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# Phytochemical and Antinematodal Screening on Water Extracts of Some Plant Wastes against *Meloidogyne incognita*

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**Abstract:**

Fifty five plant wastes belonging to eight plants (Scientific names: *Mosa spp., Punica granatum, Corchorus olitorius, Solanum melongena, Solanum tuberosum, Phoenix dactylifera, Cucumis melo* and *Zea mays*) (English names: Banana, Pomegranates, Molokheya, Eggplants, Potato, Date palm, Cantaloupe and Corn) were tested for their nematicidal activity against root knot nematode juveniles (*Meloidogyne incognita*) under lab conditions, preliminary phytochemical screening were carried out on these samples also. Freshly hatched infected stage juveniles were subjected to water extracts of different fresh (F) and dry samples (D) of plant wastes belonging to the studied plants. Results reveled that, all tested extracts possessed nematotoxic effects as they achieved mortality percentage varies between 28,54 to 100%. Twelve extracts showed 100% mortality {1. Molokheya stem D, 2. Eggplant peels D, 3. Potato peels D, 4. Potato peels F, 5. Cantalopue peels D, 6. Cantalopue peels F, 7. Mixture of Molokheya (roots and stems) D, 8. Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders) D, 9. Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders)+ Molokheya (roots and stems) + Corn (silk and leaves) + Pomegranate peels D, 10., Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders) + Molokheya (roots and stems) + Corn (silk and leaves)+ Pomegranate peels + Eggplant peels D, 11. Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders) + Molokheya (roots and stems) + Corn (silk and leaves) + Pomegranate peels + Eggplant peels + Potato peels D, 12. Mixture of Banana (leaves and peels) + Date Palm (leaves and fruit holders) + Molokheya (roots and stems) + Corn (silk and leaves) + Pomegranate peels + Eggplant peels + Potato peels + Cantalopue peels F}. Results revealed that, all studied extracts of these plant wastes containing carbohydrates and/or glycosides, anthraquinones, flavonoids, tannins, saponins, alkaloids, unsaturated sterols and/or triterpenoids, coumarins, sublimable substances, chlorides, sulphates, iridoids and cardiac glycosides, with special reference to extracts with high nematicidal activity. Results showed very strong relationship between the phytochemical composition and nematicidal activity of these studied extracts. These results offer untraditional nematicidal tool and also for cleaning the environment from unused plant wastes. *In vivo* evaluation of tested plant wastes is needed to ensure their effects on nematode suppression before the preparation of some formulations for field application.

**Key words: Plant extracts, Plant wastes, Nematicidal activity, Preliminary Phytochemical Screening.**

## 1. INTRODUCTION

Nematode attacking plants are one of the most devastating pathogens that threat agriculture production all over the world individually or combined with other soil borne pathogens, fungi, bacteria and viruses, casing severs losses. root-knot nematode (*Meloidogyne* spp.) topped all nematode genera in their undesirable impacts in plant production throughout the globe; they are considered the most important group of phytoparasitic nematodes worldwide attacking nearly every crop and affecting quantity and quality of the crop production (Pavaraj *et al.,* 2012 & Karajeh, 2015).

The impact of the *Meloidogyne* species become huge by their wide host ranges of more than five thousands plant species (Trudgill & Blok, 2001). Chemical control is the easiest tool for controlling plant feeding nematodes, but their used become restricted for many reasons; expensive, adverse impacts on environment and human healthy rather than many effective compound were panned. A few nematicides are available and are economically viable only for high value crops and create a potential hazard to the ecosystem (Tsay *et al.,* 2004). Plant wastes represent an environmental problem in many cases as recycling them are not adopted procedure

or popular culture especially in many developed countries. Many plant wastes contain different bioactive compounds also when added to the soil increase its fertility, raising organic matter content, enhancing anti-microbial activity as well as plant productivity in general (Mercy *et al.,* 2014). The employing of plant organic amendments (green manures, crop residues and decomposed plant tissues for nematode suppression) was previously trended by many investigators (Manneh *et al.,* 2016 and Ribeiro and Lima, 2012).

Various naturally occurring plant compounds were tested as components of organic amendments (or bio-fumigation), as extracts or as standalone substances, in many trails to develop alternatives to traditional nematicides (Ntalli *et al*., 2017).

Many plants have been tested for their nematicidal activities. Using plant extracts for managing nematode pests was used before this study, but using plant wastes considered as a valuable antinematodal tool as they are cheap, ecofriendly and easy to manipulate by many farmers. The addition of organic material to the soil can be an effective alternative to the environmentally unsafe chemical treatments that are used to control plant parasitic nematodes (Marek and Peter, 2015).

Some of fruit peels such as: Lemmon, Orange, Grapefruit, Banana and Pomegranate peels etc., are used to kill the nematodes (El-Gayed *et al.*, 2017, Mercy *et al.,* 2014, Jyotsna *et al.,* 2014, Abolusoro *et al.,* 2010 and Tsai, B. Y., 2008). This study is aimed to evaluate the nematicidal effects of water extracts of different plant wastes in separate or mixed form against root-knot nematode *Meloidogyne incognita* in addition to preliminary phytochemical screening of these extracts.

## 2. MATERIAL AND METHODS

### 2.1. Sample collection:

Wastes of several plants were collected from different places in Cairo, Egypt (vegetable and fruits markets or groceries, juice factories and home wastes).

