**Phytochemical Comparative Screening of Aqueous Extracts of the Leaves, Stem barks, and Roots of *Hura* *crepitans* (L) using GC – FID.**

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**Abstract:** The phytochemical screening of the aqueous extracts of leaves,stem bark and roots of *Hura* *crepitans* were analysed using the Gas Chromatography – Flame Ionization Detector (GC – FID) method. The various parts of the plants were collected and air-dried under shade for one month after which they were sent for analysis. All the various parts showed varying amounts of phytochemicals: Flavonoids, Carotenoids, Sterols, Terpenes, Alkaloids, Saponins and Phenolic acids. The Aqueous Root Extracts (ARE) showed the highest amounts of the following phytochemicals when compared with other parts: phenolic acid content of 193.776mg/100g; flavonoids total content of 151.6604g/100g; alkaloid total content of 199.41g/100g; saponin total content of 130.005mg/100g; sterol total content of 4.02985g/100g and terpenes total content of 98.2341%. The leaves showed the highest carotenoid total content of 90.9181g/100g. The rich phytochemical content of these aqueous extracts especially of the roots suggests its potential use as a medicinal plant and may also have other industrial applications as raw materials.

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**Key words:** *Hura* *crepitans,* Phytochemicals, Gas Chromatography – Flame Ionization Detector, Leaf, Bark, Roots.

1. **Introduction**

*Hura* *crepitans* (L) belongs to the family Euphorbiaceae. It is also known as the sandbox tree, possum wood or Jabillo (Duke, 1985; Morretti and Grenand, 1982). In the wild, the tree grows above 40m and the stem and branches are mainly spiny. In ancient times, the plant’s bark extract was used to treat leprosy, eczema and in warfare (Barbieri, *et al*, 1983). Recently, a wide range of therapeutic applications have been found of the leaves, stem bark, roots and seeds of *Hura* *crepitans*. Such uses include: a strong purgative; astringent and emollient actions; dermatological uses; fungicidal, antimicrobial, etc (Poswal and Akpa, 1991; David, *et al*, 2014; Adedire and Ajayi, 2003).

Phytochemicals or secondary metabolites found in plant foods and other plant extracts are numerous and exhibit various physiological actions. Apart from the nutritive values of different plants foods and extracts, they have equally proved to be strong agents of disease prevention and treatment (Elekwa, 2015). These phytochemicals that have found wide therapeutic applications include: Alkaloids, flavonoids, tannins, saponins, carotenoids, etc. For instance, many alkaloids are extremely toxic and may act as neuromuscular poisons, enzyme inhibitors or membrane transport inhibitors. Alkaloids (morphine, codeine and cocaine) are used as pain killers, anaesthetics, antimalarial, stimulants, and as insecticides (Tanaka, *et al*, 2006, Elekwa, 2015). Flavonoids also play vital roles as anti-inflammatory, anti-allergic and anti-cancer roles (Formica and Regelson, 1995). Flavonoids have been shown to possess anti-hypertensive properties (Esquivel-Gutierriz, *et al*, 2013; Khanavi, *et al*, 2013). Tannins cause protein inactivation, hence used as insecticides. They also possess astringent properties. Tannins have been showed to inactivate Polio Virus, Herpes simplex and other enteric viruses (Bajaj, 1988). Saponins also serve as natural antibiotics, reducing cardiovascular diseases and reduction in cholesterol levels (Elekwa, 2005). Carotenoids are known for their antioxidant properties thereby helping the body to get rid of free radicals. They have equally been shown to possess antihypertensive properties (Eric, *et al*, 2011; James, *et al*, 2001; Magumi, *et al*, 2008).

There is no much reported works on the phytochemical components of the different parts of *Hura* *crepitans* (leaves, bark and roots), therefore the objective of this study was to ascertain the comparative phytochemical components of the leaves, stem bark and roots of *Hura* *crepitans*.

1. **Materials and Methods**
   1. **Plant Material Collection**

Fresh leaves, stem bark and roots of *Hura* *crepitans* were collected from the premises of University of Nigeria, Nsukka and were identified in the Botany Unit of University of Nigeria Nsukka. The samples were air-dried under shade for one month.

* 1. **Preparation of Plant Extracts:**

The plant samples were pulverized using an electronic blender and 200g each of the powdered sample was dissolved using 500 ml of distilled water and allowed to stay for 72 hours. The extracts were filtered using a vacuum pump and concentrated by evaporation.

* 1. **GC Conditions for Total Carotenoids:**

The carotenoid extraction was carried out using the modified method Takagi, (1985).

Injection Temperature HP 5890 Powered with Chemstation Rev. A 09.01 [1206] software

Split Ratio 20.1

Carrier Gas Nitrogen

Inlet Temperature 250oC

Column Type AC-5

Column Dimensions 30m X 0.25mm X 0.25um

Oven Program Initial Temperature @ 60oc first ramping @ 10oc/min for 4 minutes, maintained for 4 minutes.

Detector FID

Detector Temperature 320oc

Hydrogen Pressure 30psi

Compressed Air 40psi

* 1. **GC Conditions for Total Saponins:**

The extraction was carried out using the modified method of Miringquan, *et al*, (2009).

