzohydrofurans, and their glycosides, as well as phenylethanoid glycosides. The phytochemical composition of Abroma augusta was investigated using standard analytical methods, revealing the presence or absence of phytochemicals such as tannins, flavonoids, phenolic compounds, alkaloids, saponins, steroids, cardiac glycosides, phlobatinnins, and anthraquinones. The proximate composition quantified the percentages of tannins, flavonoids, phenolic compounds, alkaloids, and saponins.

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1. Introduction

Abroma augusta, locally known as Ulatkambal, is a medicinal flowering plant growing to a height of 3 to 4 meters, belonging to the family Malvaceae. Flowers are 5 cm. in diameter, dark red, purple or yellow in color occurring on few flowered cymes. Sepals are 2.5cm. lance late, free, near to the base. Five staminoides are present. Flowering and fruiting occur in the month of December and January (Kritikar and Basu 1999; Agro techniques of selected medicinal plants, 2008). Leaves are polymorphous about 10-30cm. long and 6-18cm. broad, repand-denticulate, base 3-7 lobed *(Anonymous 2006; Agro techniques of* selected medicinal plants, 2008).The roots have a thick, fibrous, brown bark which, when freshly cut, protrudes a thick gummy substance.

The fruit is dry, 5-celled capsule, with 5 truncated wings. Each cell contains numerous black seeds. Seeds are many, small, blackish, covered with silky hairs (Anonymous 2006; Kritikar and Basu 1999; Agro techniques of selected medicinal plants, 2008).

Abroma Augusta has insecticidal activity against *Sitophylus oxyzae, Trogoderma granarum, Tribolium castaneum* and *Sitophylus oxyae* Rahamtullah *et al*. 2010). Different parts of this plant are useful in treating diabetes, stomachache, dermatitis, leucorrhoea, scabies, gonorrhea, cough, leukoderma, jaundice, nerve stimulant, weakness, hypertension, uterine disorders, rheumatic pain and headache with sinusitis (Rahmatullah *et al*. 2010). Powdered roots act as an abortifacient and anti-fertiliy agent, and the petroleum-ether extract of the roots, at a dose of 50mg/kg body wt, showed anti-implantation as well as abortifacient action in mice. The root-bark is used as an emmenagogue and uterine tonic, the action of dried roots as well as the sap of the fresh root, has been studied (Kritikar and Basu 1999).The aqueous extract of the roots showed oxytocic action. It has also been reported to possess galactotrophic effect on lactating albino rats (Anonymous 2006; Sh *et al*. 2010; Rahamtullah *et al*. 2010).The decoction of the bark and extracted juice from the fresh root of the plant are used for irregular menstruation like amenorrhea, dysmenorrheal.

From literature survey it was found that the almost all parts of the plants *A. augusta* is used in the treatment of various diseases; the roots and bark of pivari are uterine and nervous dysmenorrheal, amenorrhea, sterility and other menstrual disorder. Powdered root act as an abortifacient and anti-fertility agent. Leaves are useful in treating uterine disorders, diabetes, rheumatic pain of joints, and headache with sinusitis (Prajapati *et al.* 2003). Leaves and stem are demulcent and an infusion of fresh leaves and stem in cold water is very efficacious in gonorrhea (Nandkarni 2004).

It is highly possesses in gynecological disorders. It regulates the menstrual flow and also used as abortifacient and anti-fertility agent. In India it is used in dymenorrhea but in Indonesia it is used in scabies. It is used in dermatitis, anti-inflammatory and analgesics. The leaves and stems of *A. augusta*Linn f. were used by the traditional healers of Bogra district, but the bark of roots were used

by the traditional healers of Jessore district (Sh *et al*. 2010).

The ethanolic extraction of leaves and stems of *A. augusta* (Linn f.) is also used in menstrual disorders, diseases of uterus leucorrhoea. It shows contractile action on the uterus, and is used for the treatment of dysmenorrhea, amenorrhea, sterility, and other menstrual disorders. Powdered roots act as an abortifacient and anti-fertiliy agent, and the petroleum-ether extract of the roots, at a dose of 50mg/kg body wt, showed anti-implantation as well as abortifacient action in mice. Significant abortifacient activity was also noticed with alcoholic and chloroform extracts. The alcoholic extract of the roots showed acetyl choline-like action, comparable to that of choline on isolated smooth and skeletal muscles. The aqueous extract of the roots showed oxytocic action. It has also been reported to possess galactotrophic effect on lactating albino rats (Anonymus 2006; Sh *et al*. 2010; Rahamtullah *et al*. 2010).