**Table – 1: List of studied plants and used parts in these experiments:**

| Scientific name | English name | Part used |
|---|---|---|
| *Mosa spp.* | Banana | Leaves petioles, Leaves blades, Fruit peels |
| *Punica granatum* | Pomegranates | Fruit peels |
| *Corchorus olitorius* | Molokheya | Stems, Roots |
| *Solanum melongena* | Eggplants | Fruit peels |
| *Solanum tuberosum* | Potato | Tuber peels |
| *Phoenix dactylifera* | Date palm | Leaves petioles, Leaves blades, Fruit holders |
| *Cucumis melo* | Cantaloupe | Fruit peels |
| *Zea mays* | Corn | Corn silks, Corn leaves |

### 2. 2. Preparation of water extracts:

Plant materials were cleaned, air dried, extracted by hot water, then filtered, these extracts (1 ml of each extract = 50 mg/Dry Weight or Fresh Weight) were studied for their nematicidal activity and preliminary phytochemical screening were carried out on these extracts also (Alam, A.E., 2019).

### 2.3. Preliminary Phytochemical Screening:

#### 2.3.1. Carbohydrates and/ or Glycosides:

The ethanolic extract (5ml) was mixed with 0.5 ml of ethanolic α- naphthol reagent, then 1ml of sulphuric acid was carefully poured on the walls of the test tube. A violet ring was formed at the interface indicating the presence of carbohydrates and/or glycosides (Stank *et al.,* 1963).

#### 2.3.2. Saponins:

Saponins were determined according to the methods adopted by Hungund and Pathak, (1971).

***a-Forth test:***

About 3 grams of the dried sample were extracted with boiling water then filtered. After cooling, the aliquot was shacked vigorously until forth was obtained, then allowed to stand for 15-20 minutes and classified according to their saponin contents (No forth means negative, forth

less than 1Cm height = weakly positive and forth 1-2 Cm or higher means positive).

***b-Blood hemolysis test:***

About 5 grams of the dried sample were extracted with hot ethanol (95%). One ml aliquot portion was added to 10 ml of 1:4 suspensions of erythrocytes in physiological saline solution and hemolysis was observed indicating the presence of saponins.

**2.3.3. Tannins:**

*A*bout 5 grams of the dried sample were extracted with ethanol (50%) and filtered. The addition of ferric chloride reagent to the filtrate gave a green color, then changed to a bluish black color or precipitate indicates the presence of tannins (Trease and Evans, 1978).

**2.3.4. Unsaturated sterols and/or Triterpenes:**

The alcoholic extract (corresponding to 2 grams of the dried sample) was evaporated. The residue was treated with anhydrous chloroform (10 ml) and filtered; the filtrate was divided into two portions and subjected to the following reactions:

***a-Liebermann- Burchardt's test:***

To the first portion, 1 ml of acetic anhydride was added, followed by 2 ml of $H_2SO_4$ down on the wall of the test tube. If a reddish - violet ring was produced at the junction of two layers, then the solution become bluish- green in color in the acetic acid layer it indicates the presence of unsaturated sterols and / or triterpenes (Claus, 1967).

***b-Salkowiskit's test:***

To the second portion, an equal volume of sulphuric acid was added, if a red color was produced it indicates the presence of unsaturated sterols and/or triterpenes (Schmidt, 1964).

**2.3.5. Alkaloids and/or Nitrogenous bases:**

About 10 grams of the dried sample were extracted with 100 ml of dilute hydrochloric acid. The acidic extract was filtered, adjusted to be alkaline with ammonium hydroxide solution and extracted with chloroform. The chloroformic extract was evaporated to dryness and the residue was dissolved in about 2 ml of hydrochloric acid. The acidic solution gave faint brown precipitate with Wagner's reagent {1.3 grams of Iodine, 2 grams of Potassium iodide, dissolved in 100 ml dist. water} and very slight yellow precipitate with Mayer's reagent {1.36 grams of Mercuric chloride, 5 grams of Potassium iodide, dissolved in 100 ml dist. water }(Shellard, 1957).

**2.3.6. Cardiac glycosides:**

About 2 grams of the dried sample were boiled with 15 ml of 70 % methyl alcohol for five minutes and filtered. The filtrate was diluted with distilled water and 0.5 ml of concentrated solution of lead acetate was added (to remove chlorophyll and other pigments) and filtered, to remove the excess of lead acetate, $H_2SO_4$ (10%) was added drop wise until no further precipitate was formed, then filtered. The filtrate was extracted with 10 ml chloroform. The chloroform extract was evaporated to dryness and the following tests were carried out according to Balbaa *et al*., (1981).

***a-Killer –Kiliani test :***

About 1ml of ferric chloride solution (3.5 %) in glacial acetic acid was added to one portion of chloroform residue and left, concentrated sulfuric acid was added carefully down the wall of the test tube. On standing, a brown or red layer appeared at the interface (due to the aglycone) and the upper acetic acid layer becomes blue to green (due to desoxy sugar).

***b-Kedde's reaction:***

To another portion of the chloroform residue, 3.5-dinitrobenzoic acid (2%) in 90% methanol and one drop of NaOH (2%) were added. The solution acquired a violet color on standing.

***c- Libermann's reaction:***

The third portion of the chloroform residue was dissolved in glacial acetic acid, then acetic anhydride (2 ml) was added. Concentrated $H_2SO_4$ was added carefully down the wall of the test tube. On standing, two layers were afforded, pink color (upper layer) and green color (lower layer).

**2.3.7. Flavonoids:**

About 5 grams of the dried sample were soaked for one day with 150 ml of 1% HCl and filtered. The filtrate was tested for flavonoid compounds as follows:

About 10 ml of the filtrate were adjusted to be alkaline with sodium hydroxide. The formation of a yellow color indicates the presence of flavonoids. About 5 ml of the filtrate were mixed with 5ml HCl and small pieces of magnesium metal (0.5 g). The formation of red color after 3 minutes, indicates the presence of flavonoids (Mabry *et al* ., 1970).