GC Hp 6890 Powered with Chemstation Rev. A 09.01 [1206] software

Injection Temperature Split Injection

Split Ratio 20.1

Carrier Gas Nitrogen

Inlet Temperature 250oc

Column Type Capillary, DB-225ms

Column Dimensions 30m X 0.25m X 0.25μm.

Oven Program Initial Temperature @ 60oc for 5 minutes, First Ramping @ 12oc/min for 18 minutes, Second Ramping @ 15oc/min for 5 minutes

Detector FID

Detector Temperature 320oc

Hydrogen Pressure 30psi

Compressed Air 40psi

* 1. **GC Conditions for Total Sterols:**

Sterol analysis was carried out by following the modified AOAC 994.10 and AOAC 970.51 official methods.

GC Hp 6890 Powered with Chemstation Rev. A 09.01 [1206] software

Injection Temperature Split Injection

Split Ratio 20.1

Carrier Gas Nitrogen

Inlet Temperature 250oc

Column Type Hp INNO Wax

Column Dimensions 30m X 0.25m X 0.25μm.

Oven Program Initial Temperature @ 60oc, First Ramping @ 10oc/min for 20 minutes maintained for 4 minutes, Second Ramping @ 15oc/min for 4 minutes, maintained for 10 minutes.

Detector FID

Detector Temperature 320oc

Hydrogen Pressure 30psi

Compressed Air 40psi

* 1. **GC Conditions for Phenolic Compounds:**

Phenolic compounds were extracted from pulverized samples according to the method described by Ndoumou, *et al*, (1996).

Column Rtx-5ms, 5% Diphenyl – 95% Dimethyl Polysiloxane

Column Length 30m

Column ID 0.25mm

Column Film 0.25mm

Injection Temperature 250oc

Detector Temperature 320oc

Detector FID

Injection System Splitless

Rate 1 80oc @ 6oc/min to 200oc

Rate 2 30oc/min to 280oc and maintained for 5 minutes

Mobite Phase Carrier Nitrogen

Nitrogen Pressure Column 30 psi

Hydrogen Pressure 28 psi

Compressed Air Pressure 32 psi.

* 1. **GC Conditions for Flavonoids:**

GC Hp 6890 Powered with Chemstation Rev. A 09.01 [1206] software

Injection Temperature Split Injection

Split Ratio 20.1

Carrier Gas Nitrogen

Inlet Temperature 250oc

Column Type Hp INNO Wax

Column Dimensions 30m X 0.25mm X 0.25ηm.

Oven Program Initial Temperature @ 50oc, First Ramping @ 8oc/min for 20 minutes, Second Ramping @ 12oc/min for 4 minutes, maintained for 4 minutes.

Detector FID

Detector Temperature 320oc

Hydrogen Pressure 22psi

Compressed Air 35psi

* 1. **GC Conditions For Alkaloids**

Alkaloid extraction was carried out by following the modified method of Ngounou, *et al,* (2005).

GC Hp 6890 Powered with Chemstation Rev. A 09.01 [1206] software

Injection Temperature Split Injection

Split Ratio 20.1

Carrier Gas Nitrogen

Inlet Temperature 250oc

Column Type DB – 5ms Capillary

Column Dimensions 30m X 0.25mm X 0.25ηm.

Oven Program Initial Temperature @ 60oc for 5 minutes, First Ramping @ 10oc/min for 20 minutes, Second Ramping @ 15oc/min for 4 minutes

Detector FID

Detector Temperature 320oc

Hydrogen Pressure 28psi

Compressed Air 38psi

* 1. **GC Conditions for Terpenes:**

GC Hp 6890 Powered with Chemstation Rev. A 09.01 [1206] software

Injection Temperature Split Injection

Split Ratio 20.1

Carrier Gas Nitrogen

Inlet Temperature 150oc

Column Type Hp – 5ms Capillary

Column Dimensions 30m X 0.25mm X 0.25ηm.

Oven Program Initial Temperature @ 40oc Ramped @ 5oc/min to 200oc, Run @ 200oc for 2 minutes

Detector FID

Detector Temperature 300oc

Hydrogen Pressure 22psi

Compressed Air 28psi

**Results and Discussion**

The role of phytochemicals has been widely applied over the years especially in the treatment of diseases and as a major component of plant foods.

Gas Chromatography – Flame ionization Detector (GC – FID) is a recent technology that gives reliable evidence on the types and amounts of phytochemicals present in a given plant sample. The results of the GC – FID analysis of the leaves, stem bark, and roots of *Hura* *crepitans* showed that it contains varying amounts of flavonoids, carotenoids, alkaloids, terpenes, sterols, saponins and phenolic acid. The types and amounts of the different phytochemicals present are listed in the tables below:

**Table 1:** **The comparative amounts of alkaloids present in the aqueous leaf, stem bark and roots extracts of *Hura* *crepitans*.**

| **Stem Bark** | | | **Leaves** | | | **Roots** | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ALKALOIDS** | **RT (Min)** | **AMOUNT [Mg/100g]** | **ALKALOIDS** | **RT (Min)** | **AMOUNT [Mg/100g]** | **ALKALOIDS** | **RT (Min)** | **AMOUNT [Mg/100g]** |
| Choline | 5.134 | 2.85963e-1 | Choline | 4.886 | 2.46973 | Choline | 5.513 | 3.30983e-1 |
| Theophylline | 6.012 | 3.3574 | Theophylline | 5.764 | 2.9675 | Theophylline | 6.391 | 3.8076 |
| Dillapiole | 6.405 | 4.24777e-1 | Dillapiole | 6.157 | 3.85787 | Dillapiole | 6.784 | 4.69797e-1 |
| Angustifoline | 7.001 | 22.7812 | Angustifoline | 7.153 | 22.3913 | Angustifoline | 7.38 | 23.2314 |
| Spartein | 7.415 | 10.4103e-1 | Spartein | 8.167 | 10.0204 | Spartein | 7.794 | 10.8605e-1 |
| Ellipane | 8.261 | 8.91706e-1 | Ellipane | 8.913 | 8.52716 | Ellipane | 8.64 | 9.36726e-1 |
| Lupanine | 9.137 | 9.57561 | Lupanine | 10.189 | 9.18571 | Lupanine | 9.516 | 10.0258 |
| 13-Alphahydro-rhambifoline | 9.432 | 9.10812 | 13-Alphahydro-rhambifoline | 11.184 | 8.71822 | 13-Alphahydro-rhambifoline | 9.811 | 9.55832 |
| 9-octadecenamide | 10.902 | 7.46166 | 9-octadecenamide | 12.054 | 7.07176 | 9-octadecenamide | 11.281 | 7.91186 |
| Dihydro-oxodemethofyha-emanthamine | 12.23 | 6.56015 | Dihydro-oxodemethofyha-emanthamine | 13.082 | 6.17025 | Dihydro-oxodemethofyha-emanthamine | 12.609 | 7.01035 |
| Augustamine | 12.998 | 5.75083 | Augustamine | 13.175 | 5.36093 | Augustamine | 13.377 | 6.20103 |
| Oxoassoanine | 13.113 | 7.43161 | Oxoassoanine | 13.365 | 7.04171 | Oxoassoanine | 13.492 | 7.88181 |
| Shogal | 13.312 | 3.22534e-1 | Shogal | 13.564 | 2.83544 | Shogal | 13.691 | 3.67554e-1 |
| Piperline | 13.475 | 3.02643e-1 | Piperline | 13.627 | 2.63653 | Piperline | 13.854 | 3.47663e-1 |
| Gingerdione | 13.891 | 3.8301e-1 | Gingerdione | 14.043 | 7.04171 | Gingerdione | 14.27 | 4.2803e-1 |
| Capsalcine | 14.114 | 6.71031e-1 | Capsalcine | 14.166 | 2.83544 | Capsalcine | 14.493 | 7.16051e-1 |
| Cinchonidine | 14.725 | 6.39698 | Cinchonidine | 14.077 | 2.63653 | Cinchonidine | 14.704 | 6.84718 |
| Cinchonine | 14.948 | 4.6412 | Cinchonine | 14.2 | 3.4402 | Cinchonine | 14.827 | 5.0914 |
| Crinane-3alpha-01 | 15.033 | 8.83448 | Crinane-3alpha-01 | 14.585 | 8.44458 | Crinane-3alpha-01 | 14.912 | 9.28468 |
| Buphanidrine | 16.048 | 37.2511 | Buphanidrine | 14.542 | 36.8612 | Buphanidrine | 14.927 | 37.7013 |
| Indicine-N-oxide | 17.225 | 9.28569 | Indicine-N-oxide | 15.377 | 8.89579 | Indicine-N-oxide | 15.104 | 9.73589 |
| Powelline | 18.067 | 13.4581 | Powelline | 16.419 | 13.0682 | Powelline | 16.146 | 13.9083 |
| Undulatine | 19.717 | 18.1745 | Undulatine | 16.669 | 17.7846 | Undulatine | 17.296 | 18.6247 |
| Ambelline | 19.864 | 12.6237 | Ambelline | 17.516 | 12.2338 | Ambelline | 17.343 | 13.0739 |
| 6-hydroxybuphanidrine | 20.142 | 17.5734 | 6-hydroxybuphanidrine | 18.294 | 17.1835 | 6-hydroxybuphanidrine | 18.921 | 18.0236 |
| Aeronycine | 21.976 | 4.80104 | Aeronycine | 18.928 | 4.41114 | Aeronycine | 19.555 | 5.25124 |
| Monocrotalline | 22.803 | 5.82448 | Monocrotalline | 19.155 | 5.434 | Monocrotalline | 19.582 | 6.27468 |
| 6-hydroxypowelline | 23.096 | 3.95999 | 6-hydroxypowelline | 20.148 | 3.57009 | 6-hydroxypowelline | 19.775 | 4.41019 |
| Nitidine | 23.236 | 4.33935 | Nitidine | 21.088 | 3.94945 | Nitidine | 20.815 | 4.78955 |
| Crinamidine | 24.042 | 20.8251 | Crinamidine | 22.094 | 20.4352 | Crinamidine | 20.921 | 21.2753 |
| 1beta,2beta-Epoxyambelline | 24.832 | 3.06857 | 1beta,2beta-Epoxyambelline | 22.552 | 2.67867 | 1beta,2beta-Epoxyambelline | 22.139 | 3.51877 |
| 6-hydroxyundultine | 25.066 | 3.32349 | 6-hydroxyundultine | 22.618 | 2.93359 | 6-hydroxyundultine | 22.165 | 3.77369 |
| Epoxy-3,7-dimethoxycrinane-11-one | 25.857 | 6.77876e-1 | Epoxy-3,7-dimethoxycrinane-11-one | 23.309 | 6.38886 | Epoxy-3,7-dimethoxycrinane-11-one | 23.136 | 7.22896e-1 |
| Akuammidine | 26.115 | 16.2257 | Akuammidine | 24.067 | 15.8358 | Akuammidine | 24.106 | 14.3303 |
| Echitammdine | 26.327 | 13.8801 | Echitammdine | 24.279 | 13.4902 | Echitammdine | 25.018 | 16.546 |
| Voacangine | 26.939 | 16.0958 | Voacangine | 24.891 | 15.7059 | Voacangine | 25.203 | 8.90706 |
| Mitraphylin | 27.524 | 8.45686 | Mitraphylin | 25.276 | 8.06696 | Mitraphylin | 25.847 | 8.90706 |
| Camptothecin | 28.068 | 6.40175e-1 | Camptothecin | 26.02 | 6.01185 | Camptothecin | 26.393 | 6.85495e-1 |
| Echitamine | 26.514 | 5.10985e-2 | Echitamine | 26.466 | 4.71995 | Echitamine | 27.645 | 5.56005e-2 |
| Colchicines | 27.066 | 4.76839e-2 | Colchicines | 27.018 | 4.37849 | Colchicines | 27.822 | 5.21859e-2 |
| Emetine | 27.143 | 3.70341e-2 | Emetire | 27.395 | 3.31351 | Emetire | 26.393 | 4.15361e-2 |
| Tetrandrine | 27.829 | 3.04665e-2 | Tetrandrine | 27.581 | 2.65675 | Tetrandrine | 28.208 | 3.49685e-2 |
| Paclitaxel | 29.228 | 5.35944e-2 | Paclitaxel | 28.98 | 4.96954 | Paclitaxel | 29.607 | 5.80964e-2 |
| **TOTAL= 379.461** | | | **Total= 362.696** | | | **Total= 398.82** | | |