The root-bark is used as emmenagogue and uterine tonic (Gupta *et al*. 2011; Das *et al*. 2012). Literature survey has revealed a number of chemical and biological investigations of *A. augusta* (Laizuman *et al*. 2010; Uddin *et al*. 2012; Nahar *et al*. 1994).The present study was undertaken to comprehensively conduct the chemical and biological investigations of different parts of *A.* augusta. Singh *et al.* (2001) conducted antifeedant activity tests on a variety of plants to better understand the repellent potential of various medicinal plant extracts (Singh *et al*., 2001; Ali *et al*., 2021).

According to the history of potentiality different parts of this plant, i.e. fruit shell, leaf, root bark, root wood, seed, stem bark and stem wood have been subjected to biological screening for their possible use in pest control sector and modern medicine against different diseases. Insecticidal activities of the plant have been demonstrated by a number of recent workers viz., Prajapati *et al.* (2003), Nanda (1997), Halim (2003), Hanif *et al*. (2010), 1999), Nandkarni (2002), Rahamtullah *et al*. (2010). The rust-red flour beetle, *Tribalism castaneum* (Herbst) is a major pest of a wide range of stored commodities. The insecticidal activities of *A. augusta* extracts have been attempted and the investigation has been designed to evaluate the efficacy of the plant extracts as a possible source of potential secondary metabolites to be used as environment –friendly pest control agents against *T. castaneum.*

MATERIALS AND METHODS

Preparation of plant materials:

The fresh fruit shell, leaves, root bark, root wood, stem bark, stem wood and seed of *A. augusta* were collected from the campus of the University of Rajshahi and different areas of Rajshahi division. All parts of this plant were cutted into small pieces separately and dried at room temperature under shade into the wooden tray. The plant materials were powdered in an electric grinder.

Chemical extraction of the collected materials:

Chloroform, methanol, ethyl acetate and acetone (Merck/Germany) were selected as solvent for extract preparation. The powdered materials were weighed and placed in separate conical flasks and added sufficient amount of selected solvents (500g × 1500ml × 3 times followed by filtration through Whatman filter paper at 24h interval in the same collection flask) to yield the extracts of different solvents separately. The output extracts were poured in to glass vials and preserved in a refrigerator at 4ºC with proper labeling.

Insecticidal activity:

This method serves as a basic application technique for dosing toxic substances to insect populations. The test material is dissolved in an organic solvent at a specific concentration and applied to a Petri dish of known surface area. Upon application, the solvent quickly evaporates at ambient temperature, leaving a thin film of the substance on the Petri dish surface. Insects released into this environment come into contact with the evenly distributed substance on the dish floor. When the Petri dish is covered with its lid, it creates a confined environment where the extract is evenly distributed in the air inside, potentially causing mortality through suffocation. This effect can occur rapidly if volatile bioactive compounds are present in the test material.

Application of doses:

All extracts were diluted in their respective solvents, and the precise amount of extracted material in each dose was measured and recorded. The application of these doses was conducted using the residual film method (Busvine, 1971). A standard concentration of 10 mg/2ml was chosen as the stock dose for applying a surface film, from which other concentrations were prepared through serial dilution. This resulted in concentrations of 1560, 1300, 1040, 780, 520, 260, and 130 µg/cm².

To conduct the surface film activity test, 70 mm Petri dishes were utilized for all doses and their replicates. One milliliter of each dose was poured into the bottom of the Petri dish and allowed to dry. The solvent, being volatile, evaporated rapidly within a few minutes. Subsequently, ten insects were introduced into each treated Petri dish. Simultaneously, a control experiment using only the solvent was established under identical conditions.

To conduct the surface film activity test, 70 mm Petri dishes were utilized for all doses and their replicates. One milliliter of each dose was poured into the bottom of the Petri dish and allowed to dry. The solvent, being volatile, evaporated rapidly within a few minutes. Subsequently, ten insects were introduced into each treated Petri dish with three replicates. Simultaneously, a control experiment using only the solvent was established under identical conditions.