**2.3.8. Anthraquinones:**

About 2 grams of the dried sample were boiled for few minutes with 0.5 N KOH (10 ml) to which 1ml of diluted $H_2O_2$ was added. After cooling, the mixture was filtered and acidified, then extracted with benzene (10 ml). The benzene

extract was shacked with $NH_4OH$ (5ml). The presence of anthraquinones was indicated by the formation of red color in the alkaline layer (Farnsworth *et al.,* 1969).

**2.3.9. Coumarins:**

A small amount (5 g) of the moistened dried sample was placed in a test tube that covered with a filter paper moistened with diluted NaOH (0.1 N) solution. The tube was then removed and examined under U.V. light and any fluorescence is indicated for the presence of coumarins (Feigl, 1960).

**2.3.10. Irodoids:**

About 2 grams of fresh samples were cut into small pieces and placed in a test tube with 5 ml of 1% aqueous HCl. After 3-6 hours, 0.1 ml of the macerate was decanted into another tube containing 1 ml of the Trim and Hill reagent (10 ml acetic acid, 1 ml 0.2 % Cu $SO_4$ in water and 0.5 ml conc. HCl). When the tube is heated for a short time on a flame, a blue color is produced if a certain irodoid is present (Weiffering, 1966).

**2.3.11. Chlorides and Sulphates:**

Chlorides and Sulphates were determined according to the methods adopted by Islam *et al*., (1993).

***a-Chlorides:***

Silver nitrate solution gives with a solution containing chlorides a white flocculent precipitate of silver chloride which dissolves in ammonium hydroxide solution and does not dissolve in dilute nitric acid.*Note*: The color of the precipitate changes gradually in direct sunlight to violet.

***b-Sulphates:***

Barium chloride solution gives a white precipitate of barium sulphate which does not dissolve in mineral acids.

2.**3.12. Sublimation:**

One gram of each sample was carefully subjected to microsublimation in dry crucible, covered with a clean slide. Dark yellowish-brown fumes were evolved and condensed on the lower surface of a slide as a dark brown oily condensate which dissolved in potassium hydroxide solution producing red color indicating the presence of anthraquinons ( Afifi, 1972).

**2.4. Nematicidal activity of the plant wastes extracts:**

To study the effect of different water extracts of each plant wastes on mortality of root gall nematode, pure cultures of *Meloidogyne incognita* were maintained on tomato (*Lycopersicon esculentum* Mill.) roots in earthen pots in the greenhouse of Plant Protection Department (Desert research center, Cairo, Egypt). Second-stage juveniles ($J_2S$) were obtained from hatched eggs by incubating handpicked egg masses in sterile distilled water at 28°C. Then 2 ml of each extract was poured in a 5 cm diameter - Petri plates and about 100 freshly hatched $J_2S$ of *M. incognita* were placed in each petri dish. Juveniles kept in sterile distilled water to check what is happened, all dishes were incubated at 27°C., after 24 hours dead and alive nematodes in each plate were counted with stereo microscope (Meiji 40X) also microscope (150X) was used for detailed investigation of immobile $J_2S$. Percentage of nematodes mortality was calculated according to this formula; *Mortality percentage (M %) = [(No. of dead juveniles)/(No. of dead+ live juveniles)] x 100*. The juveniles were considered dead if they remain static or immobile (paralyzed) after probing them with a fine needle (Cayrol *et al.,* 1989; Abbasi *et al.,* 2008). The recovery test was done by transferring juveniles to distillated water then their mobility was checked after 24 hrs, the immobile larvae were considered dead (permanent death). Each treatment was replicated four times and the experiment was repeated three times as described above without any modification.

**2.5. Statistical analysis:**

The differences between means were tested using Duncan's Multiple ranged test at the 5% significance level (Duncan's, 1955). Each treatment was replicated four times and the experiment was repeated three times as described above without any modification.

**3. RESULTS**

**3.1. Nematicidal Activity of Water Extracts of Plant Wastes under Investigation:**

Fifty five plant wastes belonging to eight plants (Scientific names: *Mosa spp.*, *Punica granatum, Corchorus olitorius, Solanum melongena, Solanum tuberosum, Phoenix dactylifera, Cucumis melo* and *Zea mays*) (English names: Banana, Pomegranates, Molokheya, Eggplants, Potato, Date palm, Cantaloupe and Corn) were tested for their nematicidal activity against root knot nematode juveniles, *Meloidogyne incognita*, under lab conditions. Freshly hatched infected stage juveniles were subjected to water extracts of different fresh (F) and dry samples (D) of plant wastes belonging to these studied plants. Results reveled that, all tested extracts possessed nematotoxic effects as they achieved mortality percentage varies between 28,54 to 100%.

Twelve extracts showed 100% mortality (1. Molokheya stem D, 2. Eggplant peels D, 3. Potato peels D, 4. Potato peels F, 5. Cantalopue peels D, 6. Cantalopue peels F, 7. Mixture of Molokheya (roots and stems) D,8. Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders) D, 9. Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders) + Molokheya (roots and stems)+ Corn (silk and leaves) + Pomegranate peels D,10., Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders)+Molokheya (roots and stems) + Corn (silk and leaves) + Pomegranate peels + Eggplant peels D, 11. Mixture of Banana (leaves and peels) + Date Palm (leaves and fruit holders) + Molokheya (roots and stems)+ Corn (silk and leaves)+ Pomegranate peels+ Eggplant peels + Potato peels D, 12. Mixture of Banana (leaves and peels) + Date Palm (leaves and fruit holders)+ Molokheya (roots and stems) + Corn (silk and leaves) + Pomegranate peels + Eggplant peels + Potato peels + Cantalopue peels F.