The results showed that the aqueous root extracts contain the highest amounts of alkaloids. This result conforms to the findings of Ganiyat and Mutairu, (2014), where they showed the presence of alkaloids and other phytochemicals in methanol extracts of the stem bark and leaves of *Hura* *crepitans*. The rich alkaloid content of the different plant extracts suggest that this plant has found a potential use as analgesic, anaesthetics, stimulants and even as an insecticide (Elekwa, 2015; Tanaka, *et al*, 2006). The alkaloid-crinamidine has been shown to be cytotoxic to various strains of Plasmodium (Likhitwitayawuid, *et al*, 1993).

**Table 2: The comparative amounts of the flavonoids present in the leaves, stem bark, and roots of Hura crepitans.**

| **Stem Bark** | | | **Leaves** | | | **Roots** | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FLAVONOIDS** | **RT (Min)** | **AMOUNT [Mg/100g]** | **FLAVONOIDS** | **RT (Min)** | **AMOUNT [Mg/100g]** | **FLAVONOIDS** | **RT (Min)** | **AMOUNT [Mg/100g]** |
| 1 Catechi | 11.251 | 8.40292e-2 | Catechi | 11.038 | 8.08012e-2 | Catechi | 11.459 | 8.69492e-2 |
| 1 Resveratrol | 12.534 | 4.24841e-2 | Resveratrol | 12.321 | 3.92561e-2 | Resveratrol | 12.742 | 4.54041e-2 |
| 1 Genistein | 13.009 | 4.11006e-2 | Genistein | 12.796 | 3.78726e-2 | Genistein | 13.217 | 4.40206e-2 |
| 1 Daidzein | 13.404 | 4.06647e-2 | Daidzein | 13.191 | 3.74367e-2 | Daidzein | 13.612 | 4.35847e-2 |
| 1 Apigein | 14.18 | 3.52792e-3 | Apigein | 13.967 | 3.20512e-3 | Apigein | 14.388 | 3.81992e-3 |
| 1 Butein | 14.318 | 9.31639e-3 | Butein | 14.105 | 8.99359e-3 | Butein | 14.526 | 9.60839e-3 |
| 1 Nanasgenin | 14.597 | 3.3007e-3 | Nanasgenin | 14.384 | 2.9779e-3 | Nanasgenin | 14.805 | 3.5927e-3 |
| 1 Biochanin | 15.277 | 11.1826e-5 | Biochanin | 15.064 | 10.8578e-5 | Biochanin | 15.485 | 11.4746e-5 |
| 1 Luteolin | 15.559 | 6.45571e-5 | Luteolin | 15.346 | 6.13291e-5 | Luteolin | 15.767 | 6.74771e-5 |
| 1 Kaemferol | 17.025 | 25.1540e-5 | Kaemferol | 16.812 | 24.83125e-5 | Kaemferol | 17.233 | 25.44605e-5 |
| 1 [-]Epicatechin | 17.979 | 3.9525e-3 | [-]Epicatechin | 17.766 | 3.6297e-3 | [-]Epicatechin | 18.187 | 4.2445e-3 |
| 1 [-] Epigalocatechin | 19.328 | 6.23634e-3 | [-] Epigalocatechin | 19.115 | 5.91354e-3 | [-] Epigalocatechin | 19.536 | 6.52834e-3 |
| 1 Quercetin | 19.868 | 31.3859e-5 | Quercetin | 19.655 | 31.06579e-5 | Quercetin | 20.076 | 31.68059e-3 |
| 1 Gallocatechin | 20.362 | 7.30689e-5 | Gallocatechin | 20.149 | 6.98409e-5 | Gallocatechin | 20.57 | 7.59889e-5 |
| 1 [-] Epicatechin-3-gallate | 20.739 | 3.32901e-3 | [-] Epicatechin-3-gallate | 20.526 | 3.00621e-3 | [-] Epicatechin-3-gallate | 20.947  21.681 | 3.62101e-3 |
| 1 [-] Epigallocatechin-3-gallate | 21.473 | 2.65262e-2 | Isorhamretin | 21.26 | 2.32982e-2 | [-] Epigallocatechin -3-gallate | 21.951  22.324 | 2.94462e-2  4.1616e-3 |
| 1 Isorhamretin | 21.743 | 3.86961e-3 | Robinetin | 21.53 | 3.54681e-3 | Isorhamretin | 22.506 | 6.98339e-3 |