Statistical analyses:

The recorded mortality was adjusted using Abbott's formula (1925) as follows:

$$P_r = \frac{P_o - P_c}{100 - P_c} \times 100$$

Where:

- P_r = Corrected mortality (%)
- P_o = Observed mortality (%)
- P_c = Control mortality (%), also known as natural mortality (%)

Subsequently, the mortality percentages were statistically analyzed using the methods described by Finney (1947) and Busvine (1971), employing software developed at the Department of Agricultural Environmental Science, University of Newcastle upon Tyne, U.K. The dose-mortality relationship was quantified through determination of the median lethal dose (LD_{50}).The experiment was conducted at a room temperature of 30 ± 2^0C.

Phytochemical screening:

The plants underwent initial qualitative phytochemical screening to detect various plant constituents in their extracts, following the standard procedures outlined by Sofowora (1993, 1996). Major Phytoconstituents were

further analyzed using standard qualitative methods as described by Rizk and Bashir (1980). Phytochemical analysis of solvent-free extracts from *A. augusta* involved individual tests for alkaloids, carbohydrates, glycosides, flavonoids, steroids, terpenoids, saponins, tannins, proteins, volatile oils, and essential oils, as detailed by Parekh and Chanda (2003).

Preparation of stock solution:

A piece of pure sodium is placed inside a fusion tube, and the lower part of the tube is heated until the sodium metal melts. A few milligrams of a particular compound are added and heated until the bottom of the tube glows dull red. The contents are then transferred into a small mortar containing 15ml of distilled water. The tube is broken using a pestle, and the resulting solution is filtered. The filtrate serves as the stock solution for the specific test described below-

Test of Alkaloids (Mayer's test)

1.36 grams of mercuric chloride were dissolved in 60ml of distilled water, and separately, 5 grams of potassium iodide were dissolved in 10ml of distilled water. These two solutions were combined and diluted to a total volume of 100ml with distilled water. To 1ml of the acidic aqueous sample solution, a few drops of the reagent were added. The formation of a white precipitate indicated the presence of alkaloids.

Test of Carbohydrates (Molisch's test)

In a test tube, 2 ml of the aqueous extract of the samples was combined with 2 drops of a freshly prepared 20% alcoholic solution of alpha-naphthol. Concentrated sulfuric acid was then cautiously added to form a layer beneath the mixture. The appearance of a red-violet ring, which vanished upon the addition of excess alkali solution, indicated the presence of carbohydrates.

Test of Flavonoids

In a test tube, 0.5 ml of the alcoholic extract from the samples was combined with 5 to 10 drops of diluted hydrochloric acid (HCl) and a small quantity of zinc (Zn) or magnesium (Mg). The mixture was then boiled for a few minutes. The development of a reddish-pink or dirty brown color indicated the presence of flavonoids.

Test of Glycosides

Small quantities of the alcoholic extract from the samples were dissolved in 1 ml of water, after which aqueous sodium hydroxide was added. The appearance of a yellow color indicated the presence of glycosides.

Test of Steroids (Salkowski's test)

About 100 mg of dried extract was dissolved in 2ml of chloroform. Carefully, sulfuric acid was added to form a lower layer. The appearance of a reddish-brown color at the interface indicated the presence of a steroidal ring.

Test of Saponins

A drop of sodium bicarbonate was introduced into a test tube containing approximately 50 ml of an aqueous extract of the sample. The mixture was vigorously shaken and left to stand for 3 minutes. The formation of a honeycomb-like froth indicated the presence of saponins.

Test of Resins

2ml of chloroform or ethanolic extract was combined with 5 to 10ml of acetic anhydride and dissolved through gentle heating. After cooling, 0.5ml of sulfuric acid (H_2SO_4) was introduced. The

appearance of a bright purple color indicated the presence of resins.

Test of Phenols (Ferric Chloride Test)

1 ml of the alcoholic solution of the sample was combined with 2ml of distilled water, followed by the addition of a few drops of 10% aqueous ferric chloride solution. The development of a blue or green color indicated the presence of phenols.

Test of Tannins (Lead acetate test)

In a test tube containing approximately 5ml of an aqueous extract, a few drops of 1% lead acetate solution were introduced. The formation of a yellow or red precipitate indicated the presence of tannins.

Test of Proteins (Biuret's test)

In a test tube, add 5-8 drops of 10% (w/v) copper sulfate solution to 1ml of hot aqueous extract from the samples. The development of a red or violet color indicates the presence of protein.