In this regard, another twelve extracts showed 50% mortality and more (1. Date Palm leaves blades D (96.00 %), 2.Date Palm leaves petioles D (94.00 %), 3. Mixture of Banana leaves and peels and Date Palm leaves D (93.00 %), 4. Date Palm fruit holders D (85.00%). 5. Banana peels F (78 %), 6. Mixture of Banana leaves and peels and Date Palm leaves F (77.00 %), 7. Banana peels D (74 %), 8. Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) and Corn (silks and leaves) and Eggplant peels D (60.30 %), 9. Corn leaves D (60.00 %), 10. Mixture of Date Palm leaves blades and petioles D (58.00 %), 11. Date Palm fruit holders F (55.00%) and 12. Corn silks D (50.00 %)) (Table. 2 and Fgure.1).

**Table – 2: Nematicidal Activity of Water Extracts of Plant Wastes of Plants under Investigation against *Meloidogyne incognita* juveniles**

| Sample Number | Plant extracts | No. of dead juveniles /100 juveniles | Mortality (%) |
|---|---|---|---|
| S1 | Banana leaves blades D | 32.00 mn | 32.00 |
| S2 | Banana leaves petioles D | 11.70 s | 11.70 |
| S3 | Mixture of Banana leaves (blades + petioles) D | 26.30 p | 26.30 |
| S4 | Date palm leaves blades D | 96.00 b | 96.00 |
| S5 | Date palm leaves petioles D | 94.30 c | 94.30 |
| S6 | Mixture of Date palm leaves (blades and petioles) D | 58.00 h | 58.00 |
| S7 | Mixture of Banana and Date palm leaves (blades and petioles) D | 18.00 r | 18.00 |
| S8 | Banana leaves petioles F | 20.30 q | 20.30 |
| S9 | Banana leaves blades F | 5.30 uv | 5.30 |
| S10 | Mixture of Banana leaves (blades + petioles) F | 3.30 wxy | 3.30 |
| S11 | Banana peels D | 74.30 f | 74.30 |
| S12 | Date palm leaves blades F | 8.70 t | 8.70 |
| S13 | Date palm leaves petioles F | 5.00 uvw | 5.00 |
| S14 | Mixture of Date palm leaves (blades and petioles) F | 42.30 k | 42.30 |
| S15 | Mixture of Banana and Date palm leaves (blades and petioles) F | 3.30 wxy | 3.30 |
| S16 | Banana peels F | 78.30 e | 78.30 |
| S17 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm leaves (blades and petioles) F | 77.30 e | 77.30 |
| S18 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm leaves (blades and petioles) D | 93.30 c | 93.30 |

Table.2:(Continued)

| | | | |
|---|---|---|---|
| S19 | Date palm fruits holders F | 55.00 i | 55.00 |
| S20 | Date palm fruits holder D | 85.70 d | 85.70 |
| S21 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) F | 25.00 p | 25.00 |
| S22 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) D | 100.00 a | 100.00 |
| S23 | Pomgrante peels F | 42.70 k | 42.70 |
| S24 | Pomgrante peels D | 1.00 zA | 1.00 |
| S25 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels F | 43.00 k | 43.00 |
| S26 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels D | 20.00 q | 20.00 |
| S27 | Mixture of Date palm (leaves blades, leaves petioles and fruits holders) F | 28.70 o | 28.70 |
| S28 | Mixture of Date palm (leaves blades, leaves petioles and fruits holders) D | 25.00 s | 25.00 |
| S29 | Molokheya stems F | 3.00 AB | 3.00 |
| S30 | Molokheya roots F | 4.00 xyzA | 4.30 |
| S31 | Mixture of Molokheya stems and roots F | 3.30 zAB | 3.00 |
| S32 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) F | 17.30 u | 17.30 |
| S33 | Corn silk F | 6.00 x | 6.00 |
| S34 | Corn leaves F | 2.30 BC | 2.30 |
| S35 | Mixture of Corn silks and corn leaves F | 3.70 yzAB | 3.70 |
| S36 | Eggplant peels F | 2.00 BC | 2.00 |
| S37 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) and Corn (Silk and leaves) and Eggplant peels F | 30.30 op | 30.40 |
| S38 | Molokheya stem D | 100.00 a | 100.00 |
| S39 | Molokheya root D | 40.00 m | 40.30 |
| S40 | Mixture of Molokheya stems and roots D | 100.00 a | 100.00 |
| S41 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) D | 100.00 a | 100.00 |
| S42 | Corn silk D | 32.00 no | 32.00 |
| S43 | Corn leaves D | 60.00 h | 60.00 |

Table.2:(Continued)

| | | | |
|---|---|---|---|
| S44 | Mixture of Corn silks and corn leaves D | 50.30 k | 50.30 |
| S45 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) and Corn (silks and leaves) D | 100.00 a | 100.00 |
| S46 | Eggplant peels D | 100.00 a | 100.00 |
| S47 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) and Corn (silks and leaves) and Eggplant peels D | 60.30 h | 60.30 |
| S48 | Potato peel F | 31.00 no | 31.00 |
| S49 | Potato peel D | 100.00 a | 100.00 |
| S50 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) and Corn (silks and leaves) and Eggplant peels and Potato peels F | 1.00 CD | 1.00 |
| S51 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) and Corn (silks and leaves) and Eggplant peels and Potato peels D | 100.00 a | 100.00 |
| S52 | Cantaloupe peel F | 100.00 a | 100.00 |
| S53 | Cantaloupe peel D | 100.00 a | 100.00 |
| S54 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) and Corn (silks and leaves) and Eggplant peels and Potato peels and Cantaloupe peels F | 100.00 a | 100.00 |
| S55 | Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) and Corn (silks and leaves) and Eggplant peels and Potato peels and Cantaloupe peels D | 33.00 n | 33.00 |
| Control | | 0.00 D | 0.00 |