| 1 Robinetin | 22.116 | 6.69139e-3 | Ellagid acid | 21.903 | 6.36859e-3 | Robinetin | 23.196 | 3.19986e-3 |
| 1 Ellagid acid | 22.298 | 2.90786e-3 | Myricetin | 22.085 | 2.58506e-3 | Ellagid acid | 23.409 | 5.76536e-3 |
| 1 Myricetin | 22.988 | 5.47336e-3 | Baicalein | 22.775 | 5.15056e-3 | Myricetin | 23.581 | 5.96619e-3 |
| 1 Baicalein | 23.201 | 5.67419e-3 | Nobicalein | 22.988 | 5.35139e-3 | Baicalein | 23.755 | 11.4647e-5 |
| 1 Nobicalein | 23.373 | 11.1727e-5 | Kaempferol-3,7,4,-trinethyl ether | 23.334 | 10.8499e-5 | Nobicalein | 24.013 | 4.7215e-2 |
| 1 Kaempferol-3,7,4,-trinethyl ether | 23.547 | 4.4295e-2 | Quercetin-3,7,4-trinethyl ether | 23.592 | 4.1067e-2 | Kaempferol-3,7,4,-trinethyl ether | 23.755 | 3.12777e-2 |
| Quercetin-3,7,4-trinethyl ether | 23.805 | 2.83577e-2 | Baicalin | 23.334 | 2.51297e-2 | Quercettn-3,7,4-trinethyl ether | 24.031 | 9.14271e-2 |
| Baicalin | 23.547 | 8.85071e-2 | Tangeretin | 23.8 | 8.52791e-2 | Baicalin | 23.755 | 5.28077e-2 |
| 1 Tangeretin | 24.013 | 4.98877e-2 | Quercetin-3,7,3’,4’-tetranethyl ether | 24.032 | 4.66597e-2 | Tangeretin | 24.221 | 4.8543e-2 |
| Quercetin-3,7,3’,4’-tetranethyl ether | 24.245 | 4.5623e-2 | Artemetin | 24.126 | 4.2395e-2 | Quercetin-3,7,3’,4’-tetranethyl ether | 24.453 | 4.61429e-2 |
| 1 Artemetin | 24.339 | 4.32229e-2 | Hyperoside | 24.249 | 3.99949e-2 | Artemetin | 24.547 | 38.1882e-5 |
| Hyperoside | 24.462 | 37.8962e-2 | Silymarin | 24.359 | 37.5734e-5 | Hyperoside | 224.67 | 6.29388e-2 |
| 1 Silymarin | 24.572 | 6.00188e-2 | Kaempferol-3-Arabinoside | 24.588 | 5.67908e-2 | Silymarin | 24.78 | 5.6075e-5 |
| Kaempferol-3-Arabinoside | 24.801 | 5.3155e-5 | Quercitrin | 24.939 | 4.9927e-5 | Kaempferol-3-Arabinoside | 25.009 | 6.2304e-5 |
| Quercitrin | 24.988 | 5.9384e-5 | Naringin | 25.104 | 5.6156e-5 | Quercitin | 25.196 | 3.78316e-3 |
| 1 naringin | 25.152 | 3.49116e-3 | Isoquercetin | 25.104 | 3.16836e-3 | Naringin | 25.36 | 3.80282e-3 |
| Isoquercetin | 25.317 | 3.63226e-3 | Oriebtin | 25.211 | 3.18802e-3 | Isoquercetin | 25.525 | 3.80282e-3 |
| Oriebtin | 25.424 | 3.63226e-3 | Rutin | 25.391 | 19.83793e-5 | Oriebtin | 25.632 | 3.92426e-3 |
| 1 Rutin | 25.604 | 20.1607e-5 | Isoorientin | 25.531 | 2.45771e-2 | Rutin | 25.812 | 20.45273e-5 |
| Isoorientin | 25.744 | 2.78051e-2 |  |  |  | Isoorientin | 25.952 | 3.07251e-2 |
| **TOTAL= 292.2249** | | | **Total= 279.9585** | | | **Total= 303.3209** | | |

It also shows that the root extract contains the highest amount of flavonoids. The high amounts of flavonoids present in the root suggest its use as an anti-inflammatory, anti-allergic, and anti-cancer agents (Formica and Regelson, 1995; Elekwa, 2015). They are also used as antioxidants (Donnapee, *et al*, 2014) they have equally been showed to possess antihypertensive properties owing to the Quercetin, Kameferol, Rutin and Biochannin contents (Khanavi, *et al*, 2013; Edward, *et al*, 2007, Jonathan, *et al*, 1999).