Test for Volatile oil or Essential oil

Place a thick section of the solution of the sample on a glass slide. Added a drop of Sudan red 3rd reagent, and after two minutes, rinse with 50% alcohol before mounting in glycerin.

RESULTS AND DISCUSSION:

All chloroform, methanol, ethyl acetate, and acetone extracts of the fruit shell, leaves, root bark, root wood, seed, stem bark, and stem wood of *A. augusta* were tested against *T. castaneum* adults using residual film assay. The doses applied were 1560, 1300, 1040, 780, 520, 260, and 130 µg/cm² on the surface of Petri dishes. Test insects were released to observe mortality or any behavioral changes caused by the extracts compared to the controls. The results have been presented in Tables 1-4 for mortality of the test insects.

The seed extract demonstrated the highest mortality of the beetles. The LD_{50} values for the chloroform extracts were 13723.67, 1667.775, and 257.2156 µg/cm² for 30 minutes, 24 hours, and 48 hours of exposure respectively. For the methanol extracts, the LD_{50} values were 11479.71, 919.647, and 407.568 µg/cm² for the same time intervals. The ethyl acetate extracts had LD_{50} values of 26246.31, 2923.797, and 587.074 µg/cm², while the acetone extracts had values of 153836.4, 5386.93, and 672.290 µg/cm² for 30 minutes, 24 hours, and 48 hours of exposure, respectively. Observation after 30 minutes confirmed acute toxicity, although the LD_{50} value was comparatively higher. Based on toxicity, the fruit shell extract yielded LD_{50} values of 15509.02, 5196.236, and 1752.395 µg/cm² for the chloroform extract; 33666.75, 13464.21, and 2314.99 µg/cm² for the methanol extract; 140797.5, 29425.75, and 1853.586 µg/cm² for the ethyl acetate extract; and 19353.17, 1180.561, and 611.689 µg/cm² for the acetone extract for 30 minutes, 24 hours, and 48 hours of exposure respectively. This was followed by the leaf extract, which had LD_{50} values of 16278.99, 2923.797, and 438.459 µg/cm² for the chloroform extract; 46511.71, 8796.073, and 529.930 µg/cm² for the methanol extract; 49203.31, 7931.855, and 668.952 µg/cm² for the ethyl acetate extract; and 90060.49, 18206.32, and 1566.299 µg/cm² for the acetone extract for 30 minutes, 24 hours, and 48 hours of exposure. This was followed by the root bark extract, with LD_{50} values of 10041.92, 1234.363, and 2580.877 µg/cm² for the chloroform extract; 38577.06, 12091.71, and 3389.414

µg/cm² for the methanol extract; 39146.58, 8162.13, and 1580.342 µg/cm² for the ethyl acetate extract; and 38577.06, 4261.426, and 1804.709 µg/cm² for the acetone extract for 30 minutes, 24 hours, and 48 hours of exposure respectively. The root wood extract yielded LD_{50} values of 90060.49, 4803.207, and 639.031 µg/cm² for the chloroform extract; 497841.7, 10982.62, and 4017.242 µg/cm² for the methanol extract; 497841.7, 6084.157, and 1128.608 µg/cm² for the ethyl acetate extract; and 46511.71, 1367.233, and 579.534 µg/cm² for the acetone extract for 30 minutes, 24 hours, and 48 hours of exposure, respectively. The stem wood extract gave LD_{50} values of 5249.057, 3313.803, and 1272.258 µg/cm² for the chloroform extract; 7646.179, 3102.658, and 1104.856 µg/cm² for the methanol extract; 8089.059, 3971.692, and 1258.099 µg/cm² for the ethyl acetate extract; and 13965.01, 6167.563, and 1552.904 µg/cm² for the acetone extract for 30 minutes, 24 hours, and 48 hours of exposure, respectively.

It is noteworthy that the stem bark extract of *A. augusta* did not exhibit any activity against the beetles of *T. castaneum*. Based on the observed intensity of activity through adult beetle mortality, the potentiality of the chloroform extracts can be ranked in descending order as follows: seed > leaf > root wood > root bark > stem wood > fruit shell extracts. For the methanol extracts, the order is: seed > leaf > stem wood > fruit shell > root bark > root wood extracts. For the ethyl acetate extract, the ranking is: seed > leaf > root wood > stem wood > root bark > fruit shell extracts. For the acetone extract, the order is: seed > fruit shell > root wood > stem wood > leaf > root bark extracts.