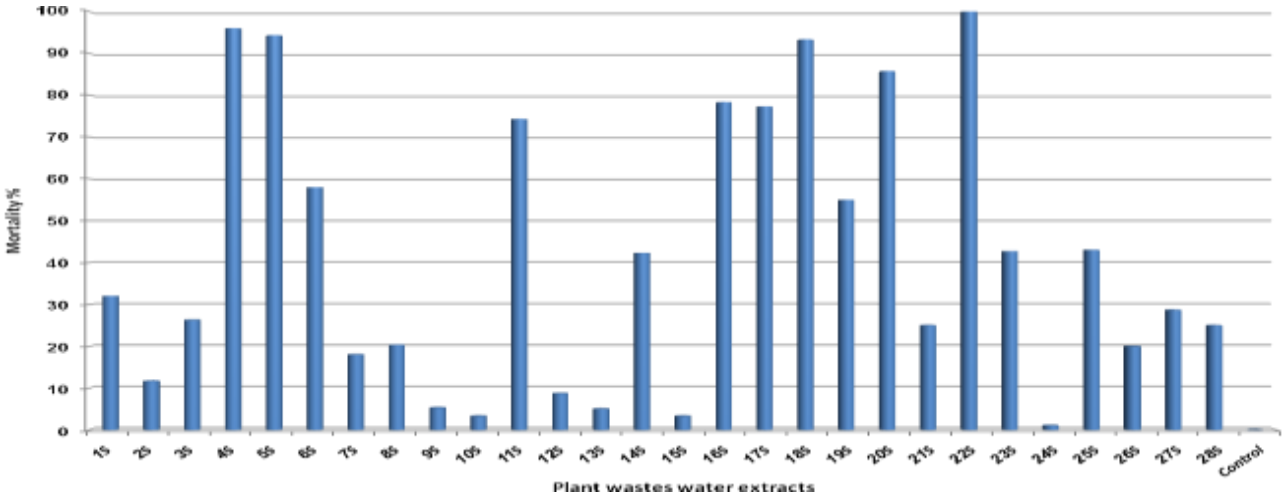


**Figure – 1: Mortality percentage of root knot nematode juveniles affected by various water extracts of plant wastes of plants under investigation.**

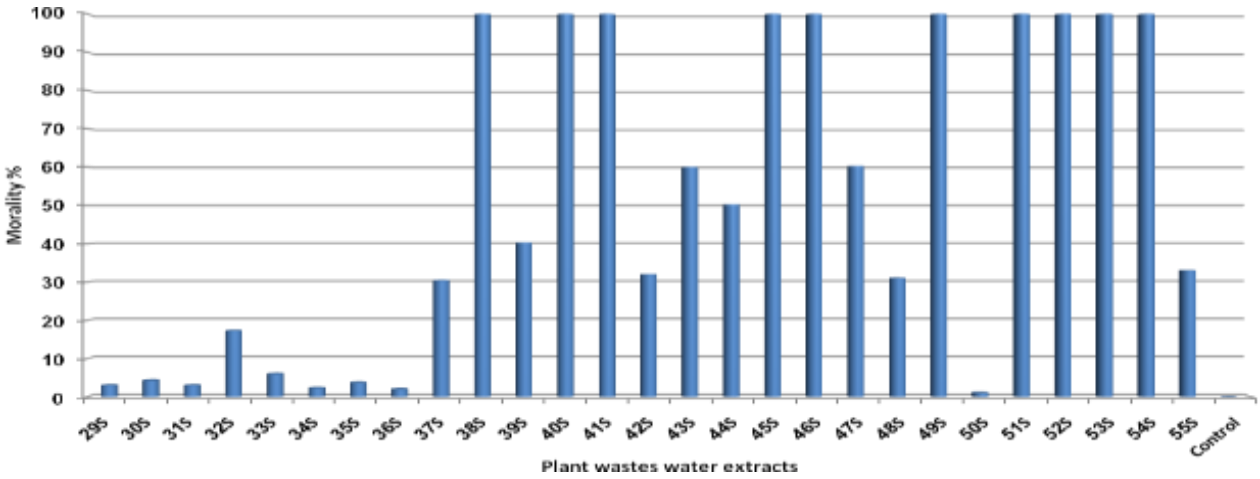


**Figure – 1: Continued. Mortality percentage of root knot nematode juveniles affected by various water extracts of plant wastes of plants under investigation.**

### 3.2. Preliminary Phytochemical Screening of Water Extracts of Plant Wastes under Investigation:

Preliminary phytochemical screening of water extracts of fifty five plant wastes belonging to eight plants (Scientific names: *Mosa spp.*, *Punica granatum, Corchorus olitorius, Solanum melongena, Solanum tuberosum, Phoenix dactylifera, Cucumis melo* and *Zea mays*) (English names: Banana, Pomegranates, Molokheya, Eggplants, Potato, Date palm, Cantaloupe and Corn).

Results revealed that, all studied extracts of these plant wastes containing carbohydrates and/or glycosides, anthraquinones, flavonoids, tannins, saponins, alkaloids, unsaturated sterols and/or triterpenoids, coumarins, sublimable substances, chlorides, sulphates, iridoids and cardiac glycosides, with special reference to extracts with high nematicidal activity. Results showed very strong relationship between the phytochemical composition and nematicidal activity of these studied extracts (Tables. 3-11).