**Table 3: The comparative amounts of saponins present in the aqueous extracts of the leaves, stem bark, and roots of *H. crepitans.***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Stem Bark** | | | **Leaves** | | | **Roots** | | |
| **SAPONINS** | **RT (Min)** | **AMOUNT [Mg/100g]** | **SAPONINS** | **RT (Min)** | **AMOUNT [Mg/100g]** | **SAPONINS** | **RT (Min)** | **AMOUNT [Mg/100g]** |
| Hispogenin | 14.607 | 2.13563 | Hispogenin | 14.178 | 1.71873 | Hispogenin | 15.012 | 2.45523 |
| Solagenin | 15.835 | 4.93381 | Solagenin | 15.406 | 4.51691 | Solagenin | 16.24 | 5.25341 |
| Diosgenin | 16.346 | 0.78e-2 | Diosgenin | 15.917 | 1.1969 | Diosgenin | 16.751 | 0.4604e-2 |
| Tigogenin | 17.036 | 1.92382 | Tigogenin | 16.607 | 1.50692 | Tigogenin | 17.441 | 2.24342 |
| Neochlorogenin | 17.712 | 10.1403 | Neochlorogenin | 17.283 | 9.72339 | Neochlorogenin | 18.117 | 10.4599 |
| Hecogenin | 18.712 | 3.56772 | Hecogenin | 18.283 | 3.15082 | Hecogenin | 19.117 | 3.88732 |
| Sapogenin | 19.846 | 45.8196 | Sapogenin | 19.417 | 45.4027 | Sapogenin | 20.251 | 46.1392 |
| Tribuloin | 20.478 | 0.0891e-2 | Tribuloin | 20.049 | 0.506e-2 | Tribuloin | 20.883 | 0.23046e-2 |
| Yanogenin | 21.213 | 2.91397 | Yanogenin | 20.784 | 2.49707 | Yanogenin | 21.618 | 3.23357 |
| Conyzorgin | 22.037 | 1.79158 | Conyzorgin | 21.608 | 1.37468 | Conyzorgin | 22.442 | 2.11118 |
| Saponine | 23.541 | 54.1317 | Saponine | 23.112 | 53.7148 | Saponine | 23.946 | 54.4513 |
| **TOTAL= 126.489** | | | **Total= 121.903** | | | **Total= 130.005** | | |

The roots also contain highest amounts of saponins. Saponins are located mainly in the cell membranes of plants. They are known for lowering blood cholesterol level, weight loss and as anti-cancer agents (Elekwa, 2015).

**Table 4: The comparative amounts of phenolic acids present in the aqueous leaf, stem bark and roots of *H. crepitans*.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Stem Bark** | | | **Leaves** | | | **Roots** | | |
| **PHENOLIC** | **RT (Min)** | **AMOUNT [Mg/100g]** | **PHENOLIC** | **RT (Min)** | **AMOUNT [Mg/100g]** | **PHENOLIC** | **RT (Min)** | **AMOUNT [Mg/100g]** |
| 4-hydroxy benazaldehyde | 5.874 | 22.6718 | 4-hydroxy benazaldehyde | 5.5 | 15.7723 | 4-hydroxy benazaldehyde | 5.805 | 23.1396 |
| 4-hydroxy benzoic acid | 9.291 | 19.2944 | 4-hydroxy benzoic acid | 8.717 | 26.2241 | 4-hydroxy benzoic acid | 9.022 | 19.7622 |
| Methyl ester | 10.382 | 70.5792 | Methyl esther | 10.208 | 22.8467 | Methyl esther | 10.513 | 71.047 |
| Vanillic acid | 12.819 | 16.7868 | Vanillic acid | 11.845 | 74.1315 | Vanillic acid | 12.15 | 17.2546 |
| Gallic acid | 13.901 | 88.6713 | Gallic acid | 12.927 | 20.3391 | Gallic acid | 13.232 | 89.1391 |
| Ferullic acid | 15.911 | 12.0994 | Ferulic acid | 14.737 | 92.2236 | Ferulic acid | 15.042 | 12.5672e-1 |
| Capsaicin | 17.937 | 30.6962 | Capsaicin | 16.363 | 15.6517 | Capsaicin | 16.668 | 31.164 |
| Rosmarinic acid | 18.206 | 123.01 | Rosmarinic acid | 17.286 | 34.2485 | Rosmarinic acid | 17.591 | 123.478 |
| Tannic acid | 21.062 | 22.6718 | Tannic acid | 19.288 | 15.7723 | Tannic acid | 19.593 | 23.1396 |
| **TOTAL= 383.809** | | | **Total= 301.438** | | | **Total= 387.551** | | |

The aqueous root extracts equally showed the highest amounts of phenolic acids. Phenolic acids are important medically as antioxidants and anti-inflammatory agents (Liu, *et al*, 2013; Wang, *et al*, 2009).