Table 1: Dose mortality effects of *A. augusta* extracts (chloroform) against *T. castaneum* adults.

Test extract	Time exposed	LD_{50} values µg/cm²	95% Conf. Limits		*Regression equation*	χ^2 Values (df)
			Lower limit	Upper limit		
Fruit shell	30 min.	155090.2	1.098	2.190E+10	Y=1.253+0.722X	0.489(3)
	24 h	5196.236	627.528	43027.38	Y=1.381+0.974X	1.036(3)
	48 h	1752.395	675.944	4543.108	Y=1.817+0.981X	0.592(3)
Leaf	30 min.	16278.99	314.343	843045.6	Y=1.251+0.890X	0.630(3)
	24 h	2923.797	449.872	19002.24	Y=2.477+0.728X	0.185(3)
	48 h	438.459	247.461	776.877	Y=2.834+0.820X	0.786(3)
Root bark	30 min.	10041.92	417.309	241643.2	Y=-.689+1.422 X	0.175(3)
	24 h	2580.877	1001.836	6648.717	Y=0.123+1.430X	0.114(3)
	48 h	1234.363	927.351	1643.016	Y=-.906+1.910 X	0.743(3)
Root wood	30 min.	90060.49	15.308	5.298E+08	Y=1.859 +0.634X	0.662(3)

	24h	4803.207	382.284	60349.81	Y =2.486+0.682X	0.982(3)
	48h	639.031	382.971	1066.298	Y=2.116+1.028 X	1.129(3)
Seed	30 min.	13723.67	5.346E-03	3.522E+14	Y=2.680+0.378X	0.131(3)
	24 h	1667.775	418.341	6648.805	Y=2.714+0.709X	0.394(3)
	48 h	257.2156	133.912	494.054	Y=2.922+0.862X	0.358(3)
Stem wood	30 min.	5249.057	956.4777	28806.33	Y=-1.799+1.828X	3.586E-02(3)
	24 h	3313.803	864.403	12703.9	Y =0.520+1.273X	0.358(3)
	48 h	1272.258	825.346	1961.165	Y =0.940+1.307X	0.650(3)

Table 2: Dose mortality effects of *A. augusta* extracts (methanol) against *T. castaneum* adults.

Test extract	**Time exposed**	**LD_{50} valueµg/cm^2**	**95% Conf. Limits**		*Regression equation*	**χ^2 Values (df)**
			Lower limit	**Upper limit**		
Fruit shell	30 min.	33666.75	68.967	1.643E+07	Y =.753+0.938 X	0.328(3)
	24 h	13464.21	181.379	999480.3	Y = 2.059+ 0.712X	0.558(3)
	48 h	2314.99	593.313	9032.629	Y =2.161+0.844 X	o.191(3)
Leaf	30 min.	46511.71	60.19644	3.5938E+07	Y =1.702+ 0.706X	0.296(3)
	24 h	8796.073	175.483	440902.2	Y =2.855+0.544X	0.200(3)
	48 h	529.930	293.508	956.789	Y =2.768+0.819X	0.513(3)
Root bark	30 min.	38577.06	14.886	9.997E+07	Y=0.110 +1.066 X	.3837055
	24 h	12091.71	178.476	819207.5	Y =1.433+0.874 X	0.1619(3)
	48 h	3389.414	696.892	16484.79	Y=1.256+1.060X	.0865(3)
Root wood	30 min.	497841.7	0.159	1.558E+12	Y =1.968+ 0.532 X	0.241(3)
	24h	10982.62	212.426	567809.5	Y =2.540+0.609 X	.5407336
	48h	4017.242	252.6967	63864.12	Y =2.989+0.558X	1.001362
Seed	30 min.	11479.71	427.604	308190.6	Y=1.091+ 0.962X	0.446(3)
	24 h	919.647	481.467	1756.617	Y =1.960 +1.026X	2.417(3)
	48 h	407.568	276.724	600.281	Y =1.766 +1.239 X	1.795(3)
Ste m wo	30 min.	7646.179	595.160	98232.44	Y =-0.918+1.524 X	0.175(3)

	24 h	3102.658	1036.202	9290.162	Y=-0.249+ 1.503X	0.100(3)
	48 h	1104.856	848.678	1438.362	Y=-0.670+1.863 X	0.683(3)

Table 3: Dose mortality effects of *A. augusta* extracts (ethyl acetate) against *T. castaneum* adults.