Table - 3: Preliminary Phytochemical Screening of Water Extracts of Plant Wastes of Plants under Investigation.

| Experiment | Leaf Blades of Banana | | Leaf Petioles of Banana | | Peels of Banana | Fruits of Banana |
|---|---|---|---|---|---|---|
| | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples |
| 1-Carbohydrates and/or Glycosides | + | + | + | + | ++ | ++ |
| 2-Tannins | + | + | + | + | ++ | ++ |
| 3-Anthraquinones | + | + | + | + | ++ | ++ |
| 4-Sublimation | + | + | + | + | ++ | ++ |
| 5-Flavonoids | + | + | + | + | ++ | ++ |
| 6-Unsaturated sterols and/or Triterpenoids | + | + | + | + | ++ | ++ |
| 7-Alkaloids | + | + | + | + | ++ | ++ |
| 8- Saponins | + | + | + | + | ++ | ++ |
| 9-Cardiac Glycosides | + | + | + | + | ++ | ++ |
| 10-Iridoids | + | + | + | + | ++ | ++ |
| 11-Chlorides | + | + | + | + | ++ | ++ |
| 12-Sulphates | + | + | + | + | ++ | ++ |

Table - 4: Preliminary Phytochemical Screening of Water Extracts of Plant Wastes of Plants under Investigation (Continued).

| Experiment | Leaf Blades of Date Palm | | Leaf Petioles of Date Palm | | Fruits Holders of Date Palm | |
|---|---|---|---|---|---|---|
| | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples |
| 1-Carbohydrates and/or Glycosides | +++ | + | +++ | + | +++ | ++ |
| 2-Tannins | +++ | + | +++ | + | +++ | ++ |
| 3-Anthraquinones | +++ | + | +++ | + | +++ | ++ |
| 4-Sublimation | +++ | + | +++ | + | +++ | ++ |
| 5-Flavonoids | +++ | + | +++ | + | +++ | ++ |
| 6-Unsaturated sterols and/or Triterpenoids | +++ | + | +++ | + | +++ | ++ |
| 7-Alkaloids | +++ | + | +++ | + | +++ | ++ |
| 8- Saponins | +++ | + | +++ | + | +++ | ++ |
| 9-Cardiac Glycosides | +++ | + | +++ | + | +++ | ++ |
| 10-Iridoids | +++ | + | +++ | + | +++ | ++ |
| 11-Chlorides | +++ | + | +++ | + | +++ | ++ |
| 12-Sulphates | +++ | + | +++ | + | +++ | ++ |

Table - 5: Preliminary Phytochemical Screening of Water Extracts of Plant Wastes of Plants under Investigation (Continued).

| Experiment | Corn Silk | | Corn Leaves | | Eggplant Peels | |
|---|---|---|---|---|---|---|
| | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples |
| 1-Carbohydrates and/or Glycosides | + | + | ++ | + | +++ | + |
| 2-Tannins | + | + | ++ | + | +++ | + |
| 3-Anthraquinones | + | + | ++ | + | +++ | + |
| 4-Sublimation | + | + | ++ | + | +++ | + |
| 5-Flavonoids | + | + | ++ | + | +++ | + |
| 6-Unsaturated sterols and/or Triterpenoids | + | + | ++ | + | +++ | + |
| 7-Alkaloids | + | + | ++ | + | +++ | + |
| 8- Saponins | + | + | ++ | + | +++ | + |
| 9-Cardiac Glycosides | + | + | ++ | + | +++ | + |
| 10-Iridoids | + | + | ++ | + | +++ | + |
| 11-Chlorides | + | + | ++ | + | +++ | + |
| 12-Sulphates | + | + | ++ | + | +++ | + |

Table - 6: Preliminary Phytochemical Screening of Water Extracts of Plant Wastes of Plants under Investigation (Continued).

| Experiment | Molokheya Stems | | Molokheya Roots | | Pomgrante Peels | |
|---|---|---|---|---|---|---|
| | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples |
| 1-Carbohydrates | +++ | + | +++ | + | + | ++ |
| 2-Tannins | +++ | + | +++ | + | + | ++ |
| 3-Anthraquinones | +++ | + | +++ | + | + | ++ |
| 4-Sublimation | +++ | + | +++ | + | + | ++ |
| 5-Flavonoids | +++ | + | +++ | + | + | ++ |
| 6-Unsaturated sterols and/or Triterpenoids | +++ | + | +++ | + | + | ++ |
| 7-Alkaloids | +++ | + | +++ | + | + | ++ |
| 8- Saponins | +++ | + | +++ | + | + | ++ |
| 9-Cardiac Glycosides | +++ | + | +++ | + | + | ++ |
| 10-Iridoids | +++ | + | +++ | + | + | ++ |
| 11-Chlorides | +++ | + | +++ | + | + | ++ |
| 12-Sulphates | +++ | + | +++ | + | + | ++ |

Table - 7: Preliminary Phytochemical Screening of Water Extracts of Plant Wastes of Plants under Investigation (Continued).

| Experiment | Potato Peels | | Cantaloupe Peels | |
|---|---|---|---|---|
| | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples |
| 1-Carbohydrates and/or Glycosides | +++ | + | +++ | +++ |
| 2-Tannins | +++ | + | +++ | +++ |
| 3-Anthraquinones | +++ | + | +++ | +++ |
| 4-Sublimation | +++ | + | +++ | +++ |
| 5-Flavonoids | +++ | + | +++ | +++ |
| 6-Unsaturated sterols and/or Triterpenoids | +++ | + | +++ | +++ |
| 7-Alkaloids | +++ | + | +++ | +++ |
| 8- Saponins | +++ | + | +++ | +++ |
| 9-Cardiac Glycosides | +++ | + | +++ | +++ |
| 10-Iridoids | +++ | + | +++ | +++ |
| 11-Chlorides | +++ | + | +++ | +++ |
| 12-Sulphates | +++ | + | +++ | +++ |

Table - 8: Preliminary Phytochemical Screening of Water Extracts of Plant Wastes of Plants under Investigation (Continued).