**Table 5: The comparative amounts of carotenoids present in the aqueous leaf, stem bark and root extracts of *H. crepitans*.**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Stem Bark** | | | **Leaves** | | | **Roots** | | |
| **Carotenoids** | **RT (Min)** | **Amount [Mg/100g]** | **Carotenoids** | **RT (Min)** | **Amount [Mg/100g]** | **Carotenoids** | **RT (Min)** | **Amount [Mg/100g]** |
| Malvidin | 7.992 | 5.008 | Malvidin | 7.139 | 3.96 | Malvidin | 9.858 | 5.421 |
| Cavotene | 9.008 | 46.51 | Cavotene | 8.155 | 47.558 | Cavotene | 10.874 | 46.097 |
| Lycopene | 9.911 | 4.9158 | Lycopene | 9.058 | 3.8678 | Lycopene | 11.777 | 5.3288 |
| Beta-erytoxanthin | 10.832 | 34.101 | Beta-crytoxanthin | 9.979 | 35.149 | Beta-crytoxanthin | 12.698 | 33.688 |
| Lutein | 11.073 | 26.602 | Lutein | 10.22 | 24.65 | Lutein | 12.939 | 23.189 |
| Anther-xanthin | 13.352 | 4.994 | Anther-xanthin | 12.499 | 3.946 | Anther-xanthin | 15.218 | 5.407 |
| Asta-xanthin | 14.085 | 6.29 | Asta-xanthin | 13.232 | 5.242 | Asta-xanthin | 15.951 | 6.703 |
| Viola-xanthin | 14.827 | 18.835 | Viola-xanthin | 13.944 | 19.883 | Viola-xanthin | 16.693 | 18.422 |
| Neo-xanthin | 15.475 | 36.01 | Neo-xanthin | 14.622 | 37.058 | Neo-xanthin | 17.341 | 35.597 |
| Xanthophylls | 12.506 | 33.506 | Xanthophylls | 11.653 | 34.554 | Xanthophylls | 6.419 | 33.093 |
| **TOTAL= 171.356** | | | **Total= 181.836** | | | **Total= 167.226** | | |

The aqueous leaf extract showed the highest amount of carotenoids. Carotenoids are organic pigments found in the chloroplasts and chromoplasts of plants. They function mainly as antioxidants, anti-cancer agents and prevention of cardiovascular diseases. B-carotene- a component of carotenoid has been shown to possess strong anti-hypertensive properties (Hoon, *et al¸*2013; Eric*, et al*, 2011; Megumi, *et al*, 2008).

**Table 6: The comparative amounts of sterols in the aqueous leaf, stem bark and root extracts of *H. crepitans*.**

| **Stem Bark** | | | **Leaves** | | | **Roots** | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sterols** | **RT (Min)** | **Amount [Mg/100g]** | **Sterols** | **RT (Min)** | **Amount [Mg/100g]** | **Sterols** | **RT (Min)** | **Amount [Mg/100g]** |
| Cholesterol | 7.999 | 0.38132 | Cholesterol | 7.629 | 0.2177e-1 | Cholesterol | 8.133 | 0.36474 |
| Cholestanol | 16.093 | 1.254e – 1 | Cholestanol | 15.723 | 1.853 | Cholestanol | 16.227 | 0.5627e-2 |
| Ergosterol | 17.197 | 1.154e – 1 | Ergosterol | 16.827 | 1.753 | Ergosterol | 17.331 | 0.0461e-2 |
| Campesterol | 17.981 | 0.33445 | Campesterol | 17.611 | 0.2646e-1 | Campesterol | 18.115 | 0.0873 |
| Stia-masterol | 18.467 | 1.76637 | Stia-masterol | 18.097 | 1.16737 | Stia-masterol | 18.601 | 0.59029 |
| Savenasterol | 19.667 | 6.29703 | Savenasterol | 19.297 | 5.69803 | Savenasterol | 19.801 | 4.59061 |
| Sitasterol | 20.595 | 0.13872 | Sitasterol | 20.225 | 0.4603e-1 | Sitasterol | 20.729 | 0.10399e-2 |
| **TOTAL= 6.50989** | | | **Total= 2.31689** | | | **Total= 8.05969** | | |

The aqueous root extract showed the highest amount of sterols. Sterols are important class of organic molecules. They occur naturally in plants, animals and fungi. Sterols have been shown to have high efficacy and safety in the management of blood cholesterol levels (Katan, *et al*, 2003; Harland, 2012). This shows their role in preventing cardiovascular diseases. Also, it has been shown to relieve prostrate by reducing the symptoms of benign prostatic hyperplasia such as frequent urination, urgency and incomplete voiding. Plant sterols and sterols appear to be capable of selectively enhancing the activity of beneficial immune cells, while inhibiting the response of those that cause inflammation and chronic diseases (Shailendra, 2008).