Test extract	**Time exposed**	**LD_{50} values µg/cm^2**	**95% Conf. Limits**		*Regression equation*	**χ^2 Values (df)**
			Lower limit	**Upper limit**		
Fruit shell	30 min.	140797.5	1.217	1.629E+10	Y =1.386 +0.702 X	0.312(3)
	24 h	29425.75	45.603	1.8987E+07	Y=2.388+ 0.584 X	0.232(3)
	48 h	1853.586	671.516	5116.451	Y =1.853+ 0.963 X	1.101(3)
Leaf	30 min.	49203.31	66.956	3.615E+07	Y =1.727+ 0.697X	0.238(3)
	24 h	7931.855	214.4697	293348.9	Y =2.746+0.578 X	0.372(3)
	48 h	668.952	433.675	1031.873	Y = 1.470+1.249 X	2.263(3)
Root bark	30 min.	39146.58	11.984	1.278E+08	Y =0.357+1.011 X	0.356(3)
	24 h	8162.13	234.7132	283837.6	Y=1.791+ o.820 X	0.189(3)
	48 h	1580.342	1027.574	2430.465	Y=-0.628+ 1.759 X	1.373(3)
Root wood	30 min.	497841.7	.1590719	1.558E+12	Y=1.968+0.532 X	0.240(3)
	24h	6084.157	358.852	103153.7	Y =2.398+0.687X	1.602E-02(3)
	48h	1128.608	372.214	3422.107	Y=2.907+0.686 X	0.303(3)
Seed	30 min.	26246.31	172.1596	4001337	Y=1.143+0.873X	0.494(3)
	24 h	2923.797	449.872	19002.24	Y =2.477+ 0.728 X	0.185(3)
	48 h	587.074	327.301	1053.025	Y =2.609+0.863X	0.187(3)
Stem wood	30 min.	8089.059	604.086	108317.2	Y =-1.618+1.693X	0.500(3)
	24 h	3971.692	874.6408	18035.23	Y =0.216 +1.329 X	0.150(3)
	48 h	1258.099	873.223	1812.608	Y =0.258+1.530X	0.515(3)

Table 4: Dose mortality effects of *A. augusta* extracts (acetone) against *T. castaneum* adults.

Test extract	Time exposed	LD_{50} values µg/cm^2	95% Conf. Limits		Regression equation	χ^2 Values (df)
			Lower limit	Upper limit		
Fruit shell	30 min.	19353.17	204.959	1827407	Y =0.746+0.992X	0.160(3)
	24 h	1180.561	703.500	1981.131	Y=1.125+1.261 X	0.841(3)
	48 h	611.689	415.2968	900.9528	Y=1.550+1.238 X	1.451(3)
Leaf	30 min.	90060.49	15.30783	5.298E+08	Y =1.859 0.634X	0.662(3)
	24 h	18206.32	78.740	4209681	Y =2.881+0.497X	0.170(3)
	48 h	1566.299	448.109	5474.768	Y=2.586+ 0.755 X	0.884(3)
Root bark	30 min.	38577.06	14.886	9.997E+07	Y=0.110+1.066 X	0.384(3)
	24 h	4261.426	764.536	23752.65	Y=0.546+1.227X	0.217(3)
	48 h	1804.709	1002.311	3249.466	Y=2.558E-02+1.527X	0.870(3)
Root wood	30 min.	153836.4	3.940	6.006E+09	Y=2.025 +0.574 X	0.296(3)
	24h	5386.93	217.752	133266.3	Y = 2.975+0 .542X	0.146(3)
	48h	672.290	292.093	1547.367	Y = 3.169 + 0.647 X	7.208E-02
Seed	30 min.	46511.71	60.19644	3.594E+07	Y=1.70 + 0.707X	0.297(3)
	24 h	1367.233	535.316	3492.006	Y=2.065+0.936 X	0.916(3)
	48 h	579.534	370.182	907.281	Y=1.901+1.122 X	1.309(3)
Stem wood	30 min.	13965.01	219.467	888613.2	Y =-.695+1.374 X	0.276(3)
	24 h	6167.563	505.323	75276.26	Y =0.968+1.064X	3.015E-02
	48 h	1552.904	911.503	2645.64	Y =0 .599 +1.379 X	0.237(3)