| Experiment | Mixture of Banana Leaves (Blades and Petioles) | | Mixture of Banana (Leaves and Peels) | |
|---|---|---|---|---|
| | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples |
| 1-Carbohydrates and/or Glycosides | + | + | + | + |
| 2-Tannins | + | + | + | + |
| 3-Anthraquinones | + | + | + | + |
| 4-Sublimation | + | + | + | + |
| 5-Flavonoids | + | + | + | + |
| 6-Unsaturated sterols and/or Triterpenoids | + | + | + | + |
| 7-Alkaloids | + | + | + | + |
| 8- Saponins | + | + | + | + |
| 9-Cardiac Glycosides | + | + | + | + |
| 10-Iridoids | + | + | + | + |
| 11-Chlorides | + | + | + | + |
| 12-Sulphates | + | + | + | + |

Table - 9: Preliminary Phytochemical Screening of Water Extracts of Plant Wastes of Plants under Investigation (Continued).

| Experiment | Mixture of Date Palm and Banana Leaves (Blades and Petioles) | | Mixture of Date Palm (Leaves) + Banana (Leaves and Peels) | | Mixture of Date Palm (Leaves and Fruits Holders) + Banana (Leaves and Peels) | |
|---|---|---|---|---|---|---|
| | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples |
| 1-Carbohydrates and/or Glycosides | + | + | +++ | ++ | +++ | + |
| 2-Tannins | + | + | +++ | ++ | +++ | + |
| 3-Anthraquinones | + | + | +++ | ++ | +++ | + |
| 4-Sublimation | + | + | +++ | ++ | +++ | + |
| 5-Flavonoids | + | + | +++ | ++ | +++ | + |
| 6-Unsaturated sterols and/or Triterpenoids | + | + | +++ | ++ | +++ | + |
| 7-Alkaloids | + | + | +++ | ++ | +++ | + |
| 8- Saponins | + | + | +++ | ++ | +++ | + |
| 9-Cardiac Glycosides | + | + | +++ | ++ | +++ | + |
| 10-Iridoids | + | + | +++ | ++ | +++ | + |
| 11-Chlorides | + | + | +++ | ++ | +++ | + |
| 12-Sulphates | + | + | +++ | ++ | +++ | + |

Table - 10: Preliminary Phytochemical Screening of Water Extracts of Plant Wastes of Plants under Investigation (Continued).

| Experiment | Mixture of Date Palm (Leaves and Fruits Holders) + Banana (Leaves and Peels)+ Pomgranate Peels | | Mixture of Molokheya (Stems and Roots) | | Mixture of Date Palm (Leaves and Fruits Holders) + Banana (Leaves and Peels) + Pomgranate Peels+ Molokheya (Stems and Roots) | |
|---|---|---|---|---|---|---|
| | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples |
| 1-Carbohydrates and/or Glycosides | + | + | +++ | + | +++ | + |
| 2-Tannins | + | + | +++ | + | +++ | + |
| 3-Anthraquinones | + | + | +++ | + | +++ | + |
| 4-Sublimation | + | + | +++ | + | +++ | + |
| 5-Flavonoids | + | + | +++ | + | +++ | + |
| 6-Unsaturated sterols and/or Triterpenoids | + | + | +++ | + | +++ | + |
| 7-Alkaloids | + | + | +++ | + | +++ | + |
| 8- Saponins | + | + | +++ | + | +++ | + |
| 9-Cardiac Glycosides | + | + | +++ | + | +++ | + |
| 10-Iridoids | + | + | +++ | + | +++ | + |
| 11-Chlorides | + | + | +++ | + | +++ | + |
| 12-Sulphates | + | + | +++ | + | +++ | + |

Table - 11: Preliminary Phytochemical Screening of Water Extracts of Plant Wastes of Plants under Investigation (Continued).

| Experiment | Mixture of Date Palm (Leaves and Fruits Holders) + Banana (Leaves and Peels)+ Pomgranate Peels+ Molokheya (Stems and Roots)+ Corn (Silk and Leaves)+ Eggplants Peels+ Potato Peels | | Mixture of Date Palm (Leaves and Fruits Holders) + Banana (Leaves and Peels) + Pomgranate Peels + Molokheya (Stems and Roots) + Corn (Silk and Leaves) + Eggplants Peels+ Potato Peels + Cantaloupe Peels | |
|---|---|---|---|---|
| | Dry Samples | Fresh Samples | Dry Samples | Fresh Samples |
| 1-Carbohydrates and/or Glycosides | +++ | + | +++ | + |
| 2-Tannins | +++ | + | +++ | + |
| 3-Anthraquinones | +++ | + | +++ | + |
| 4-Sublimation | +++ | + | +++ | + |
| 5-Flavonoids | +++ | + | +++ | + |
| 6-Unsaturated sterols and/or Triterpenoids | +++ | + | +++ | + |
| 7-Alkaloids | +++ | + | +++ | + |
| 8- Saponins | +++ | + | +++ | + |
| 9-Cardiac Glycosides | +++ | + | +++ | + |
| 10-Iridoids | +++ | + | +++ | + |
| 11-Chlorides | +++ | + | +++ | + |
| 12-Sulphates | +++ | + | +++ | + |

**4. Discussion**

Root-knot nematodes (*Meloidogyne spp*.) are among the most polyphagous and damaging genera of plant-parasitic nematodes. In the tropics, significant yield loss has been recorded in tomato due to root-knot nematode damage and, in some cases; the plants die before reaching maturity. The high rate of development and fecundity of these nematode species, make their control difficult (Manneh, *et al.,* 2016).