**Table 7: The comparative amounts of Terpenes present in the aqueous leaf, stem bark and root extracts of *H. crepitans*.**

| **Stem Bark** | | | **Leaves** | | | **Roots** | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Terpenes** | **RT (Min)** | **Norm (%)** | **Terpenes** | **RT (Min)** | **Norm (%)** | **Terpenes** | **RT (Min)** | **Norm (%)** |
| Alpha Pinene | 7.784 | 8.33339 | Alpha Pinene | 7.264 | 7.42319 | Alpha Pinene | 8.342 | 8.67919 |
| Beta Pinene | 9.142 | 30.966 | Beta Pinene | 8.622 | 30.0558 | Beta Pinene | 9.7 | 31.3118 |
| CIS Ocimene | 9.546 | 0.84897 | CIS Ocimene | 9.026 | 0.0612 | CIS Ocimene | 10.104 | 1.19477 |
| Myrcene | 10.355 | 0.1753 | Myrcene | 9.835 | 1.0855 | Myrcene | 10.913 | 0.17048 |
| Allo Ocimene | 10.597 | 0.56338 | Allo Ocimene | 10.077 | 0.3468 | Allo Ocimene | 11.155 | 0.90918 |
| Limonene | 11.000 | 0.1356 | Limonene | 10.48 | 1.0458 | Limonene | 11.558 | 0.21021 |
| Camphene | 11.458 | 0.1091 | Camphene | 10.938 | 1.0193 | Camphene | 12.016 | 0.23669 |
| Sabinene | 11.834 | 0.3975 | Sabinene | 11.314 | 1.3077 | Sabinene | 12.392 | 0.0517 |
| Alpha thujene | 12.362 | 0.3257 | Alpha thujene | 11.842 | 1.2359 | Alpha thujene | 12.92 | 0.02013 |
| Camphor | 12.989 | 0.3965 | Camphor | 12.469 | 1.3067 | Camphor | 13.547 | 0.0507 |
| Neral | 13.252 | 0.4018 | Neral | 13.005 | 1.312 | Neral | 14.083 | 0.056 |
| 1, 8 – cineole | 13.741 | 8.88795 | 1, 8 – cineole | 13.221 | 7.97775 | 1, 8 – cineole | 14.299 | 9.23375 |
| Borneol | 14.197 | 0.4084 | Borneol | 13.677 | 1.3186 | Borneol | 14.755 | 0.0626 |
| Linalool | 14.3 | 14.1414 | Linalool | 13.78 | 13.2312 | Linalool | 14.858 | 14.4872 |
| Neril (gemaniol) | 14.651 | 31.2243 | Nerol (geraniol) | 14.131 | 30.3141 | Nerol (geraniol) | 15.209 | 31.5701 |
| Alpha terpineol | 14.851 | 0.4042 | Alpa terpineol | 14.331 | 1.3144 | Alpha terpineol | 15.409 | 0.0584 |
| Terpinen-4-01 | 15.125 | 0.4017 | Terpinen-4-01 | 14.605 | 1.3119 | Terpinen-4-01 | 15.683 | 0.0559 |
| Citronellol | 15.572 | 0.3949 | Citronellol | 15.052 | 1.3051 | Citronellol | 16.13 | 0.0491 |
| Ethyl Cimnamiate | 15.857 | 0.18974 | Ethyl Cimnamiate | 15.337 | 0.7205 | Ethyl Cimnamiate | 16.415 | 0.53554 |
| Bomeol acetate | 16.224 | 0.1074 | Bomeol acetate | 15.704 | 1.0176 | Bomeol acetate | 16.782 | 0.23838 |
| Neryl acetate | 16.897 | 0.4085 | Neryl acetate | 16.377 | 1.3187 | Neryl acetate | 17.455 | 0.0627 |
| Geranyl acetate | 17 | 0.4085 | Geranyl acetate | 16.48 | 1.3187 | Geranyl acetate | 17.558 | 0.0627 |
| Tarateron | 17.853 | 0.4069 | Tarateron | 17.333 | 1.3171 | Tarateron | 18.411 | 0.0611 |
| Alpha amyrin | 18.945 | 0.4094 | Alpha amyrin | 17.93 | 1.3196 | Alpha amyrin | 19.008 | 0.0636 |
| Beta amyrin | 18.945 | 0.4083 | Beta amyrin | 18.425 | 1.3185 | Beta amyrin | 19.503 | 0.0625 |
| Lupeol | 19.315 | 0.411 | Lupeol | 18.795 | 1.3212 | Lupeol | 19.873 | 0.0652 |
| Alpha Bergamotere | 19.97 | 0.1471 | Alpha Bergamotene | 19.45 | 1.0573 | Alpha Bergamotere | 20.528 | 0.19875 |
| **TOTAL = 88.8975** | | | **TOTAL= 64.3221** | | | **Total= 98.2341** | | |

The aqueous root extract showed the highest amount of terpenes. Terpenes are a large and diverse class of organic compounds that are protective in function. They are major constituents of plant resins and essential oils extracted from such plants. Terpenes have found its uses both industrially and medically. For instance, they are used industrially in the manufacture of perfumes, insect repellents, cosmetics, cleaners and air fresheners. It equally has found wide application as an antiseptic because of its anti-microbial properties as well as in thes treatment of fungal skin infection (Isman, 2000; Boutanaev, *et al*, 2015).

**Conclusion**

The phytochemical screening of the aqueous leaf, stem bark and roots extracts of *Hura crepitans* have been shown that these parts of *Hura crepitans* are very rich in various phytochemicals. This plant owing to its vast phytochemicals can be evaluated further to ascertain its potential use in the treatment of various ailments as claimed by herbalists and can as well find its relevance as a potential cheap, easy accessible and available source of local raw materials.

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