Phytochemical screening:

Screening of phytochemicals of the plant extract of *A. augusta*

The present study focused on the analysis of plant extracts, revealing the presence of bioactive compounds with medicinal importance. The whole plant was found to contain several alkaloids and secondary metabolites, including steroids, triterpenes, flavonoids, megastigmanes, benzohydrofurans, and their glycosides, as well as phenylethanoid glycosides, which have demonstrated efficacy against various bacteria and fungi (Gupta *et al*., 2011). The phytochemical composition of *A. augusta* was investigated using standard analytical methods, revealing the presence or absence of phytochemicals such as tannins,

flavonoids, phenolic compounds, alkaloids, saponins, steroids, cardiac glycosides, phlobatinnins, and anthraquinones. The proximate composition quantified the percentages of tannins, flavonoids, phenolic compounds, alkaloids, and saponins. Detailed results are presented in Tables 5 to 9.

Table 5. Phytochemical screening of leaf extracts of *A. augusta*

Class of compounds indicated	Chloroform	Methanol	Ethyl acetate	Acetone
Alkaloids	+	+	+	+
Carbohydrates	-	+	+	+
Flavonoids	-	+	+	+
Glycosides	-	+	+	+
Phenols	-	+	+	+
Proteins	+	-	-	-
Resins	-	+	+	+
Saponins	-	+	+	+
Tanins	-	+	+	+
Steroids	+	+	+	+

(+)=Presence; (-)=Absence

Table 6. Phytochemical screening of seed extracts of *A. augusta*.

Class of compounds indicated	Chloroform	Methanol	Ethyl acetate	Acetone
Alkaloids	+	+	+	+
Carbohydrates	+	+	-	+
Flavonoids	-	-	+	-
Glycosides	-	-	-	-
Phenols	+	+	+	+
Proteins	+	+	+	+
Resins	-	-	+	-
Saponins	-	-	-	-
Tanins	+	+	+	+
Steroids	-	-	-	-

(+)=Presence, (-)=Absence

Table 7. Phytochemical screening of root bark extracts of *A. augusta*

Class of compounds indicated	Chloroform	Methanol	Ethyl acetate	Acetone
Alkaloids	+	+	+	+
Carbohydrates	-	+	+	+
Flavonoids	-	+	+	+
Glycosides	-	+	+	+
Phenols	-	+	+	+
Proteins	-	-	-	-
Resins	-	-	-	-
Saponins	-	+	+	+
Tanins	+	+	+	+
Steroids	-	+	+	+

(+)=Presence, (-)=Absence

Table 8. Phytochemical screening of root wood extracts of *A. augusta*.

Class of compounds indicated	Chloroform	Methanol	Ethyl acetate	Acetone
Alkaloids	+	+	+	+
Carbohydrates	-	+	+	+
Flavonoids	-	+	+	+
Glycosides	-	+	+	+
Phenols	-	+	+	+
Proteins	-	+	+	+
Resins	-	+	+	+
Saponins	-	+	+	+
Tanins	-	+	+	+
Steroids	+	+	+	+

(+)=Presence, (-)=Absence

Table 9. Phytochemical screening of stem bark *extracts of A. augusta*

Class of compounds indicated	Chloroform	Methanol	Ethyl acetate	Acetone
Alkaloids	+	+	+	+
Carbohydrates	-	+	+	+
Flavonoids	-	+	+	+
Glycosides	-	+	+	+
Phenols	-	+	+	+
Proteins	-	-	-	-
Resins	-	+	+	+
Saponins	-	-	-	-
Tanins	+	+	+	+
Steroids	-	-	-	-

Bangladesh, situated in the Oriental Region (Subtropical), harbors a rich biodiversity that includes numerous valuable plant species. Among these, *A. augusta* stands out for its long-established medicinal value. Despite being a native plant, it has not been extensively studied for its potential contributions to the country's development. Hence, this research aimed to explore the extractives from various parts of *A. augusta* such as the fruit shell, leaves, root bark, root wood, seed, stem bark, and stem wood for their insecticidal effects against *T. castaneum*.