In many cases, crop losses are reduced by the annual application of expensive and highly toxic soil fumigants or non-fumigant nematicides. These chemicals pose serious health and environmental hazards and therefore, not sustainable. In addition, the economic cost of research and registration of new chemicals are big obstacles for prospective new chemical nematicides to overcome. Also, agrochemical companies are more likely to focus their spending on research into products with a potentially high market-value such as herbicides and insecticides than nematicides. Therefore, many Nematologists are pessimistic about the importance of future chemical management of nematodes. Consequently, several groups of nematologists are trying to develop plant-based chemical products for effective nematode management. Alternative control techniques, such as organic amendment have been used with some success.

The use of organic amendments for management of plant-parasitic nematodes has been demonstrated in a number of studies (Manneh *et al.,* 2016 and Ribeiro and Lima, 2012).

Various naturally occurring plant compounds were tested as components of organic amendments (or biofumigation), as extracts or as standalone substances, in many trails to develop alternatives to traditional nematicides (Ntalli *et al.,* 2017). Many plants have been tested for their nematicidal activities. Using plant extracts for managing nematode pests was used before this study, but using plant wastes considered as a valuable antinematodal tool as they are cheap, ecofriendly and easy to manipulate by many farmers. The addition of organic material to the soil can be an effective alternative to the environmentally unsafe chemical treatments that are used to control plant parasitic nematodes (Marek and Peter, 2015). Some of the fruit peels such as: *Citrus,* Lemmon, Orange, Grapefruit, Banana and Pomegranate peels etc., may use to kill the nematodes (El- Gayed *et al*., 2017, Mercy *et al.*, 2014, Jyotsna *et al*., 2014, Abolusoro *et al.*, 2010, Tsai, 2008 and El-Nuby, 2002).

Our results indicated that, high nematotoxicity were found using water extracts of some tested plant wastes. Fifty five plant wastes belonging to eight plants (Scientific names: *Mosa*

*spp., Punica granatum, Corchorus olitorius, Solanum melongena, Solanum tuberosum, Phoenix dactylifera, Cucumis melo* and *Zea mays*) (English names: Banana, Pomegranates, Molokheya, Eggplants, Potato, Date palm, Cantaloupe and Corn) were tested for their nematicidal activity against root knot nematode juveniles, *Meloidogyne incognita*, under lab conditions, preliminary phytochemical screening were carried out on these samples also. Freshly hatched infected stage juveniles were subjected to water extracts of different fresh (F) and dry samples (D) of plant wastes belonging to the studied plants. results reveled that, all tested extracts possessed nematotoxic effects as they achieved mortality percentage varies between 28,54 to 100%. Twelve extracts showed 100% mortality {1. Molokheya stem D, 2. Eggplant peels D, 3. Potato peels D, 4. Potato peels F, 5. Cantalopue peels D, 6. Cantalopue peels F, 7. Mixture of Molokheya (roots and stems) D, 8. Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders) D, 9. Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders)+Molokheya (roots and stems)+ Corn (silk and leaves)+ Pomegranate peels D, 10., Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders)+Molokheya (roots and stems)+ Corn (silk and leaves)+ Pomegranate peels+ Eggplant peels D, 11. Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders)+Molokheya (roots and stems)+ Corn (silk and leaves)+ Pomegranate peels+ Eggplant peels+ Potato peels D, 12. Mixture of Banana (leaves and peels) +Date Palm (leaves and fruit holders)+Molokheya (roots and stems)+ Corn (silk and leaves)+ Pomegranate peels+ Eggplant peels+ Potato peels + Cantalopue peels F}.

In this regard, another twelve extracts showed 50% mortality and more {1. Date Palm leaves blades D (96.00 %), 2.Date Palm leaves petioles D (94.00 %), 3. Mixture of Banana leaves and peels and Date Palm leaves D (93.00 %),4. Date Palm fruit holders D (85.00%). 5. Banana peels F (78 %), 6. Mixture of Banana leaves and peels and Date Palm leaves F (77.00 %), 7. Banana peels D (74 %), 8. Mixture of Banana (leaves blades, leaves petioles and peels) and Date palm (leaves blades, leaves petioles and fruits holders) and Pomegranate peels and Molokheya (stems and roots) and Corn (silks and leaves) and Eggplant peels D (60.30 %), 9. Corn leaves D (60.00 %), 10. Mixture of Date Palm leaves blades and petioles D (58.00 %), 11. Date Palm fruit holders F (55.00%) and 12. Corn silks D (50.00 %)}.

Preliminary phytochemical screening of water extracts of these studied plant wastes showed very strong relationship between the phytochemical composition and nematicidal activity of these studied extracts. Results revealed that, all studied plant wastes containing carbohydrates and/or glycosides, anthraquinones, flavonoids, tannins, saponins, alkaloids, unsaturated sterols and/or triterpenoids, coumarins, sublimable substances, chlorides, sulphates, iridoids and cardiac glycosides with special reference to samples with high nematicidal activity.

These results offer untraditional nematicidal tool and also clean the environment from unused plant wastes. In vivo evaluation of tested plant wastes is needed to ensure their effects on nematode suppression before the preparation of some formulations for field application.

More investigations on the effects of secondary plant metabolites derived from different plant species and their parts on different plant parasitic nematode species as well as on beneficial soil free living nematodes need to be performed. A better understanding of the interaction between plant parasitic nematodes and plant secondary metabolites could contribute to increase plant defence against nematodes in resistant cultivars. (Marek and Peter , 2015).

## 5. CONCLUSION

Results showed very strong relationship between the phytochemical composition and nematicidal activity of these studied extracts. These results offer untraditional nematicidal tool and also for cleaning the environment from unused plant wastes. *In vivo* evaluation of tested plant wastes is needed to ensure their effects on nematode suppression before the preparation of some formulations for field application.

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