The chloroform, methanol, ethyl acetate, and acetone extracts derived from the fruit shell, leaf, root bark, root wood, seed, stem bark, and stem wood of *A. augusta* exhibited insecticidal properties, with their LD_{50} values determined. Among these, the seed extracts demonstrated the highest mortality rates against *T. castaneum* beetles. Conversely, higher doses of leaf, root wood, root bark, stem wood, and fruit shell extracts showed weaker effects. All seven extracts induced mortality within 30 minutes of application, indicating acute toxicity. Particularly, the root wood and leaf extracts displayed significant bioactivity, with the root wood extract exhibiting the highest insecticidal activity after the seed extract. In contrast, the fruit shell extract showed mild activity, followed by the stem wood extract, while the stem bark extracts exhibited no activity against *T. castaneum* adults in the surface film assay.

Our findings corroborate Naqvi and Parveen's (1991) discovery of significant

insecticidal properties in *A. augusta* seed extract against *T. castaneum*. Our study clearly demonstrates that chloroform and methanol extracts from various parts of *A. augusta* exhibit notable insecticidal activities.

These results are similar with the results of Mondal *et al*. 2013 which they described the insecticidal activities of *A. augusta* (L.) chloroform and methanol extracts against *T. castaneum* (herbst) adults.

These results are in agreement with the results of Khatun *et al* 2021 which they described in vitro efficiency of crude extract of *Ricinus communis, Abroma augusta*, and *Bombax ceiba* seed on brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee.

These results align with the works done by Krishnamurti and Rao (1944), Sangapa (1977), Rao *et al*. (2010) and Abdullah *et al*. (2011), who evaluated the mortality and repellent effects of chloroform extracts from different parts of *Urena sinuata* on *T. castaneum* adults.

Located in the Oriental Region (Subtropical), Bangladesh boasts a diverse array of plant species, among them *A. august* stands out for its rich phytochemical profile. Various extracts (petroleum ether, benzene, chloroform, acetone, methanol, rectified spirit, and water) from this plant have been found to contain alkaloids, carbohydrates, proteins, tannins, saponins, anthraquinone glycosides, cardiac glycosides, flavonoids, phenolic compounds, quinones, and steroids.

The entire plant of *A. augusta* contains a variety of alkaloids and secondary metabolites, such as steroids, triterpenes, flavonoids, megastigmanes, benzohydrofurans, glycosides, and phenylethanoid glycosides, which have shown significant efficacy against specific bacteria and fungi (Gupta *et al.* 2011). These findings are supported by Dr. Siva Rami Reddy E's review in 2018, which summarized the pharmacological and phytochemical studies of *A. augusta*. The seeds of *A. augusta* were extracted using chloroform and methanol, and the extracts were evaluated for their phytotoxic effects.

Additionally, Rahmatullah *et al.* (2010) investigated the phytotoxic activity of the seed oil by assessing growth inhibition under controlled conditions. Paraquat served as a standard inhibitor, and the study demonstrated that the oil effectively inhibited the growth of *Lemna aequinoctialis Welv.*, achieving an 82.35% inhibition rate at a concentration of 500 μg/ml.

Chemical analysis of the extracts revealed the presence of fatty acids, steroids, triterpenoids, alkaloids, phenols, phenyl propionates, tannins, and mucilage (Uyub *et al.* 2010). The analyzed extracts also contained various bioactive phytochemicals, including significant quantities of phenolics, flavonoids, anthocyanidins, and alkaloids. These findings are consistent with previous studies (Paliwal *et al.* 2011; Aliyu *et al.* 2016).

These results are more or less similar with the results of Dr. Siva Rami Reddy E (2018) which they explained a review on pharmacological and phytochemical study of *Abroma augusta*.

CONCLUSION

A perusal of the data revealed that *A. augusta* extracts can be used as insecticidal compounds in the grain and cereal stores to manage the population of *T. castaneum*. These results also seem to be encouraging when there is a greater need for environment –friendly pesticides than ever before. The overall assessment of toxicity of *A. augusta* extracts are very much promising and their

efficacy on stored grain pests might have future to be used as a control agent or tool. We may concluded that the evaluation of potentiality of the extractives of this plant in many projections in consideration of their versatile activity and for the possibility of their various uses of different diseases and in the environmentally friendly pest control sector of the contemporary Bangladesh.

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